Capital Flows, Cross-Border Banking and Global Liquidity*

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Abstract

We investigate the role of global factors in driving cross-border capital flows. We formulate a model of gross capital flows through the banking sector and derive a closed form solution that highlights the leverage cycle of global banks and its interaction with recipient country characteristics. We test the predictions of our model in a panel study of 46 developed and emerging economies and find empirical support for the key predictions of our model.

JEL codes: F32, F33, F34
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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.

Advanced economies have not been immune to reversals of capital flows. Whereas current account gaps have traditionally been considered as the determinant of capital flows, Obstfeld (2012a, 2012b) has drawn attention to the dramatic increase in gross capital flows that dwarf current account gaps in recent years, concluding 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." (Obstfeld (2012b, p. 3). One reason for the caution is that the growth in gross capital flows was associated with increased leverage, and hence with financial fragility (see Borio and Disyatat (2011) and Gourinchas and Obstfeld (2012)).

The objective of our paper is to formulate a framework for the global factors behind capital flows. We make three main contributions.

First, we construct a model of global banking that builds on recent advances in understanding the banking sector, especially the procyclical nature of bank leverage in which leverage builds up in booms and falls in busts. The general equilibrium framework of Geanakoplos (1997, 2009) and Fostel and Geanakoplos (2008, 2012) has shed light on how the risk bearing capacity of the financial system fluctuates with the procyclical nature of leverage implicit in collateral requirements. Similarly, Gorton (2007, 2009) and Gorton and Metrick (2010) have explored the analogy between classical bank runs where depositors withdraw funds from conventional banks and the modern run in capital markets where runs are driven by increased collateral requirements (increased "haircuts") and hence the reduced capacity to borrow. Adrian and Shin (2010) document the procyclical nature of leverage for US investment banks.

Our model of global banking builds on these earlier insights by combining the procyclicality of leverage with the interaction between local and global banks and the centralized funding and credit allocation decisions of international banks, as extensively documented by Cetorelli and Goldberg (2009, 2010). Thanks to the closed-form solution given by our model, we derive a number of crisp predictions on which global factors will drive capital flows through the banking sector. Our model highlights variables such as the net assets of foreign bank branches in the US vis-à-vis their headquarters, as well as the interactions between bank balance sheet quantities and Value-at-Risk. We also address the key institutional feature of banking sector capital flows where the US saw capital *outflows* through the banking sector during the boom years, which then reversed during the crisis. In addition, our focus is on the variation in leverage as the driver of capital flows rather than changes in net worth.

Our second contribution is to conduct an empirical investigation to see how closely the theoretical predictions are borne out empirically. Our sample is a panel of 46 countries - both advanced and emerging economies with significant and open banking sectors. We find support for the model's prediction that the global factors driving capital flows can be found in the determinants of the balance sheet capacity of international banks. We find that the leverage of market-based financial intermediaries is a key driver of capital flows, confirming our theoretical predictions. In turn, Adrian and Shin (2010, 2012) showed that the bank's Value-at-Risk (a quantile measure of potential losses) is a key determinant of intermediary leverage and that the VIX index of implied volatility of S&P 500 equity index options mirrors banks' Value-at-Risk. A sharp prediction of our model, therefore, is that both the *level* of the VIX (which determines the rate at which one dollar's increase in bank capital is turned into lending) and the *change* in the VIX (which determines the lending based on *existing*, or *infra-marginal* bank capital) should enter as being significant determinants of capital flows. We find that both these predictions receive strong empirical support. Our results therefore shed light both on Forbes and Warnock's (2011) finding of the explanatory power of the VIX index for gross capital flows in surge episodes, as well as the importance of leverage as identified by Gourinchas and Obstfeld (2012). Our framework serves as the common thread that ties together these two strands of the literature.

The third contribution of our paper is to shed light on the impact of currency appreciation on capital flows through the risk-taking behavior of intermediaries. The banks in our model do not have currency mismatch on their balance sheets, but if they lend to borrowers who hold local currency assets funded with US dollars, then exchange rate movements impact the banks' behavior through changes in the credit risk of the borrowers. In particular, our model has the feature that an appreciation shock to the local currency leads to subsequent acceleration of capital inflows. We find that this prediction receives strong support in our empirical investigation.

The role played by the US dollar as the currency that underpins the global banking system suggests that the value of the US dollar may thus be a bellwether for global financial conditions, as recently suggested by Lustig, Roussanov and Verdelhan (2012) and Maggiori (2010). More broadly, the role of the US dollar in the global banking system opens up important questions on the transmission of financial conditions across borders, a phenomenon often referred to as "global liquidity" by commentators and policy makers.[1] In a financial system with interlocking claims and obligations, one party's obligation is another party's asset. When global banks apply more lenient conditions on local banks, the more lenient credit conditions are transmitted to the recipient economy. In this way, more permissive liquidity conditions in the sense of greater availability of credit will be transmitted across borders through the interactions of global and local banks. Our framework suggests a way of identifying and measuring global liquidity in terms of the aggregate cross-border lending through the banking sector.

The outline of the paper is as follows. 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. In Sections 3 and 4, we subject our predictions to an empirical investigation and presents robustness checks on our empirical results, and Section 5 concludes with a discussion of directions for future study.

[1] See the BIS report on global liquidity delivered to the G20, also known as the Landau report (BIS (2011)).

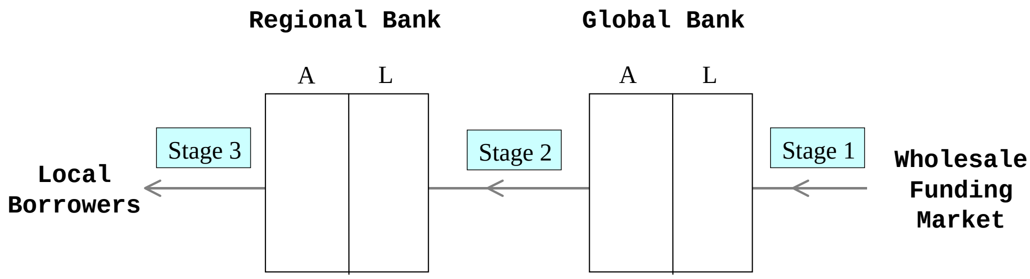

Figure 1. Three stages of cross-border banking sector flows.

2 Model of Bank Capital Flows

2.1 Institutional Background

The structure of the global banking system examined in our paper is sketched in Figure 1. The direction of financial flows goes from right to left, to keep 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 (2009, 2010) 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.[2]

A crucial piece of evidence on the activity of global banks borrowing in financial centers is given in Figure 2, which plots the assets and liabilities of foreign banks in the United States

[2] See also Baba, McCauley and Ramaswamy (2009), McGuire and von Peter (2009), IMF (2011) and Shin (2012), who note that in the run-up to the crisis, roughly 50% of the assets of U.S. prime money market funds were obligations of European banks. The funds channeled by the branch to headquarters (interoffice assets) constitute gross capital outflows from the United States.

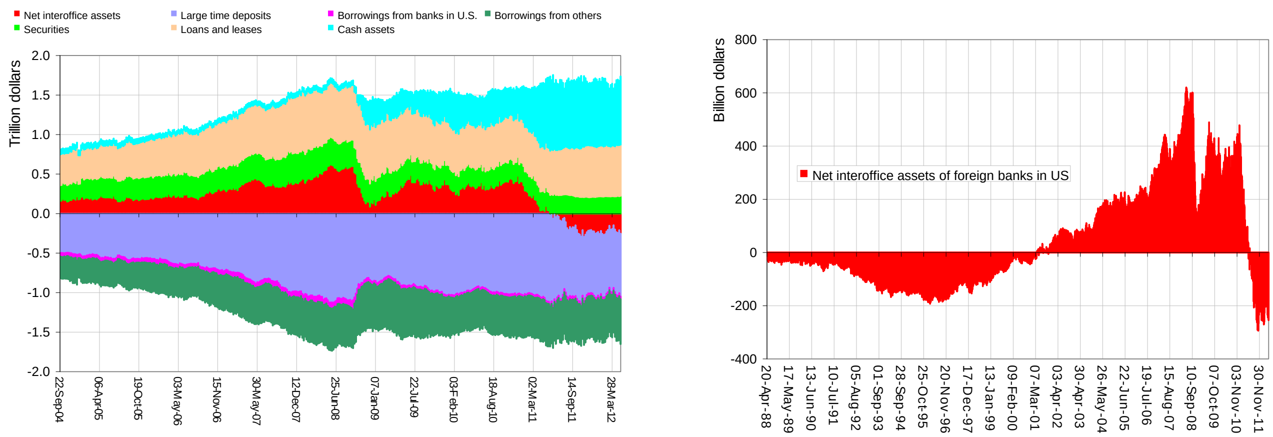

Figure 2. The left hand chart shows the assets and liabilities of foreign bank branches and subsidiaries ("foreign-related institutions") in the US. The right hand chart shows the net interoffice assets of foreign banks in the US on their parent, given by the negative of the "net due to foreign-related offices". (Source: Federal Reserve H8 series)

(left panel) and their "net interoffice assets" (right panel). Net interoffice assets measure the net claim of the branch or subsidiary of the foreign bank on its parent. Normally, net interoffice assets would be negative, as foreign bank branches act as lending outposts by drawing funding from headquarters. However, the decade between 2001 to 2011 was an exceptional period when net interoffice assets of foreign banks in the US turned sharply positive. Net interoffice assets returned to negative territory during the height of the European crisis in 2011. Chudik and Fratzscher (2012) find that the 2007-9 crisis differs from the later 2010-11 crisis in terms of their dynamic properties, reflecting the changed environment after 2011.

In effect, during the decade between 2001 and 2011, foreign bank offices became *funding sources* for the parent, rather than lending outposts. The right hand panel of Figure 2 therefore reflects the extent to which global banks were engaged in supplying US dollar funding to other parts of the world. Shin (2012) shows that the European banks were primarily responsible for the "round trip" capital flows, where deposit funding (including that raised from money market funds) is taken out of the US, only to re-enter the US through the purchase of non-Treasury securities. Our model is designed to capture the capital *outflows* through the intermediary

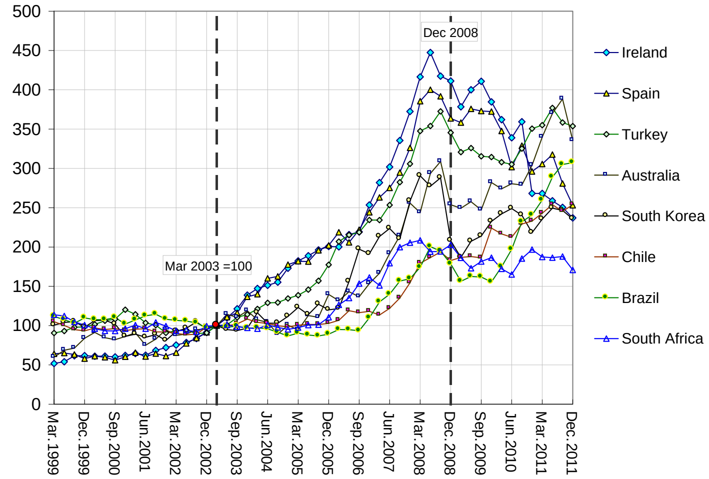

Figure 3. External claims (loans and deposits) of BIS reporting country banks on borrowers in countries listed. The series are normalized to 100 in March 2003 (Source: BIS Locational Banking Statistics, Table 7A)

sector, which then finances US dollar lending elsewhere in the world. 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.

In our empirical investigation below, we will use the growth of the net interoffice assets of foreign banks in the US as a key empirical proxy for the availability of wholesale bank funding. 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 3 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 global factors in the spirit of Calvo, Leiderman and Reinhart (1993, 1996).

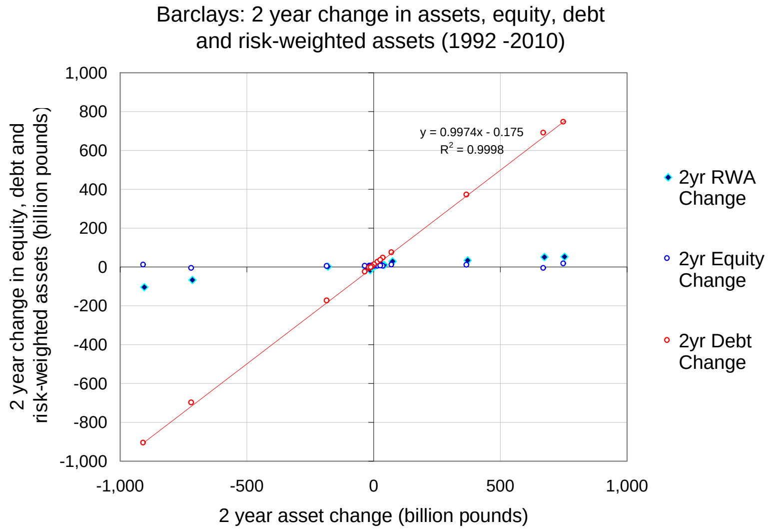

Figure 4. Scatter chart of relationship between the two year change in total assets of Barclays against two-year changes in debt, equity and risk-weighted assets (Source: Bankscope)

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. Figure 4 plots $\{(\Delta A_t, \Delta E_t)\}$, $\{(\Delta A_t, \Delta D_t)\}$ and $\{(\Delta A_t, \Delta \text{RWA}_t)\}$ where ΔA_t is the two-year change in assets, and where ΔE_t, ΔD_t and 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

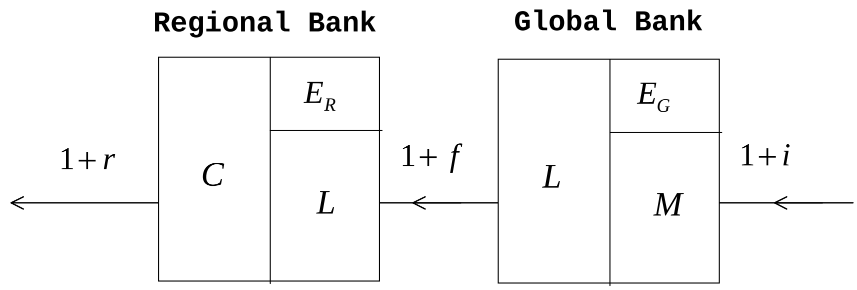

Figure 5. Regional and global bank balance sheets

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. An alternative measure of equity would have been the bank's market capitalization, which gives the market price of its traded shares. However, since our interest is in the portfolio decision of the bank (i.e. its lending decision), book equity is the appropriate notion. In particular, note that market capitalization may differ from the *marked-to-market value of book equity.* The market capitalization reflects discount rates for cash flows to shareholders, as well as the snapshot value of the bank's portfolio. Since our concern is with lending decisions of the banks, we focus on the bank's portfolio, and hence the book value of equity is the appropriate concept when measuring leverage. 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 formal model. We begin by summarizing the notation for cross-border banking in our model, given in Figure 5. The regional banks provide private credit (denoted C) to local borrowers at the rate $1 + r$. This private credit is funded by cross-border liabilities (denoted by L) drawn from the global banks at the funding rate $1 + f$. For the global banks,

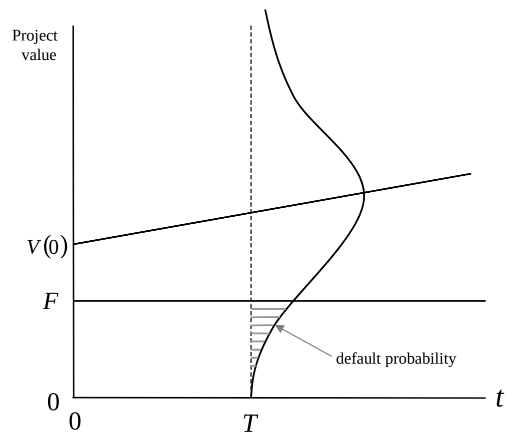

Figure 6. Value of projects of local borrowers and default probability

the cross-border lending L appears on the asset side of the balance sheet, and the funding rate $1+f$ is the rate earned on its assets. The global banks finance themselves by drawing on money market funds M at the interest rate $1+i$. 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 shortly, 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

We first consider the credit supply decision of a regional bank. Each regional bank has a well diversified loan portfolio consisting of loans to many borrowers. Credit risk follows the Vasicek (2002) model, which is based on the well-known Merton (1974) model of credit risk, with the additional feature the bank can diversify across many borrowers. The Vasicek (2002) model has been adopted by the Basel Committee for Banking Supervision as the basis for minimum bank capital requirements (BCBS (2005)).

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

$$\begin{aligned} \text{Prob}\left(V_T < F\right) &= \text{Prob}\left(W_j < -\frac{\ln\left(V_0/F\right) + \left(\mu - \frac{s^2}{2}\right) T}{s\sqrt{T}} \right) &(2) \\ &= \Phi\left(-d_j\right) &(3) \end{aligned}$$

where $\Phi\left(.\right)$ 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.

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

The standard normal W_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:

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

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

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 1) 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 assets at date 1 is the random variable $w(Y)$ defined as:

$$\begin{aligned} w(Y) &\equiv (1+r)C \cdot \Pr(Z_j \geq 0|Y) \\ &= (1+r)C \cdot \Pr\left(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)|Y\right) \\ &= (1+r)C \cdot \Phi\left(\frac{Y\sqrt{\rho}-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \end{aligned} \tag{7}$$

The c.d.f. of the realized value of the loan portfolio at date 1 is given by

$$\begin{aligned} F(z) &= \Pr(w \leq z) \\ &= \Pr\left(Y \leq w^{-1}(z)\right) \\ &= \Phi\left(w^{-1}(z)\right) \qquad (8) \\ &= \Phi\left(\frac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}\left(\frac{z}{(1+r)C}\right)}{\sqrt{\rho}}\right) \qquad (9) \end{aligned}$$

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 realization $1-\varepsilon$.

2.3.2 Value-at-Risk Rule

We now introduce our key behavioral assumption. The bank is risk-neutral, and the bank's objective is to maximize expected profit subject only to its Value-at-Risk constraint that stipulates that the probability of default is no higher than some constant $\alpha > 0$.

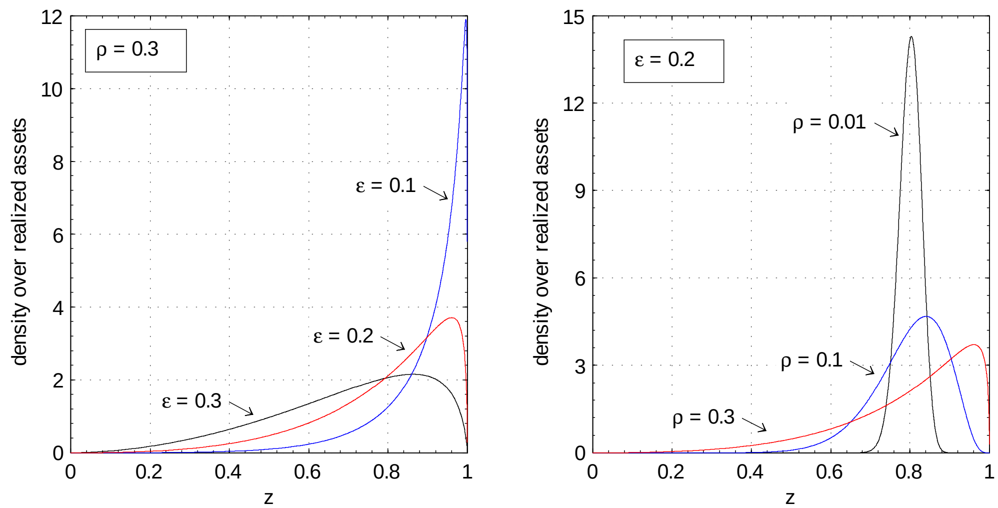

Figure 7. The two charts plot the densities over realized assets when $C(1+r) = 1$. The left hand charts plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies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

The Value-at-Risk (VaR) constraint is well-known from the Basel bank capital regulations. However, our motivation for adopting the VaR constraint is not merely to appeal to the regulatory setting. Instead, our objective is to find a simple behavioral rule that conforms to the twin features that leverage is procyclical, and that fluctuations in leverage are driven by shifts in measured risks. As we see in our empirical section, these two features conform closely to actual behavior of international banks.

The reason for not appealing directly to the regulatory setting is twofold. First, the Basel regulators have motivated their adoption of the VaR rule in terms of following "private sector best practice". In other words, the behavior conforming to the VaR rule is prior to the regulations.

Second, we know from Adrian and Shin (2012) that a contracting model with moral hazard can yield a VaR-type rule as the outcome of the optimal contracting problem, even without any formal regulation imposed from the outside. Under additional assumptions on the parameters of the problem, Adrian and Shin (2012) show that the Value-at-Risk rule is an exact solution to the contracting problem. We will not address here the question of microfoundations or the welfare issues, but merely build on existing work by adopting the Value-at-Risk constraint as a simple modeling assumption that captures the way that banks react to changing perceptions of risk.

The benefit of adopting the VaR rule is that we can obtain simple closed-form solutions that captures the key behavioral trait of procyclical leverage. Therefore, in what follows we assume that the bank follows the Value-at-Risk (VaR) rule of maintaining sufficient equity to limit the insolvency probability to $\alpha > 0$. The bank remains solvent as long as the realized value of $w(Y)$ is above its notional liabilities at date 1. Since the funding rate on liabilities is f, the notional liability of the bank at date 1 is $(1+f)L$. The bank grants private credit C so that its VaR constraint just binds.

$$\Pr\left(w < (1+f)L\right) = \Phi\left(\frac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\,\Phi^{-1}\left(\frac{(1+f)L}{(1+r)C}\right)}{\sqrt{\rho}}\right) = \alpha \tag{10}$$

Re-arranging (10), we can write the ratio of notional liabilities to notional assets as follows.

$$\frac{\text{Notional liabilities}}{\text{Notional assets}} = \frac{(1+f)L}{(1+r)C} = \Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \tag{11}$$

We will use the shorthand:

$$\varphi(\alpha, \varepsilon, \rho) \equiv \Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}(\alpha)-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \tag{12}$$

Clearly, $\varphi \in (0,1)$. From (11) and the balance sheet identity $E_R + L = C$, we can solve for the bank's supply of private credit. When private credit supply is positive, we have

$$C = \frac{E_R}{1 - \frac{1+r}{1+f}\cdot\varphi} \tag{13}$$

Note that C is proportional to the bank's equity E_R, and so (13) also denotes the *aggregate* supply of private credit as a function of the *aggregate* equity of the sector. The leverage of the bank (and the sector) is the ratio of assets to equity, and is

$$\text{Leverage} \ = \frac{1}{1-\frac{1+r}{1+f}\cdot\varphi} \tag{14}$$

On the liabilities side of the balance sheet, the regional bank's demand for cross-border funding L can be solved from (11) and the balance sheet identity $E_R + L = C$.

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

By equating (15) with the supply of loans by the global banks, we can solve for the equilibrium stock of cross-border lending. Thus, we now turn to the lending behavior of global banks.

2.3.3 Global Banks

The behavior of global banks is formalized in terms of a "double-decker" version of the Vasicek model as follows. There are many regions and each global bank has a well-diversified portfolio of cross-border loans to regional banks across many regions. However, the global banks bear global risk that cannot be diversified away. The credit risk structure for global banks is depicted in Figure 8.

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

$$Z_{kj} \equiv -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y_k + \sqrt{1-\rho}X_{kj} \tag{16}$$

where

$$Y_k = \sqrt{\beta}G + \sqrt{1-\beta}R_k \tag{17}$$

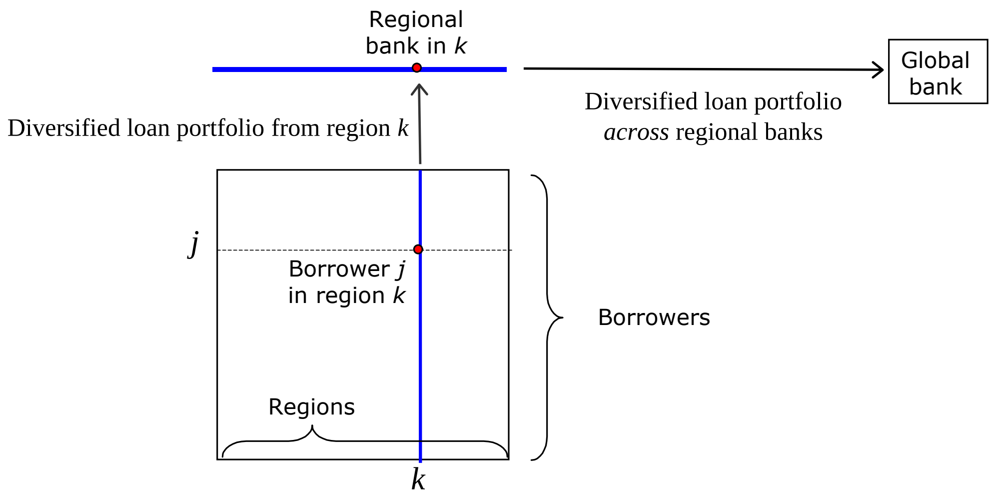

Figure 8. Global and regional banks

In (17), 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 that affects all private credit recipients everywhere. 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 the VaR threshold 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 in the sense that the number of borrower regions becomes large for a fixed size of notional assets. From (9), a regional bank k defaults on its cross-border liability when

$$Y_k < w^{-1}\left(\left(1+f\right)L\right) = \tfrac{1}{\sqrt{\rho}}\left(\Phi^{-1}\left(\varepsilon\right) + \sqrt{1-\rho}\,\Phi^{-1}\left(\varphi\right)\right) \tag{18}$$

where φ is the notional debt/assets ratio given in (12). A regional bank from k defaults when

$\xi_k < 0$, where ξ_k is the random variable:

$$\begin{aligned} \xi_k &\equiv \sqrt{\rho} Y_k - \Phi^{-1}(\varepsilon) - \sqrt{1-\rho}\Phi^{-1}(\varphi) \\ &= \sqrt{\rho\beta} G + \sqrt{\rho(1-\beta)} R_k - \Phi^{-1}(\varepsilon) - \sqrt{1-\rho}\Phi^{-1}(\varphi) \end{aligned} \tag{19}$$

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

$$\begin{aligned} w(G) &= (1+f)L \cdot \Pr(\xi_k \geq 0 | G) \\ &= (1+f)L \cdot \Pr\left(R_k \geq \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho(1-\beta)}} - \sqrt{\tfrac{\beta}{1-\beta}} G \middle| G \right) \\ &= (1+f)L \cdot \Phi\left(\sqrt{\tfrac{\beta}{1-\beta}} G - \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho(1-\beta)}} \right) \end{aligned} \tag{20}$$

The quantiles of the asset realizations follow from the c.d.f. of $w(G)$.

$$\begin{aligned} F(z) &= \Pr(w(G) \leq z) \\ &= \Pr\left(G \leq w^{-1}(z)\right) \\ &= \Phi\left(w^{-1}(z)\right) \end{aligned}$$

where

$$w^{-1}(z) = \sqrt{\tfrac{1-\beta}{\beta}} \left[\Phi^{-1}\left(\tfrac{z}{(1+f)L}\right) + \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho(1-\beta)}} \right] \tag{21}$$

The global bank follows the Value-at-Risk (VaR) rule of keeping enough equity to limit the insolvency probability to $\gamma > 0$. The bank is risk-neutral and aims to maximize expected profit subject to its Value-at-Risk constraint. The bank remains solvent as long as the realized value of assets is above its notional liabilities. The notional liability of the global bank is $(1+i)M$. The probability that its asset realization falls short of this level is set equal to γ. Hence,

$$\begin{aligned} \gamma &= \Pr(w(G) < (1+i)M) \\ &= \Phi\left(\sqrt{\tfrac{1-\beta}{\beta}} \left[\Phi^{-1}\left(\tfrac{(1+i)M}{(1+f)L}\right) + \tfrac{\Phi^{-1}(\varepsilon)+\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho(1-\beta)}} \right] \right) \end{aligned} \tag{22}$$

Re-arranging (22), we can write the ratio of notional liabilities to notional assets of the global bank as:

$$
\begin{aligned}
\frac{\text{Notional liabilities}}{\text{Notional assets}} &= \frac{(1+i)\,M}{(1+f)\,L} \\
&= \Phi\left(\frac{\sqrt{\rho\beta}\Phi^{-1}(\gamma)-\Phi^{-1}(\varepsilon)-\sqrt{1-\rho}\Phi^{-1}(\varphi)}{\sqrt{\rho(1-\beta)}}\right) \qquad (23) \\
&\equiv \psi\left(\beta,\gamma,\varepsilon,\rho\right) \qquad (24)
\end{aligned}
$$

Clearly $\psi \in (0,1)$. From (23) and the balance sheet identity $E_G + M = L$ of the global bank, we can solve for the supply of cross-border lending as

$$L = \frac{E_G}{1 - \frac{1+f}{1+i}\psi} \qquad (25)$$

L is proportional to equity E_G, and so (25) also denotes the *aggregate* supply of cross-border lending as a function of the *aggregate* equity of the global banking sector. The leverage of the global bank (and of the sector) is the ratio of assets to equity:

$$\text{Leverage} = \frac{1}{1 - \frac{1+f}{1+i}\psi} \qquad (26)$$

2.4 Closed-Form Solution

From the demand and supply relationships for L in (15) and (25), we will solve for the equilibrium L and f in closed form. The market clearing condition for L is

$$\frac{E_R}{\frac{1+f}{1+r}\cdot\frac{1}{\varphi}-1} = \frac{E_G}{1-\frac{1+f}{1+i}\psi} \qquad (27)$$

The funding rate f can be solved as

$$1+f = \frac{1}{\mu\frac{1}{(1+r)\varphi} + (1-\mu)\,\frac{\psi}{1+i}} \qquad (28)$$

where

$$\mu = \frac{E_G}{E_G + E_R} \tag{29}$$

We can then solve for the private credit in the regions by substituting (28) into the supply of private credit given by (13), giving the succinct expression:

$$C = \frac{E_G + E_R}{1 - \frac{1+r}{1+i}\varphi\psi} \tag{30}$$

This expression can be written in long hand as:

$$\begin{array}{c}\text{Total private}\\ \text{credit}\end{array} = \frac{\text{Aggregate bank capital (regional + global)}}{1 - \text{ spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{31}$$

The variables φ and ψ can be seen as normalized leverage measures (regional and global) that lie in the unit interval $(0, 1)$.

We now turn to cross-border lending and the consequent capital inflows through the banking sector. Substituting the solution for the funding rate f into (25), we can solve for the equilibrium stock of cross-border lending L as

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

In long hand, we can express equilibrium L as

$$\begin{array}{c}\text{Total cross-}\\ \text{border lending}\end{array} = \frac{\text{Global and weighted regional bank capital}}{1 - \text{ spread} \times \begin{array}{c}\text{regional}\\ \text{leverage}\end{array} \times \begin{array}{c}\text{global}\\ \text{leverage}\end{array}} \tag{33}$$

Thus, the predicted total cross-border lending has qualitatively similar features to the predictions regarding regional private credit. The BIS banking statistics on external claims is our empirical counterpart to L. The important point to note is that cross-border banking sector flows are a combination both of "push" and "pull" factors. The distinction between the demand and supply of wholesale funding harks back to Calvo, Leiderman and Reinhart (1993, 1996), who distinguished the "push" and "pull" factors that drive capital flows into emerging economies. However, although demand and supply factors can be distinguished in theory, the closed form solution in (33) shows that both demand and supply factors enter co-mingled in the closed form solution, making it difficult fully to disentangle the two forces in practice.

2.5 Global Factors in Capital Flows

In preparation for our empirical investigation, we draw implications for global factors that determine capital flows from our closed form solution for L given by (32). Consider the impact on L of shocks to global bank equity E_G and global bank (normalized) leverage ψ. Then, neglecting the interest spread term for notational economy, the comparative statics impact on L can be written as

$$\begin{aligned}\Delta L &\simeq \frac{\partial L}{\partial E_R}\Delta E_G + \frac{\partial L}{\partial \psi}\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + \left(\frac{(1-\varphi\psi)\,E_R\varphi - (E_G + E_R\varphi\psi)(-\varphi)}{(1-\varphi\psi)^2}\right)\Delta\psi \\ &= \frac{1}{1-\varphi\psi}\Delta E_G + C\frac{\varphi}{1-\varphi\psi}\Delta\psi \qquad (34)\end{aligned}$$

where C is private credit in the recipient economy, as given in (30).

The first term in (34) 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 (34) suggests that capital flows are increasing in global bank equity and banking sector leverage.

The second term in (34) 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 summarize the empirical implications of our comparative statics on the global factors as follows.

Empirical Hypothesis. Banking sector capital flows are 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. Our empirical investigation will attempt to find empirical proxies for the global and local variables, and gauge their relative impact. We address measurement issues in our empirical section, and then investigate how well our predictions are borne out in the empirical analysis.

2.6 Effect of Currency Appreciation

A distinctive feature of our model is the impact of currency appreciation on capital flows. When regional banks lend in dollars, but the borrowers holds local currency assets, changes in the exchange rate have an impact on default probability ε, since borrowers with currency mismatch are sensitive to currency movements. Local borrowers could be either household or corporate borrowers. For corporate borrowers, incurring liabilities in foreign currency is one way for exporters to hedge their export receivables, or they may simply engage in outright speculation. For households, mortgage borrowing in foreign currency (Swiss francs and euros) was prevalent in Hungary and other countries in emerging Europe.

Figure 9 illustrates the impact of currency appreciation when borrowers from local banks have a currency mismatch. An appreciation of the local currency results in a decline in the default probability ε due to the greater value of the borrowers assets relative to the dollar debt F. Recall that the normalized leverage φ is a decreasing function of the probability of default ε, given by

$$\varphi(\varepsilon) \equiv \Phi\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha)-\Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \tag{35}$$

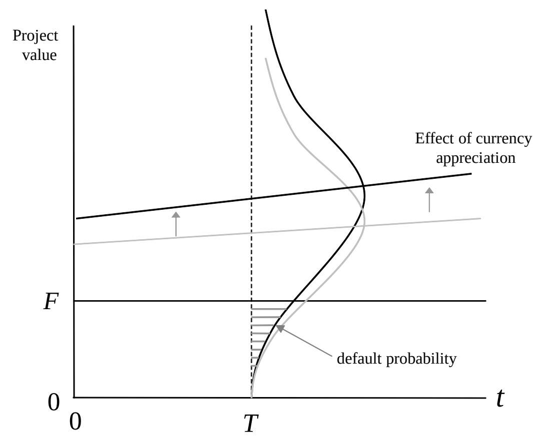

Figure 9. The borrower defaults when asset realization falls short of notional debt F. When the borrower has local currency assets but dollar liabilities, the effect of the local currency appreciation is to shift the outcome density upward, lowering the default probability ε.

An appreciation shock to the local currency lowers the probability of default ε, and thus raises φ. In turn, our closed form solution for L given by

$$L = \frac{E_G + E_R \cdot \frac{1+r}{1+i}\varphi(\varepsilon)\psi}{1 - \frac{1+r}{1+i}\varphi(\varepsilon)\psi} \tag{36}$$

which is an increasing function of φ. Taken together, we have the implication that an *appreciation* shock which leads to a decline in ε results in *greater* cross-border lending.

This result is counterintuitive in that a higher relative price of the local currency increases the capital flows into that country, rather than diminish it. However, the theme of currency appreciation in times of capital inflows is a familiar one from the emerging market crisis literature. Indeed, Calvo, Leiderman and Reinhart (1993) focused on the relationship between capital inflows into Latin America and the appreciation of the capital recipient country currencies. Indeed, we find evidence of precisely such an effect in our empirical section, where past currency appreciation is followed by acceleration of capital inflows.

In general, the impact of capital flows on exchange rates suggests that the role of the US dollar is special given the dollar's status as the currency that underpins the global banking system. Lustig, Roussanov and Verdelhan (2012) find that the US dollar tends to appreciate when US interest rates are low relative to interest rates for other currencies, and coin the concept of the "dollar carry trade". Adrian, Etula and Shin (2009) show that the dollar tends to appreciate when US-dollar based intermediaries are expanding borrowing. Our framework may potentially shed light on both sets of results, since both phenomena are closely linked to the operation of global banks using US dollars. We now turn to our empirical investigation.

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 channel through which global banks channel funds internationally, the criterion for inclusion is whether foreign banks play an economically significant role in the country's financial system. In addition to the banking systems in 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. We use the ranking on foreign banks penetration from Claessens, van Horen, Gurcanlar and Mercado (2008).

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. Table 1 gives the main summary statistics of our sample of 46 countries.

We track the global consequences of the channeling of funds raised in the US through the quarterly growth in external claims of BIS reporting country banks. 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

Table 1. **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						
ΔLoan	Quarter	2944	0.025	0.090	-0.172	0.240
Global Variables						
ΔInteroffice	Quarter	64	0.087	0.515	-1.362	1.908
VIX	Quarter	64	3.045	0.347	2.433	3.787
BD Leverage	Quarter	64	0.203	0.046	0.124	0.304
ΔEquity	Annual	14	0.131	0.219	-0.266	0.697
Local Variables						
ΔRER	Quarter	2942	-0.002	0.068	-0.510	1.030
ΔM2	Annual	532	0.135	0.152	-0.253	1.413
GDP growth	Annual	532	0.080	0.078	-0.208	0.607
Debt to GDP	Annual	532	0.517	0.284	0.067	1.272
Inflation	Annual	532	0.046	0.054	-0.004	0.365
Stock volatility	Annual	465	3.213	0.425	2.195	4.705
Bank ROA	Annual	465	0.007	0.011	-0.041	0.026

appropriate for measuring capital flows in a given period. Our definition of capital flows 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.

3.1 Proxies for Global and Local Factors

Our empirical hypothesis highlights the leverage and (book) equity of global banks that facilitate cross-border bank lending. As discussed in Shin (2012), 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.

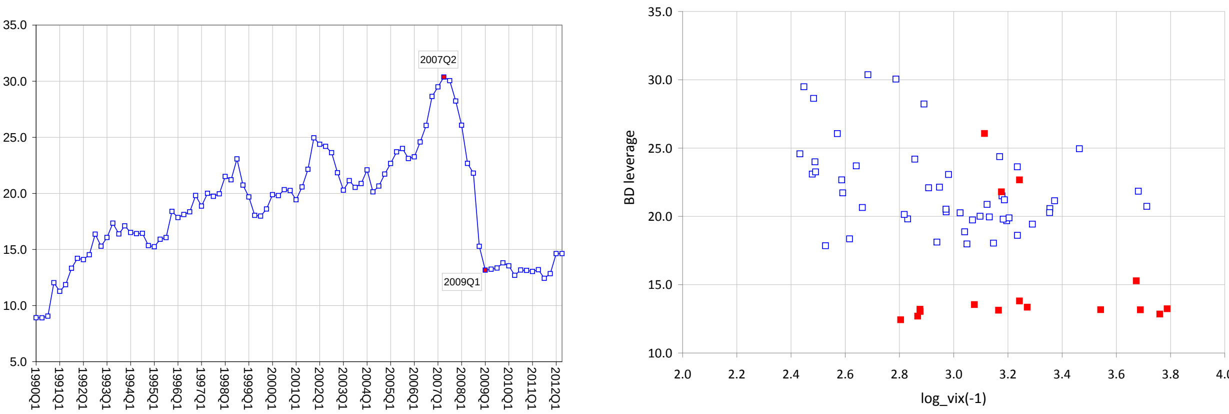

Figure 10. The left panel plots the leverage of the US broker dealer sector from the Federal Reserve's Flow of Funds series. Leverage is defined as (equity + total liabilities)/equity. The right panel plots the scatter chart of US broker dealer leverage against the log VIX index lagged one quarter. The dark shaded squares are the post-crisis observations after 2007Q4 (Source: Federal Reserve and CBOE)

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 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. 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. 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 10 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. In our empirical analysis we normalize the leverage variable by dividing by 100, as shown in Table 1.

Table 2. **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. Column 2 includes the post-crisis dummy that takes the value 1 after 2007Q4 and zero otherwise.

	1	2
VIX(-1)	-0.058***	-0.031***
	[0.000]	[0.008]
Post-crisis dummy		-0.059***
		[0.000]
Constant	0.379***	0.312***
	[0.000]	[0.000]
Observations	64	64
R^2	0.20	0.471
Adjusted R^2	0.187	0.453

The right panel of Figure 10 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 chart adds weight to our theory based on Value-at-Risk constrained banks, and 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 2 presents simple 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. When a post-crisis dummy is included to capture the more subdued leverage of the broker dealer sector after the crisis, the adjusted R^2 is as high as 45%. Thus, Table 2 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 that is readily available at high frequency, and which has also been used by finance researchers for other purposes, thereby helping us to guide more focused investigations that link with finance and asset pricing exercises. It also provides a point of contact with Forbes and Warnock (2012) who have highlighted the explanatory power

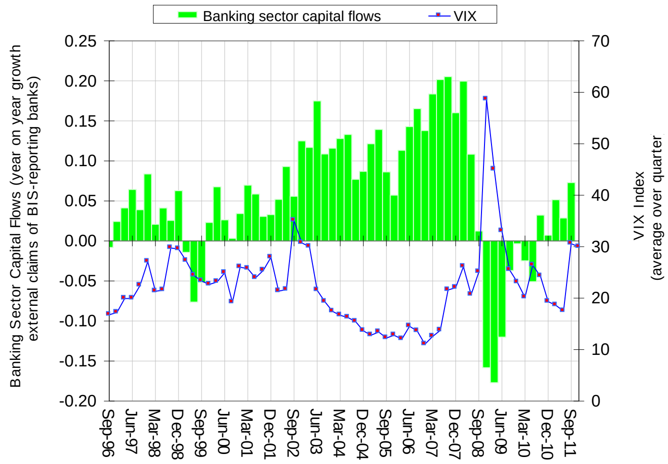

Figure 11. This figure plots cross-border banking sector capital flows as year-on-year growth in external claims of BIS-reporting banks (Table 7A). The VIX series is the quarterly average of CBOE VIX index.

of the VIX index for gross capital flows.

Based on these considerations, we will pursue a two-pronged investigation in our panel regressions. In our first set of panel regressions, we use the broker dealer leverage variable and its interactions as our empirical proxy for the variable ψ, which is our model-based variable of global bank leverage. Then, we use the log VIX index as an alternative empirical proxy for ψ, and compare the results. 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 2 as an explanatory variable and see whether the variable is significant.

The consequence of shifting VIX for capital flows is captured in Figure 11, which shows the fluctuations in gross capital flows in the banking sector from 1996, as measured by the cross-border claims of developed economy banks compiled by the Bank for International Settlements (BIS). Gross banking flows are large when the VIX index is low, but crash when the VIX index spikes with the onset of the financial crisis. And as the acute phase of the crisis passes, gross flows resume once more. The reflected symmetry of the two series is striking.

The other global variable predicted by the theory is the growth in the equity of global banks

(ΔEquity). 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. 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, our use of ΔEquity would be justified. Bankscope has historical banking data from 1997, hence ΔEquity is available since 1998.

We also include several local control variables as possible push and pull factors of capital flows. We include the log real exchange rate (RER), 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).

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. We will see shortly that our prediction is borne out in the data.

GDP growth and Inflation are the country percentage change in GDP and Inflation, respectively, from the previous year (data from the WEO). Debt to GDP is the government gross debt as percentage of the GDP (from WEO). The sample period spans from the first quarter of 1996 (the first date covered in Table 7A of the BIS locational data) or from the first quarter of 1998 (the first ΔEquity available data) to the last quarter of 2011.

We also use two additional country-level variables from the World Bank Database on Financial Development and Structure (updated September 2012): Stock volatility, defined as the (log of) volatility of the 360-day standard deviation of the return on the national stock market index, and Bank ROA, defined as the commercial banks' net income to yearly averaged total assets. However, such additional data are available only until 2010 and on a lower frequency and we therefore use them only in some specifications.

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 is given by (33), and the empirical predictions on capital flows follow from (34). They suggests that leverage should enter both in levels and in changes (both negatively) while the growth in banking sector equity should enter positively. Our panel regressions are on quarterly data with country fixed effects and clustered standard errors at the country level:

$$\begin{aligned}\Delta L_{c,t} &= \beta_0 + \beta_1 \cdot \Delta\text{Interoffice}_{t-1} + \beta_2 \text{BD Leverage}_{t-1} + \beta_3 \cdot \Delta\text{BD Leverage}_t \\ &\quad + \beta_4 \Delta\text{Equity}_t + \text{controls}_{c,t} + e_{c,t} \qquad (37)\end{aligned}$$

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 $t-1$; BD Leverage_{t-1} is the leverage of the broker dealer sector lagged by one quarter; $\Delta\text{Interoffice}_{t-1}$ is the percentage growth in net interoffice assets of foreign banks in the US lagged by one quarter. $\Delta\text{Equity}_{c,t}$ is the growth (log difference) in equity of global banks, not lagged. ΔBD Leverage is the log difference in broker dealer leverage from the previous quarter, not lagged.

Note that we have broker dealer leverage entering both in levels and in changes. 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.

As well as the global variables, we include local variables for each country. We include the lagged change in the exchange rate ΔRER(-1) as suggested by our theory, where RER is the price of the dollar in local currency terms, so that an increase in RER is a depreciation of the local currency. In addition, we include the growth in the M2 money stock, to capture the speculative holding of domestic currency deposits by non-bank borrowers, as well as GDP growth, Debt to GDP ratio and Inflation as a control for local economic conditions. We also include the one year daily historical volatility of the local stock market as our empirical proxy for the (inverse) leverage of the local banks, φ. Local bank equity is proxied by the return on assets (ROA) of the banks in the country. ΔL, ΔInteroffice, Debt/GDP, Inflation, and Bank ROA are winsorized at the 2.5% percentile to limit the effect of the outliers. The annual local variables are all lagged by 4 quarters. 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 (3) is the specification that includes only the global variables. The panel within-R^2 is 11.2% in this specification. In column (2) we note that just the combination of the level of broker dealer leverage and the change in the leverage gives $R^2 = 9.7\%$.

The local variables in Table 3 enter with the predicted signs. The variable RER is the price of dollars in local currency in real terms, so that a fall in RER represents an appreciation of the local currency. The variable ΔRER(-1) is the quarterly log difference of the real exchange rate to the US dollar lagged by one quarter. We see that the coefficient on this variable 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

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 by BIS reporting banks given by BIS Locational Statistics Table 7A. BD Leverage(-1) is the leverage of the US broker dealer sector lagged one quarter. ΔInteroffice(-1) is the quarterly percentage growth in net interoffice assets of foreign banks in the US lagged one quarter. ΔEquity is the change in the dollar value of equity of the top 10 non-US banks from the quarter before (not lagged). ΔBD Leverage is the log difference of BD Leverage from the quarter before (not lagged). ΔRER(-1) is the log difference of the real exchange rate (lagged by one quarter). Other local variables are GDP growth, Debt to GDP ratio, growth of M2 money stock, stock market volatility, bank ROA and Inflation, all measured at the end of the calendar year and lagged by one year. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6
ΔInteroffice(-1)	0.0179***		0.0048			0.0065**
	[0.000]		[0.137]			[0.048]
BD Leverage(-1)		0.5485***	0.5487***			0.4091***
		[0.000]	[0.000]			[0.000]
ΔBD Leverage		0.2067***	0.1900***			0.1793***
		[0.000]	[0.000]			[0.000]
ΔEquity			0.0301***			0.0272***
			[0.002]			[0.004]
ΔRER(-1)				-0.1452***	-0.1502***	-0.0892***
				[0.000]	[0.000]	[0.005]
ΔM2(-4)					0.0586**	0.0421**
					[0.021]	[0.036]
GDP growth(-4)					0.1122*	0.0576
					[0.093]	[0.290]
DEBT/GDP(-4)					-0.0066	-0.0286
					[0.718]	[0.173]
Inflation(-4)					-0.2278**	-0.1755*
					[0.044]	[0.069]
Stock volatility(-4)					-0.0295***	0.0049
					[0.000]	[0.588]
Bank ROA(-4)					1.5050***	1.4313***
					[0.000]	[0.000]
Constant	0.0237***	-0.0855***	-0.0905***	0.0251***	0.1082***	-0.0734*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.060]
Observations	2,944	2,944	2,576	2,942	2,020	2,020
R^2	0.011	0.097	0.112	0.013	0.113	0.176
# countries	46	46	46	46	44	44

the intuition that a higher price should lead to a fall in demand, but which is consistent with the risk-taking channel of capital flows outlined earlier in our paper. In our model, the banks act myopically, constrained only by their Value-at-Risk constraint, and the increase capital inflows reflect additional lending following a decline in measured credit risk.

From columns (4) to (6) of Table 3, we see that the addition of other local variables does not diminish the role of global variables. Higher GDP growth, proxing for high domestic demand conditions, is positively associated with capital flows, whereas the deterioration of lending conditions (higher inflation) 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 outlined above. From columns (5) and (6), we see that our proxy for the growth of local equity - the ROA of the local banks - shows up strongly in the results with the predicted sign, even when the global variables are included. Columns (5) and (6) show that our proxy for the φ variable (the local leverage) given by the one year historical volatility of the local stock index is significant when only local variables are included in the regression (see column (5)), but is driven out when the global variables are included (column (6)). This finding is perhaps not surprising, and suggests that global risk factors that drive leverage are highly correlated with local stock market volatility.

Overall, Table 3 reveals that our theoretical predictions receive broad support in the data, and justify the interpretation of global bank leverage and growth of equity as global factors that drive 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. In this set of panel regressions, we use the (negative of) the VIX index as the proxy for ψ, rather than using broker dealer leverage. Hence, we include the lagged log VIX variable entering both in levels as well as in its quarterly growth. We also include the second-order interaction term between the log VIX variable with ΔEquity. 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, the global variables are listed in the top half of the table, and the local variables listed in the bottom half. We see that the VIX in levels, in its growth ΔVIX and the ΔInteroffice variables 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.

The economic magnitudes are also sizeable. For instance, the coefficient on the VIX level is around 5%. 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 $0.51 \times 0.05 \simeq 0.025$, implying a difference in quarterly flows of 2.5%. When annualized, this translates into a roughly 10% difference. This sizeable impact illustrates well the important role played by measured risks in determining capital flows.

We also note that ΔEquity and its interaction with VIX(-1) also figures prominently in the regressions with the predicted sign. Thus, we verify both the impact of the marginal bank equity that interacts with the level of leverage, as well as the impact of the change in leverage, for the existing *infra-marginal* units of equity. In particular, the significance of the interaction term ΔEquity*VIX(-1) strongly suggests that changing balance sheet capacity of global banks are important determinants of capital flows.

In columns (5) and (6) we add the residual from the OLS regression of BD leverage on lagged log VIX and the post-crisis dummy, as given in column (2) of Table 2. The variable is called "Leverage residual". This residual captures the unexplained portion of BD 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

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. VIX(-1) is the log of the end-quarter VIX index lagged one quarter. ΔInteroffice(-1) is the quarterly log difference in net interoffice assets of foreign banks in the US lagged one quarter. ΔEquity is the change in the dollar value of equity of the top 10 non-US banks from the quarter before (not lagged). ΔVIX is the log difference of VIX from the quarter before (not lagged). Leverage residual is the residual from the OLS regression of BD leverage on lagged log VIX with the post-crisis dummy, as given in column (2) of Table 2. ΔRER(-1) is the log difference of the real exchange rate (lagged by one quarter). Other local variables are GDP growth, Debt to GDP ratio, growth of M2 money stock, stock market volatility, bank ROA and Inflation, all measured at the end of the calendar year and lagged by one year. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6
ΔInteroffice(-1)	0.0126***	0.0140***	0.0113***	0.0120***	0.0097***	0.0109***
	[0.001]	[0.000]	[0.002]	[0.000]	[0.006]	[0.002]
VIX(-1)	-0.0719***	-0.0533***	-0.0491***	-0.0438***	-0.0501***	-0.0455***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ΔVIX	-0.0303***	-0.0214***	-0.0270***	-0.0272***	-0.0300***	-0.0297***
	[0.000]	[0.002]	[0.000]	[0.001]	[0.000]	[0.001]
ΔEquity	-0.0272***	0.3492**	0.2155*	0.1304	0.2023*	0.1285
	[0.002]	[0.013]	[0.068]	[0.204]	[0.082]	[0.210]
ΔEquity∗VIX(-1)		-0.1224***	-0.0755**	-0.0471	-0.0697*	-0.0456
		[0.007]	[0.046]	[0.152]	[0.059]	[0.162]
Leverage Residual					0.1490**	0.1041
					[0.040]	[0.218]
ΔRER(-1)			-0.1264***	-0.1156***	-0.1191***	-0.1098***
			[0.000]	[0.000]	[0.000]	[0.001]
ΔM2(-4)			0.0602***	0.0485**	0.0585***	0.0475**
			[0.007]	[0.021]	[0.007]	[0.021]
GDP growth(-4)			0.2628***	0.1313**	0.2423***	0.1272**
			[0.000]	[0.042]	[0.000]	[0.046]
DEBT/GDP(-4)			-0.0761***	-0.0370*	-0.0685***	-0.0353*
			[0.000]	[0.064]	[0.001]	[0.081]
Inflation(-4)			-0.3526***	-0.1964*	-0.3361***	-0.1944*
			[0.000]	[0.067]	[0.000]	[0.064]
Stock Volatility(-4)				-0.0120*		-0.0076
				[0.091]		[0.295]
Bank ROA(-4)				1.2705***		1.2720***
				[0.000]		[0.000]
Constant	0.2460***	0.1856***	0.2004***	0.1995***	0.1996***	0.1890***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	2,576	2,576	2,300	2,020	2,300	2,020
R^2	0.071	0.076	0.137	0.153	0.139	0.154
# Countries	46	46	46	44	46	44

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 (34) as a package, we conclude that the theoretical predictions receive broad support from both Table 2 and Table 3. As discussed already, global banks reallocate internal funds raised in the US across locations which impacts capital flows. Cetorelli and Goldberg (2009, 2010) 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 of interoffice dynamics by showing the consequences of the internal capital market reallocations on aggregate outcomes and the global nature of the bank leverage channel.

4.3 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 Bond (1991), making good use of our panel structure.

Specifically, we investigate the dynamic system GMM that uses a stacked system consisting of both first-differenced and level equations. We select the lag length of the endogenous variables to use as instruments in order to satisfy the AR(1) and AR(2) tests of autocorrelation in the residuals and the Hensen J-statistic for exogeneity. If the assumptions of our specification are valid, by construction the residuals in first differences (AR(1)) should be correlated, but there should be no serial correlation in second differences (AR(2)). At the same time we need to use a parsimonious number of lags to maintain the efficiency of the system. The rule of thumb is to keep the number of instruments less than or equal to the number of groups. This represent an empirical trade-off. Given that our regressors are already lagged by at least a quarter in the original specification, we start using the second lag as an instrument.

Table 5. **Testing for endogeneity.** This table presents results for tests for endogeneity by using the dynamic panel GMM methods of Arellano and Bond (1991). The dynamic system GMM uses a stacked system consisting of both first-differenced and level equations. The p-values for the AR(1) and AR(2) tests of autocorrelation in the residuals and the Hansen J-statistic for exogeneity are presented at the foot of the table. The tests indicate that the residuals in first differences (AR(1)) are correlated, but there is no serial correlation in second differences (AR(2)).

	1	2
ΔInteroffice(-1)	0.0306***	0.0297***
	[0.000]	[0.000]
BD Leverage(-1)	0.6244***	
	[0.000]	
VIX(-1)		-0.0519***
		[0.001]
ΔBD Leverage	0.0064	
	[0.901]	
ΔVIX		0.0025
		[0.888]
ΔEquity	0.0525**	0.0632***
	[0.044]	[0.009]
ΔL(-1)	0.2134	-0.068
	[0.323]	[0.709]
Constant	-0.1297***	0.2435***
	[0.005]	[0.001]
Country controls	Y	Y
Observations	2,300	2,300
# countries	46	46
AR(1) p-value	0.004	0.015
AR(2) p-value	0.25	0.74
Hansen test p-value	0.132	0.239

Our assumption in the system GMM regression is that all the regressors - both global variables (ΔInteroffice, BD Leverage, VIX and ΔEquity) and local variables (RER, GDP growth, Debt to GDP, Inflation and M2) - are endogenous. In the regression specification given by (37) where BD leverage is used as regressor, the second and third lags of the endogenous variables complies with the above mentioned tests. In contrast, in the specification when VIX is used as regressor the second lag is always associated with second order serial correlation no matter how many additional lags we use. We therefore use the third, fourth and fifth lag of the endogenous variables which allow us not to reject the null hypothesis of no second-order autocorrelation. We use a robust two-step estimation, where the standard covariance matrix is robust to panel specific autocorrelation and heteroskedasticity and finite-sample corrected. The dynamic model also includes a lag of ΔLoan (our dependent variable) as an explanatory variable.

Table 5 shows that all our global variables remain significant, therefore giving some reassurance against potential endogeneity undermining our conclusions. The only slight disappointment is the change in VIX and the change in the BD leverage, both of which lose significance. One reason for loss of significance may be that in the system GMM estimation the VIX and the BD leverage are first-differenced and then used as instruments in the same system of equations with ΔVIX and ΔBD Leverage. The AR(2) tests yield p-values of 0.25 and 0.74 respectively, depending on whether we use BD Leverage (in column (1)) or VIX (in column (2)). From our results we conclude that we cannot reject the null hypothesis of no second-order serial correlation in both specifications. The results also reveal Hansen J-statistics with p-values of 0.13 and 0.24, so that we cannot reject the hypothesis that our instruments are valid. 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.

4.4 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 leverage and the VIX index play the role of global factors, we now go one step further and attempt to address the quantitative question of how much our global variables account for some hypothetical totality of global factors.

To address our question, we follow a method used 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. Using this method, they find that observable firm characteristics have very limited explanatory power, and that country observable characteristics explain much more of the variation.

In our context, the appropriate comparison is between our favored specification using our global variables with the specification using time dummies together with local variables only that provide the theoretical upper bound on the goodness of fit from all potential global variables. By comparing the relative size of the R^2 between our favored specification and the one using time dummies and local variables only, we can proceed in the same spirit as in Doidge, Karolyi Stulz (2007) and derive results that may be interpreted similarly as ascertaining the proportion of total global variation that can be explained by our global variables.

We implement such a procedure by re-running our regressions reported in Table 3 using the broker dealer leverage variable, where we include time dummies, with or without local and global variables. Table 6 reports the adjusted R-squared statistics obtained from OLS estimations of our specification (37) with BD leverage.. In Panel A, we report the results for the full sample. In column (3), we see that local variables alone explain 8.5% of the variation, while in column (2), we see that global variables alone explain 11.5%.

Column (4) is our main specification where both local and global variables enter, and the

Table 6. **Accounting for global factors.** This table compares the adjusted R-squared statistics obtained from OLS regressions with time dummies, global variables (ΔInteroffice, Leverage, ΔLeverage and ΔEquity), and local variables (GDP growth, Debt/GDP, Inflation, and ΔM2). Panel A is for the full sample of countries. Panels B is for the sample with large foreign bank presence and Panel C is for low foreign bank presence. See text for definitions.

	1	2	3	4	5
Panel A: All sample					
Time dummies	Y				Y
Global variables		Y		Y	
Local variables			Y	Y	Y
Adjusted R-squared	0.221	0.115	0.0852	0.154	0.269
Observations	2,300	2,300	2,300	2,300	2,300
Panel B: High foreign bank presence					
Time dummies	Y				Y
Global variables		Y		Y	
Local variables			Y	Y	Y
Adjusted R-squared	0.3	0.165	0.136	0.205	0.36
Observations	952	952	952	952	952
Panel C: Low foreign bank presence					
Time dummies	Y				Y
Global variables		Y		Y	
Local variables			Y	Y	Y
Adjusted R-squared	0.193	0.101	0.0554	0.136	0.231
Observations	1,348	1,348	1,348	1,348	1,348

adjusted R^2 is 15.4%. We compare this with column (5), which is the specification with time dummies and local variables only. Column (5) therefore corresponds to a flexible specification where the time dummies measure all global factors, and hence its R^2 is taken to be the hypothetical upper bound for a model that has all global factors. We see from column (5) that the adjusted R^2 is 26.9%. Thus, comparing the ratio of the adjusted R^2 between columns (4) and (5), we conclude that our global variables (ΔInteroffice, broker dealer leverage in levels and growth rates and global bank equity) account for 0.154/0.269 = 57.2% of the total global variation.

Alternatively, we could base our comparison between columns (1) and (2) in Table 6 that does not include any of the local variables. In such a comparison, our global variables account for 11.5% of the variation while the specification with the time dummies account for 22.1%, giving us the ratio of adjusted R^2 numbers of 0.115/0.221 = 52%.

In Table 6, we extend our analysis by exploring the extent to which the openness of the banking sector influences our results. We use the database on foreign bank presence due to Claessens, van Horen, Gurcanlar and Mercado (2008), and partition the countries in our sample into those countries where more than 50% of the banking assets are those of foreign banks and those with less than 50% of banking sector assets being those of foreign banks. Panel B presents the accounting exercise for global factors when using the subsample of open banking sector countries, while Panel C presents results of the accounting exercise using the sample of countries with less open banking sectors. Our results reveal that our favored global factors account for a much larger proportion of the variation for the sample of open banking sector countries than for the less open banking sector countries. The inclusion of country dummies or of additional local variables do not alter the main conclusions.

4.5 Crisis Dummy

We now ask to what extent are our empirical results are driven by the crisis period. We use the NBER business cycle dating scheme[3] to define the crisis period as from December 2007 to June

[3] http://www.nber.org/cycles.html

2009. We construct a dummy variable *Crisis* equal to 1 for the quarters during this period and 0 otherwise. The results are presented in Table 7.

In Table 4, Column (1) shows that the crisis period is caracterized by a reversal of banking sector capital flows. However, the dummy *Crisis* becomes insignificant when added to our main specification with either BD Leverage or the VIX variables, with the preceding evidence remaining unchanged (columns (2) and (3)). We then interact our dummy variable *Crisis* with ΔInteroffice (columns (4) and (5)), BD leverage (column (6)) and the VIX (column (7)). Such interaction term captures the incremental effect of the global variables during the financial crisis with respect to the non-crisis period, whereas the coefficient of the global variable by itself captures the total effect during the non-crisis period. All the specifications include the usual country-level control variables (ΔM2, GDP growth, Debt/GDP and Inflation). The results are unchanged with the additional variable ROA and Volatility.

The coefficient of the interaction term ΔInteroffice$*$Crisis is positive and significant, indicating a significant (at the 1%) incremental effect during the crisis period and demonstrating that the impact of the interoffice variable is amplified during the crisis. ΔInteroffice (by itself) remains positive and significant when included in the specification with the VIX, confirming the role of global funding also in non crisis periods.

The BD Leverage variable by itself remains positive and significant at 1% in all periods, with a negative incremental effect at the 10.2% level during the crisis period and with a total effect given by the sum of the coefficients $(0.413 - 0.0682)$ still positive and significant during the crisis period (F-value= 19.16, p=0.000). This result suggests that the predictive role of the BD Leverage variable does not disappear when confining attention to non-crisis periods, with a slightly attenuated effect during the crisis period following the deleveraging of global banks.

A similar pattern occurs for the VIX variable. The VIX variable by itself remains negative and significant at 1% in all periods, with a significant (negative) incremental effect during the crisis period. This result confirms the predictive role of the VIX variable during the non-crisis periods. However, we also verify the additional kick given by crisis periods, demonstrating that the impact of the VIX is amplified during the crisis period.

Table 7. **Crisis dummy.** This table summarizes the robustness check regressions for banking sector capital flows by means of a crisis period dummy. See text for explanation of methodology. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6	7
ΔInteroffice(-1)		0.0058*	0.0110***	0.0021	0.0083**	0.0067*	0.0142***
		[0.083]	[0.003]	[0.544]	[0.032]	[0.051]	[0.000]
ΔInteroffice(-1)∗Crisis				0.0267***	0.0205***		
				[0.000]	[0.009]		
BD Leverage(-1)		0.4222***		0.4516***		0.4130***	
		[0.000]		[0.000]		[0.000]	
BD Leverage(-1)∗Crisis						-0.0682	
						[0.102]	
ΔBD Leverage		0.1669***		0.1508***		0.1588***	
		[0.000]		[0.000]		[0.000]	
VIX(-1)			-0.0540***		-0.0545***		-0.0456***
			[0.000]		[0.000]		[0.000]
VIX(-1)∗Crisis							-0.0120***
							[0.000]
ΔVIX			-0.0306***		-0.0292***		-0.0274***
			[0.000]		[0.000]		[0.000]
ΔEquity		0.0313***	0.2352*	0.0302***	0.2532**	0.0309***	0.2008*
		[0.001]	[0.054]	[0.001]	[0.038]	[0.001]	[0.097]
ΔEquity * VIX(-1)			-0.0835**		-0.0903**		-0.0687*
			[0.034]		[0.022]		[0.078]
ΔRER(-1)		-0.1065***	-0.1274***	-0.0973***	-0.1198***	-0.1106***	-0.1291***
		[0.001]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]
Crisis	-0.0110**	-0.0037	0.0109	-0.0083	0.0099	0.0075	0.0406***
	[0.042]	[0.527]	[0.108]	[0.161]	[0.146]	[0.405]	[0.000]
Constant	0.0265***	-0.0373**	0.2121***	-0.0440***	0.2128***	-0.0344**	0.1895***
	[0.000]	[0.024]	[0.000]	[0.009]	[0.000]	[0.037]	[0.000]
Country controls	Y	Y	Y	Y	Y	Y	Y
Observations	2,944	2,300	2,300	2,300	2,300	2,300	2,300
R^2	0.002	0.154	0.138	0.157	0.14	0.155	0.144
# countries	46	46	46	46	46	46	46

Overall, this evidence is consistent with the findings in De Haas and Van Horen (2012), who find that during crisis banks curtail lending abroad, and with the findings in Cetorelli and Goldberg (2010), who find that during crisis lenders depending on US dollar funding curtailed cross-border lending. Our results show that the cross-border lending reduction happened through the de-leveraging channel of global banks.

In additional regressions (not reported) we also included individual country bank crisis dummies, for each year in which a country experiences a banking sector crisis as classified by Laeven and Valencia (2010), and we verified that the individual country banking crisis dummy has a negative effect on banking flows but this does not alter the role of our global variables.

4.6 Developing Country Dummy

We now address whether our results vary systematically between developed and developing countries. Table 8 presents the results of a robustness analysis using a developing country dummy. We create a dummy *Developing* which is equal to 1 when a country is a developing economy, and 0 otherwise.[4] We then interact the dummy *Developing* with ΔInteroffice, BD Leverage and VIX.

In Table 8, we can interpret the coefficient of the global variables by themselves as their effect on cross-border banking in developed countries, whereas the interaction term between the developing country dummy and the global variable gives the *incremental* impact of global variables on emerging economies.

Looking across the columns of Table 8, we see that ΔInteroffice, BD leverage and VIX by themselves are significant in all the specifications, while their interaction terms with the dummy *Developing* 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.

[4]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.

Table 8. **Developing country dummy.** This table summarizes the robustness check regressions for banking sector capital flows by means of a developing country dummy. See text for explanation of methodology. p-values are reported in parantheses. Standard errors are clustered at the country level.

	1	2	3	4	5	6
ΔInteroffice(-1)	0.0082*	0.0134***	0.0056*	0.0113***	0.0058*	0.0121***
	[0.057]	[0.002]	[0.091]	[0.002]	[0.089]	[0.001]
ΔInteroffice(-1)∗Developing	-0.0056	-0.0047				
	[0.418]	[0.478]				
BD Leverage(-1)	0.4211***		0.3709***		0.4212***	
	[0.000]		[0.000]		[0.000]	
BD Leverage(-1)∗Developing			0.1151			
			[0.329]			
VIX(-1)		-0.0490***		-0.0475***		-0.0479***
		[0.000]		[0.000]		[0.000]
VIX(-1)∗Developing				-0.0039		
				[0.692]		
ΔBD Leverage	0.1760***		0.1772***		0.1760***	
	[0.000]		[0.000]		[0.000]	
ΔVIX		-0.0270***		-0.0270***		-0.0258***
		[0.000]		[0.000]		[0.001]
ΔEquity	0.0310***	0.2159*	0.0308***	0.2159*	0.0267***	0.2039*
	[0.001]	[0.067]	[0.001]	[0.068]	[0.003]	[0.099]
ΔEquity*VIX (-1)		-0.0756**		-0.0756**		-0.0731*
		[0.045]		[0.046]		[0.065]
Capital regulatory index					0.0013	0.0011
					[0.290]	[0.407]
Constant	-0.0388**	0.1997***	-0.0358**	0.2009***	-0.0609***	0.1695***
	[0.015]	[0.000]	[0.024]	[0.000]	[0.000]	[0.000]
Country fixed effects	Y	Y	Y	Y	Y	Y
Observations	2,300	2,300	2,300	2,300	2,200	2,200
R^2	0.154	0.137	0.155	0.137	0.148	0.129
# Countries	46	46	46	46	46	46

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. Columns (5) and (6) show that the earlier evidence remains unchanged.

In untabulated regressions we also add additional control variables, like the Chinn-Ito Index measuring a country's degree of capital account openness, or the share of foreign bank assets to the total country bank assets to control for foreign banks penetration. The previous results remain unchanged.

5 Extensions and Further Research

The evidence in our paper suggests that the driving force behind banking sector capital flows is the leverage cycle of the global banks. Furthermore, credit growth in the recipient economy is explained, in part, by the fluctuations in global liquidity that follow the leverage cycle of the global banks. 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 determing financial conditions. The current account and net external asset positions of countries are clearly important for assessing the long-run sustainability of the current account (see Hau and Rey (2011), Lane and Milesi-Ferretti (2007) and Gourinchas and Rey (2007) and the post-crisis updated evidence in Gourinchas, Govillot and Rey (2010) and Gourinchas, Rey and Truempler (2011)). Nevertheless, gross flows, and in particular measures of banking sector liabilities may hold important information for risk premiums and hence financial sector vulnerability.[5]

For the European financial crisis, the important distinction is less between net and gross flows, but instead whether the flows have been financed by the banking sector or through some other channel. In practice, the credit boom in countries such as Ireland and Spain were financed primarily through the banking sector (see Allen, Beck, Carletti, Lane, Schoenmaker and Wagner (2011) and Lane and Pels (2011)). Therefore, the mechanisms outlined here on the link between capital flows and leverage are relevant in understanding the European crisis.

Our findings highlight the role of financial intermediaries in driving fluctuations in risk premiums and financial conditions, especially in connection with the growing use of wholesale bank funding. When credit is growing rapidly, the core funding such as household deposits available to the banking sector is likely to be insufficient to finance the rapid growth in new lending. Other sources of wholesale (or "non-core") funding is then tapped to finance bank lending. Global 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. 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 evidence in our paper suggests that the driving force behind banking sector capital flows is the leverage cycle of the global banks. Furthermore, credit growth in the recipient economy is explained, in part, by the fluctuations in global liquidity that follow the leverage cycle of the global banks. Our findings reinforce the argument in Borio and Disyatat (2011) and Obstfeld (2012a, 2012b) on the importance of *gross* capital flows between countries in determing financial conditions, rather than *net* flows. Gross flows, and in particular measures of banking sector liabilities should be an important source of information for risk premiums and hence financial sector vulnerability.[6]

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

[6] See Shin and Shin (2010) and Hahm, Shin and Shin (2011) for empirical analyses of this issue.

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