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Bank Funding Constraints and International Shock Transmission

during the 2007-09 Crisis

By Ralph De Haas and Neeltje Van Horen[*]

After Lehman Brothers filed for bankruptcy on September 15th 2008, international bank lending contracted sharply. While cross-border credit declined by 58 per cent *on average*, the magnitude of the decline varied considerably between destination countries. Why? Disparities in the adjustment of economic activity and credit demand likely played a role but a curtailment of the *supply* of international lending may have contributed too. Balance-sheet shocks may have forced banks to deleverage abroad, transmitting the crisis across borders and potentially exacerbating output declines in destination countries.

We use loan- and bank-level data to examine whether balance-sheet constraints caused international banks to reduce their foreign lending during the crisis. Specifically, we analyze the impact of shocks to banks' bond funding and capital base. Existing empirical work has instead mainly focused on shocks to short-term bank funding; perhaps not surprising as various bouts and types of illiquidity were emblematic of the crisis.[1]

Evidence suggests that liquidity shortages indeed constrained bank lending. Ivashina and Scharfstein (2010) find that U.S. banks that depended more on wholesale funding before the

[1] See Gorton and Metrick (2010) on inter-bank lending and repos, Kacperczyk and Schnabl (2010) on Asset-Backed Commercial Paper (ABCP), and Brunnermeier (2009) on illiquidity in general.

crisis, and were more exposed to credit lines being drawn down during the crisis, cut domestic lending more. Raddatz (2010) shows how banks that relied more on wholesale and less on deposit funding experienced sharper stock-price declines and reduced lending more. Cetorelli and Goldberg (2011a) show how banking systems' that were dependent on short-term U.S. dollar funding curtailed cross-border lending. Lastly, Cetorelli and Goldberg (2011b) find that U.S. banks with high pre-crisis ABCP exposures became more constrained when related off-balance sheet commitments had to be taken on-balance sheet. Such balance-sheet constraints also affected their foreign affiliates.

The crisis was also characterized by shocks to banks' access to long-term debt and equity. Losses on real estate and structured products have been substantial, with write-offs between mid-2007 and end-2010 estimated at USD 2.2 trillion (IMF, 2010). These numbers mask substantial heterogeneity in banks' losses on sub-prime assets. Similar differences exist as regards the amount of maturing bonds that banks had to roll over during the crisis.

The evidence on how lending reacted to banks' problems with rolling over bonds, to the depletion of their capital, and to pressure on their stock prices is scarce and fragmented. Puri, Rocholl, and Steffen (2011) find that German Landesbanken with (indirect) exposures to U.S. sub-prime assets reduced domestic retail credit more than unaffected banks. Barajas et al. (2010) suggest that capital and not liquidity was the main constraint on domestic lending by large U.S. banks during the crisis. To the best of our knowledge, the only paper that addresses the impact of capital constraints on *cross-border* lending is Popov and Udell (2010). They provide indirect evidence that Western European banks with low capital ratios and high losses on financial assets reduced the credit supply of their Eastern European subsidiaries during the early stages of the crisis.

We contribute to this literature by using a dataset on lending by 75 banks from 20 countries to 59 destination countries. We exploit detailed data on the underlying deals and

bank-specific shocks to capital and long-term funding. This allows us to assess how and to what extent funding shocks contributed to the sharp curtailment of cross-border credit after the demise of Lehman Brothers.

I. Data and Methodology

A. *Data*

To develop an identification strategy that isolates the causal impact of funding shocks on cross-border lending, we need detailed data that cover lending to various countries by individual banks (to exploit within-bank variation) and lending by various banks to individual countries (to control for credit demand at the country level). Data ideally also contain the individual deals that underlie these credit flows. We use information on cross-border syndicated bank lending that fulfils these requirements.

Syndicates – groups of financial institutions that jointly provide large loans to firms – are one of the main channels of cross-border debt finance to developed countries and emerging markets. Balance-sheet constraints may have become particularly binding in this market as the secondary market for syndicated loans, which depended on the structuring of collateralized loan obligations, dried up during the crisis. Banks that wanted to remain active in syndications now had to keep loans on their own balance sheet.

Our data source is Dealogic Loan Analytics from which we download all syndicated loans to private borrowers worldwide during January 2000-September 2009. We split each loan into the portions provided by the syndicate members and use these portions to reconstruct for each bank the volume and country distribution of its cross-border lending.[2] We focus on the 75 largest banks from high-income countries which jointly have a share of

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[2] See De Haas and Van Horen (2011) for more detailed information about data construction.

over 90 per cent of the cross-border syndications market. For each bank we calculate cross-border lending to individual destination countries in the pre-crisis period (July 2006-June 2007) and the period after the Lehman Brothers collapse (October 2008-September 2009). We disregard the period July 2007-September 2008, i.e. the early stage of the crisis.

In addition, we create three bank-level funding-shock measures. First, we use the WDCI (Write Down vs. Capital Infusion) function that Bloomberg introduced during the crisis to provide information about crisis-related asset write-downs and credit losses. WDCI includes, inter alia, losses related to sub-prime mortgages, structured finance products, credit-defaults swaps, and exposure to monolines. Losses due to regular operating activities are excluded to the extent they can be segregated from investments in sub-prime assets.

For each bank we calculate the log of crisis-related write-downs during Q2 2007-Q2 2008 (*Write-downs*). Write-downs were unexpected, recorded before the Lehman Brothers bankruptcy, and pertained mainly to mortgage and real estate portfolios. For these reasons we treat *Write-downs* as exogenous to lending to foreign firms after the Lehman Brothers default. We expect that in the presence of minimum capital requirements large unexpected write-downs limit subsequent lending if these requirements are binding (Peek and Rosengren, 1995) or are expected to become binding (Chami and Cosimano, 2010).

Second, we use Thomson Financial to calculate for each bank the (log) amount of bonds that were issued *before* the crisis and that matured *during* the post-Lehman Brothers period (Q3 2008-Q2 2009). Banks with maturing loans were more constrained compared to otherwise similar banks that had rolled-over their long-term debt just before the crisis. As banks made decisions about bond issues before the onset of the crisis, the variable *Maturing bonds* is exogenous to the crisis period (see Almeida et al. 2011).

Third, we use Bloomberg to calculate the log change in the ratio between the market and book value of each bank's equity over the pre-crisis period July 2007-September 2008.

Changes in stock-market valuation during the first stage of the crisis influenced the prospective costs and ease of raising new equity. We therefore use *ΔMarket-to-book* as a third proxy for funding constraints after Lehman Brothers' downfall.

B. *Methodology*

We compare, in a cross-sectional setting, a bank's lending volume in the year after the Lehman-Brothers collapse to its lending in the year before the crisis. We use two dependent variables. The first is *Sudden stop*, a dummy variable that is 1 for each bank-country pair where a bank completely stopped lending during the crisis (but where it was active before). The second – *Volume* – is the log difference of (1 plus) the amount of cross-border lending by a bank to a country between the post-Lehman Brothers and the pre-crisis period.

We then test whether these changes in the supply of cross-border lending can be explained by the exogenous funding shocks *Write-downs*, *Maturing bonds*, and *ΔMarket-to-book*.[3] We use country-fixed effects to focus on differences *across* banks *within* the same destination country. This allows us to control for changes in credit demand at the country level. This approach is based on Khwaja and Mian (2008), who control for credit demand through firm-fixed effects in regressions on a dataset of firms borrowing from multiple banks. We also control for pre-crisis bank characteristics which are measured at end-2006 and based on BankScope data: size (log assets), solvency (equity/assets), wholesale funding (loans/deposits), profitability (return on assets), and loan quality (loan-loss reserves/assets).

In all regressions we also include three variables at the level of bank-country pairs that measure how 'close' banks are to firms in various destination countries (see De Haas and Van Horen, 2011). The first such variable is the geographical *Distance* (in log kilometres) between a bank's headquarters and a country of operation. Second, *Experience* is the log of

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[3] The three funding measures are not highly correlated, with pair-wise correlation coefficients of 0.3 or less.

the number of syndicated loans that a bank provided to a country since 2000 and that had matured by July 2006. Third, we count for each bank and each destination country the number of domestic banks with which it cooperated in a syndicate since 2000. We divide this by the total number of domestic banks in a country to create the variable *Domestic lenders*. We expect that banks that are geographically close to their borrowers, that built up pre-crisis experience in a country, and that cooperated with local banks were relatively stable cross-border lenders during the crisis. Summarizing, our cross-sectional baseline specification is:

(1) $$\Delta L_{ij} = \beta_1 \cdot F_i + \lambda' \cdot X_i + \gamma' \cdot C_{ij} + \varphi_j + \eta_{ij}$$

where ΔL_{ij} is *Sudden stop* or *Volume* and subscripts i and j denote banks and destination countries, respectively; β_1 is a coefficient; λ' and γ' are coefficient vectors; F_i is a funding-shock variable; X_i is a matrix of bank-level controls; C_{ij} is a matrix of closeness variables; φ_j is a vector of country-fixed effect coefficients, and η_{ij} is the error term.

We also estimate *firm-level* regressions on a sample of firms that before the crisis borrowed from at least two banks in our dataset and that borrowed at least once after the Lehman Brothers bankruptcy. The dependent variable is *Termination*, the probability that bank i – a pre-crisis creditor of firm k – stopped lending to firm k during the crisis. We now include firm fixed effects which allows us to more precisely control for credit demand.

Throughout the paper we use OLS for *Volume* regressions and a linear-probability model for the *Sudden stop* and *Termination* regressions. Standard errors are heteroskedasticity robust and clustered by bank. Results are robust to clustering at the country level.

II. Results

Table 1 provides baseline regression results from specifications that contain our funding-shock variables, pre-crisis bank controls, the three bank-country closeness variables, and destination country fixed effects. We find that funding shocks had a negative impact on the supply of cross-border lending during the crisis. Columns [1]–[3] show how international banks with higher sub-prime related losses, larger amounts of maturing bonds, and sharper declines in market-to-book value were significantly more likely to completely cut lending to a destination country (when compared to less constrained but otherwise similar banks that were lending to the same country). Columns [4]–[6] show that funding-constrained banks also reduced their overall credit supply faster during the crisis than less constrained banks.

Table 1–Bank Funding Shocks and International Crisis Transmission

	Sudden stop			Volume		
	[1]	[2]	[3]	[4]	[5]	[6]
Write-downs	0.006**			-0.049***		
	(0.050)			(0.001)		
Maturing bonds		0.010**			-0.062***	
		(0.015)			(0.001)	
Δ market-to-book			-0.144**			0.880**
			(0.041)			(0.023)
Pre-crisis bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral closeness controls	Yes	Yes	Yes	Yes	Yes	Yes
Destination country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,338	1,338	1,130	1,315	1,315	1,112
R-squared	0.38	0.39	0.38	0.30	0.30	0.31

Notes: This table shows estimates to explain the decline in cross-border lending from bank i to destination country j after the Lehman Brothers default. *Sudden stop* is a dummy that is 1 if bank i stopped lending to country j after the default. *Volume* is the log change in 1 plus the amount of cross-border lending by bank i to country j in the post-Lehman Brothers period compared to the pre-crisis period. *Write-downs* is the log of total crisis-related write-downs by bank i during Q2 2007-Q2 2008. *Maturing bonds* is the log of the amount of bonds issued by bank i before the crisis that matured during Q3 2008-Q2 2009. *Δ market-to-book* is the log change in the market-to-book ratio of bank j during July 2007-September 2008. We use a linear probability model and an OLS model for the *Sudden stop* and *Volume* regressions, respectively. Standard errors are heteroskedasticity robust and clustered by bank. Robust p-values appear in parentheses.

*** Significant at the 1 per cent level.
** Significant at the 5 per cent level.
* Significant at the 10 per cent level.

The economic magnitude of these supply-side effects is substantial. For instance, a one standard deviation increase in write-downs or maturing bonds increases the probability of a full stop in lending with 3.8 and 4.3 percentage point, respectively (compared to a mean probability of 42 percent). Likewise, a one standard deviation decline in a bank's market-to-book value leads to an increase in the probability of a sudden stop of 3.7 percentage points. For *Volume* regressions we find similar magnitudes.

The results for the (unreported) control variables are as expected. Banks that were larger and more solvent before the crisis were in a better position to keep lending during the crisis. Moreover, banks reduced their lending more to distant borrowers, to countries where they had less pre-crisis lending experience, and to countries where they had cooperated less with domestic banks (cf. De Haas and Van Horen, 2011).

Table 2 shows regression estimates to assess whether banks that faced more severe funding constraints not only withdrew *more* from abroad but also withdrew *from different types of countries* compared to less constrained banks. We expect that constrained banks in particular may have 'fled to quality' to reduce unsafe lending, for instance by mainly curtailing credit to countries with risky macroeconomic and institutional environments.

To analyze the relationship between bank-funding shocks and destination-country characteristics, we replace the country fixed effects with a set of macroeconomic variables. Importantly, we now control for credit demand in each destination country through average GDP growth in 2008-09. The (unreported) coefficient is as expected positive and highly significant. We also include for each country a dummy that is 1 if the current account deficit exceeded 6 per cent of GDP in 2007; average GDP growth during 2005-07; and the ratio of FX reserves to GDP. We find that banks reduced lending more to countries with slow pre-crisis growth and with high FX reserves (unreported). The latter result may reflect that

emerging markets that (correctly) expected a high probability of capital-flow reversals during a crisis had accumulated more precautionary FX reserves.

Columns [1]–[6] report specifications that each contain an additional country-level characteristic, both as a level variable and as an interaction term with *Write-downs* (see the notes to Table 2 for variable definitions and sources). The dependent variable is *Volume*.

Table 2–International Crisis Transmission and Destination-Country Characteristics

	Volume					
	[1]	[2]	[3]	[4]	[5]	[6]
	Experience	Emerging market	Country risk	Legal difference	Weak institutions	Weak contract enforcement
Write-downs	-0.068***	-0.044***	-0.045***	-0.055***	-0.041**	-0.047***
	(0.002)	(0.006)	(0.005)	(0.002)	(0.010)	(0.004)
Write-downs * X	0.009*	0.001	0.000	0.016	-0.007	0.006
	(0.067)	(0.974)	(0.988)	(0.405)	(0.669)	(0.772)
X	0.366***	0.011	0.005	-0.848***	0.175	-0.073
	(0.000)	(0.959)	(0.887)	(0.000)	(0.433)	(0.798)
Pre-crisis bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral closeness controls	Yes	Yes	Yes	Yes	Yes	Yes
Country level controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,315	1,315	1,278	1,315	1,315	1,315
R-squared	0.17	0.17	0.16	0.17	0.17	0.17

Notes: This table shows estimates to explain the decline in cross-border lending from bank i to destination country j after the Lehman Brothers default. The dependent variable is *Volume. Experience* is the number of loans provided by bank i to country j since 2000 that had matured by July 2006. *Emerging market* is a dummy that is 1 if the destination country is not a high-income OECD country. *Country risk* is the numerical equivalent of the long-term foreign-currency letter rating of the destination country in August 2007 (Standard and Poor's). *Legal difference* is a dummy variable that is 1 if the legal origin of the bankruptcy law in the home country of bank i is different from the legal origin in destination country j (La Porta et al. 1998). *Weak institutions* is a dummy that is 1 if the quality of governance in destination country j is weaker than in the median country (Kaufmann, Kraay, and Mastruzzi, 2010). *Weak contract enforcement* is a dummy that is 1 if the costs of using the judicial or administrative system in country j to collect overdue debt is above the median cost level (*Doing Business* database). We use an OLS model with heteroskedasticity robust standard errors clustered by bank. Robust p-values appear in parentheses. Robust p-values appear in parentheses.

*** Significant at the 1 per cent level.
** Significant at the 5 per cent level.
* Significant at the 10 per cent level.

The level variables ('X') illustrate how various institutional country characteristics influence the decline in cross-border credit during the crisis. Column [1] indicates, as we found before, that banks reduced lending less to destination countries in which they had built up pre-crisis experience. Column [4] shows that a bank's cross-border lending fell more to countries with bankruptcy laws that are based on a different legal regime than in its home country. The other

destination country characteristics do not seem to impact the magnitude of the decline in bank lending. For instance, banks did not differentiate between advanced countries and emerging markets; between countries with a high or a low country risk rating; between countries with good or with weak governance mechanisms; or between countries with strong or weak contract enforcement. These findings are in line with Giannetti and Laeven (2011) who show that during crises international banks' home bias increases, but that his 'flight home' affects emerging and advanced countries alike.

Lastly, while funding-constrained banks reduced cross-border credit more – see the first line – the interaction terms indicate that they did so in the same way as less constrained banks. In short: unexpected funding shocks made banks cut their foreign lending more, but they retrenched from abroad in the same way as their less-affected competitors.

Lastly, Table 3 presents firm-level results to investigate whether funding-constrained banks not only withdrew from the same type of countries but also from the same type of borrowers (compared to less affected banks). In line with a flight-to-quality effect (Bernanke, Gertler, and Gilchrist, 1996) we expect that funding-constrained banks rationed credit more to smaller, less transparent borrowers.

In these firm-level regressions the dependent variable is the probability that a bank terminates a lending relationship with an existing borrower after the Lehman Brothers default. As before, we include a set of bank-level controls and the three bank-country level closeness variables. We now also include firm fixed effects to compare the behavior of banks that were lending to the same firm before the crisis.

The odd columns confirm our earlier result that more constrained banks reduce lending more. All else equal, constrained banks display a higher probability of terminating lending relationships, although the coefficients are imprecisely estimated for *Write-downs* and *Δmarket-to-book*. Reassuringly, the size of the coefficients for these *bank-level* 'sudden stop'

effects corresponds closely with the magnitude of the impacts on the probability of a 'sudden stops' at the *country level* (as reported in columns [1]-[3] of Table 1).

Table 3–International Crisis Transmission: Firm-Level Evidence

	Termination					
	Write-downs		Maturing bonds		Δ market-to-book	
	[1]	[2]	[3]	[4]	[5]	[6]
Funding shock	0.005	0.007**	0.008**	0.013***	-0.118	-0.208**
	(0.139)	(0.029)	(0.039)	(0.002)	(0.162)	(0.010)
Funding shock * Large firm		-0.005***		-0.008**		0.171***
		(0.008)		(0.027)		(0.005)
Pre-crisis bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral closeness controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,671	1,671	1,671	1,671	1,472	1,472
R-squared	0.16	0.16	0.16	0.16	0.16	0.16

Notes: This table shows estimates to explain the variable *Termination,* the probability that bank i discontinued lending to firm k after the Lehman Brothers default. The sample includes all firms that borrowed from at least two different lenders in our sample during the pre-crisis period. The funding variables are defined in the Notes to Table 1. *Large firms* are firms with an above-median aggregate syndicated borrowing volume during January 2000-July 2007. We use a linear probability model. All specifications include a dummy that indicates whether bank i acted as an arranger for firm k in the past. Standard errors are heteroskedasticity robust and clustered by bank. Robust p-values appear in parentheses.

*** Significant at the 1 per cent level.
** Significant at the 5 per cent level.
* Significant at the 10 per cent level.

In the even columns, we interact the funding shock with a dummy variable *Large firm* which is 1 for firms of above-median size. As a proxy for firm size we use the total amount of syndicated borrowing during January 2000-July 2007. In line with an international flight-to-quality, we find that constrained banks mainly reduced their cross-border lending to small borrowers. The disparity between the supply-side effects on small versus large borrowers is considerable. For large firms, the probability that a bank with unexpected sub-prime write-downs terminated a lending relationship was only 29 per cent of the probability that the bank would stop lending to a small firm. These numbers are 38 and 18 per cent in case of shocks from maturing bonds or reduced market-to-book values, respectively.

III. Discussion

In the wake of the Great Recession, the virtues and vices of financial globalization – and of cross-border banking in particular – are being re-evaluated. On the one hand, international banks may reduce macroeconomic volatility in recipient countries if the size, strength, and diversified nature of their balance sheet makes them relatively stable credit sources in the case of local shocks. On the other hand, international banks can reallocate capital across borders in search of the best lending opportunities and this may exacerbate local business cycles (Morgan, Rime, and Strahan, 2004). The 2007-09 crisis has also shown that the financial strength of international banks may quickly dwindle if they assume large and concentrated risks in a few highly-correlated markets. When large international banks are shocked at their core, their role as stable lenders in recipient countries breaks down.

This paper shows how international banks that were confronted with sudden write-offs, difficulties with rolling over long-term debt, and reduced equity valuations, transmitted these shocks across borders by reducing their lending abroad. Moreover, at the firm level we find that banks restricted their lending especially to small borrowers.

Our results do not bode well for firms, such as in various countries in Emerging Europe, that depend on cross-border lending from Western European banking groups. The 2007-09 crisis has merged almost seamlessly into the 2010-12 Eurozone crisis and the transmission mechanisms highlighted in this paper appear to be at the core of the current crisis too. Large and unexpected write-downs now stem from exposures to sovereign risk in the Eurozone periphery. In addition, banks are once more experiencing difficulties in rolling over maturing bonds. Our findings suggest that both types of balance-sheet shocks will translate into substantial reductions in cross-border lending, hurting smaller companies with few alternative funding options in particular.

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