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Crisis Transmission through the Global Banking Network*

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Abstract

We study the transmission of financial sector shocks across borders through international bank connections. For this purpose, we use data on long-term interbank loans among more than 6,000 banks during 1997-2012 to construct a yearly global network of interbank exposures. We estimate the effect of direct (first-degree) and indirect (second-degree) exposures to countries experiencing systemic banking crises on bank profitability and loan supply. We find that direct exposures to crisis countries squeeze banks' profit margins, thereby reducing their returns. Indirect exposures to crisis countries enhance this effect, while indirect exposures to non-crisis countries mitigate it. Furthermore, crisis exposures have real effects in that they reduce banks' supply of domestic and cross-border loans. Our results, based on a large global sample, support the notion that interconnected financial systems facilitate shock transmission.

JEL Codes: F34, F36

Keywords: long-term interbank exposures, systemic banking crises, financial networks, syndicated loans

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1 Introduction

It is often argued that the interconnectedness of the global financial system, which increased significantly prior to the global financial crisis, was a key driver of its severity. As William Dudley, President of the Federal Reserve Bank of New York, remarked, the failure of financial firms has negative externalities for the financial system, and these externalities become "disproportionately high in the case of large, complex, and interconnected firms" (Dudley, 2012). Ben Bernanke, Chairman of the Board of Governors of the Federal Reserve System, argued that interconnectedness was one of several vulnerabilities that "has the potential to magnify shocks to the financial system" (Bernanke, 2013). In recent years, both academia and policy institutions have called for more research on the linkages that transmit distress from one financial firm to another and ultimately impact the broader financial system. Gertrude Tumpel-Gugerell, Member of the Executive Board of the European Central Bank, argued that such research would ideally include the interactions of interbank exposures with the real economy (Tumpel-Gugerell, 2009).

Despite the emergence of a vibrant literature on financial stability and systemic risk, there is little evidence to date on the propagation of shocks across borders through interbank exposures. The lack of evidence is partially due to the scarcity of comprehensive information on individual institutions' exposures to foreign markets. In this paper, we attempt to provide new evidence of such propagation by exploiting detailed data from the interbank long-term lending market. Specifically, we compute time-varying exposures for a large number of banks (more than 6,000) and model them as a network (the "global banking network"). Our goal is to analyze how systemic banking crises are transmitted through this network to affect bank profitability and lending decisions. We empirically estimate the distinct effects of direct (first-order) and indirect (second-order) exposures to banks in countries that experience systemic banking crises. We find that crises affect bank returns and loan supply through cross-border interbank connections. In particular, we document a statistically significant and economically meaningful negative impact of direct exposures to crises. Conditional on this effect, there is an additional negative impact of indirect exposures to banks in crisis countries and a mitigating impact of indirect exposures to banks in non-crisis countries.

To map interbank connections internationally and construct measures of interbank exposures, we exploit data from the relatively understudied market for long-term interbank loans over more than two decades. It is well known that long-term syndicated loans are an important source of funding for corporations and sovereigns.[1] We show that these loans are also important funding sources

[1] See Ivashina & Scharfstein (2010) and Altunbaş et al. (2010).

for financial institutions. Interbank loans account for about 10 percent of global syndicated loan volume, which peaked at 4.3 trillion U.S. dollars in 2007. The average loan extended in this market amounts to 500 million U.S. dollars and matures in 5 years. Banks from both advanced economies and emerging markets use syndicated loans to broaden their funding sources and support balance sheet growth. Syndicated interbank borrowing represents a sizeable share of wholesale funding, particularly for banks from emerging markets. In terms of overall deal volume, the largest lenders and borrowers are U.S. and U.K. banks.

For our analysis, we assemble a unique dataset of foreign interbank exposures at the individual bank level and combine it with information on bank balance sheets and country-level systemic banking crises. Interbank exposures are constructed from data on individual loan deals that includes the identities and location of each lender and borrower, as well as the terms of the deal. To construct our dataset, we draw on information for more than 170,000 loans extended during 1990-2012 to banks, corporates, and sovereign borrowers in more than 200 countries. Of these, 16,526 are loans issued by banks to banks for a total of 6,083 distinct banks. Two thirds of interbank loans and three quarters of all loans are syndicated, while the rest are single-lender loans. We gather data on loan origination and use the signing and maturity dates of each loan to compute bilateral bank-borrower exposures. Coupled with data on systemic banking crises in borrower countries, we construct measures of direct (one step away) and indirect (two steps away) exposures to banks in countries experiencing systemic banking crises—we call these "crisis exposures." Exposures to banks in countries that are not experiencing a crisis are "non-crisis exposures."

We empirically examine the link between crisis exposures on the one hand, and banks' profitability and supply of credit on the other. First, we focus on profitability given that low banking system profitability is associated with bank failures, impaired financial intermediation, and low economic growth (Carlson et al., 2011). Second, we assess the impact of crisis exposures on the the banks' fundamental function of financial intermediation. Specifically, using data on loan origination to individual borrowers, we examine whether crisis exposures translate into a lower ability to extend new loans.

We present two sets of results. For the profitability analysis we use return on assets (ROA), return on equity (ROE), and net interest margins (NIM) as general indicators of bank performance and financial health. The specifications are estimated in a bank-year panel over 1997-2012 with bank country*year fixed effects to account for time-varying country-level unobservables such as changes in the macroeconomic environment, financial regulation, and crisis management policies.

To examine lending behavior, we aggregate individual loan amounts extended over the same period at the bank-borrower-year level and regress them on interbank crisis and non-crisis exposures. This data structure allows us to separate loan supply effects from loan demand effects by isolating multiple bank relationships and adding borrower*year fixed effects (Khwaja & Mian, 2008). Similar to the profitability regressions, we control for bank country*year fixed effects to account for macroeconomic unobservables that may affect a banking system's ability and willingness to lend.

We show that a larger number of crisis exposures is associated with lower bank profitability and lower supply of new loans. Holding the total number of (direct and indirect) exposures constant, an additional direct exposure to a bank in a crisis country reduces bank ROA by 0.03 percent in the same year. This effect is 32 percent larger for an additional indirect crisis exposure through banks in a crisis country. Conversely, an additional indirect exposure to banks in non-crisis countries through a crisis country dampens the negative effect of the direct crisis exposure by 23 percent. One mechanism that explains the negative effect of crisis exposures on bank performance is lower profit margins, which we argue may be linked to loan restructuring, a common practice for severely impaired syndicated loans. Indeed, we find that NIMs are lower by 23 basis points for each additional direct crisis exposure. A back-of-the-envelope calculation indicates the impact of direct crisis exposures on NIMs accounts for about half of that impact on ROA.

Next, we look at the effect of foreign interbank crisis exposures on lending decisions and find that, holding the total number of exposures constant and turning ten non-crisis direct exposures into crisis exposures reduces a bank's supply of loans by 2.4 percent. This effect is greater for banks that have second-degree crisis exposures on top of first-degree crisis exposures, and, by contrast, is smaller for banks with second-degree non-crisis exposures. The loan supply impact of second-degree crisis exposures is stronger for cross-border loans than it is for domestic loans, for which we cannot reject statistically insignificant effects. These findings are consistent with a growing body of evidence on bank deleveraging, which shows that in the wake of negative balance sheet shocks, banks retrench vis-a-vis more distant markets before doing so in the home markets (de Haas & van Horen, 2013; Giannetti & Laeven, 2012).

A direct interpretation of interbank exposures is that they capture credit risk associated with lending to foreign banks—"idiosyncratic risk." These exposures could also reflect risks associated with lending to foreign markets in general—"country risk." Even in the absence of bankruptcies and outright defaults of individual counterparties, a bank's performance can be affected upon the emergence of bad economic, financial, or political news about the foreign markets to which the

bank is exposed. As a consequence of such news, the bank may experience a loss of business from the affected market and from similar markets, a higher cost of funds, and even a creditor run. Given that we define crisis exposures using an indicator of country-wide systemic banking crises, and bank defaults are rare, the negative effect we document is largely driven by the "country risk" component of these exposures.

Interbank exposures also provide an indirect way of capturing banks' total exposure to foreign markets. Since data on bank-level foreign exposures by country is not publicly available for a large set of banks, it is difficult to know how strong the correlation between cross-border interbank exposures and total exposures is. Nonetheless, for U.S. banks, we are able to document a strong positive correlation between bank-level exposures aggregated at the destination country level and long-term interbank exposures. In fact, in our dataset interbank exposures are more strongly correlated with total exposures than are exposures to firms and sovereigns. This finding suggests that interbank exposures, which can be constructed from loan origination data on a high-frequency basis, could be useful for real-time monitoring of vulnerabilities to stress in foreign markets both at the institution- and banking system level.

Our study adds to the literature on contagion in financial markets, which highlights the role of international banks in transmitting financial sector shocks to the real economy.[2] Within this literature, the link between shocks to asset values and bank lending has received particular attention. Ongena et al. (2015) and Puri et al. (2011) use supervisory data for German banks to show that banks with higher exposure to U.S. subprime assets retrenched lending operations when U.S. real estate prices started to fall. de Haas & van Horen (2012) similarly show that international banks with higher losses on subprime assets transmitted the liquidity crunch caused by the Lehman Brothers bankruptcy by curtailing their foreign lending more than did other banks.[3] We contribute to this literature by examining not only the first-order (direct) effects of troubled exposures, but also the second-order (indirect) effects, and by significantly enlarging the scope of the analysis to cover more financial crises and international banks than before.[4]

A closely related strand of literature, which focuses on shock transmission *among* financial firms, examines the effect of exposures to failed firms on creditors' stock market performance. Jorion &

[2]See, for instance Kapan & Minoiu (2014), de Haas & van Horen (2013), Cetorelli & Goldberg (2011), and Ivashina & Scharfstein (2010) for analyses of the global financial crisis.

[3]In the context of the European sovereign debt crisis, Popov & van Horen (2015) find that exposures to risky foreign sovereign debt are associated with lower bank credit.

[4]Note that we do not examine here the transmission of crises through the liability-side network since exposures on the liability side to creditors in stress do not impose costs on the borrower.

Zhang (2009) document "credit contagion," a causal link from announcements of bank bankruptcies to negative equity returns and higher credit default swap spreads of their creditors. Helwege & Zhang (2015) show that exposures to failed financial institutions are associated with lower market valuations and a higher cost of funds than for firms in the same location or that have similar portfolios. Both a "counterparty contagion" channel, capturing direct losses caused by bankruptcy filings, and an "information contagion" channel, reflecting negative externalities from bad news about a particular institution or type of asset, account for these results. However, banks hold diversified portfolios, limiting their exposures to individual counterparties. Therefore, in Helwege & Zhang (2015) the counterparty channel is empirically small and there is no evidence of a cascade of failures. We contribute to the literature by conducting an analysis of credit risk exposures among financial institutions in a *global* context and examining the impact of these exposures not only on bank performance, but also on the supply of credit.

We also add to the literature modelling connections among financial institutions as networks (for a review, see Allen & Babus (2009)). In this approach, contagion occurs when banks are connected through bilateral exposures given that the default of one bank can create difficulties at the banks with claims on it, and these difficulties can propagate through the financial system through chains of interbank claims. Studies of complex networks advance the notion that a denser web of interconnections is both good and bad. Higher network connectivity provides risk sharing opportunities in the case of small shocks. However, past a certain level of connectivity, the network enables shock propagation (Acemoglu et al., 2015; Elliott et al., 2014; Allen & Gale, 2000). The literature that studies financial stability in interbank networks[5] typically tests the resilience of such networks to shocks using either data from the domestic overnight interbank market (Gabrieli & Georg, 2014) or from simulations (Glasserman & Young, 2015; Upper, 2011; Halaj & Kok, 2013). We overcome previous data limitations by exploiting transaction-level data to construct mutual exposures among financial institutions in different countries and analyze the cross-border transmission of financial sector shocks empirically rather than through simulations.[6]

The paper proceeds as follows. In Section 2 we briefly describe the interbank long-term lending market. In Section 3 we present a simple framework describing the shock transmission mechanism

[5]See Huser (2015) and Summer (2013) for reviews.

[6]Our paper is also related to studies of other types of networks underpinned by interactions in the syndicated loan market. Cai et al. (2014) construct "co-syndication networks," in which links arise when banks participate in the same lending syndicate, to capture banks' interconnectedness through common asset exposures. Our approach differs in that we focus on contractual interconnectedness, which is created through lending and borrowing activities rather than interconnectedness due to overlapping portfolios. Contractual and common exposures interconnectedness are sometimes referred to as "direct" and "indirect" interconnectedness.

in the global banking network, which grounds our empirical specifications. In Section 4 we describe our data sources, variables, and correlations of interbank and total foreign exposures. In Section 5 we report our main results. Section 6 concludes.

2 The Interbank Long-Term Lending Market

Two thirds of the interbank loans we use to construct the global banking network are syndicated.[7] Therefore, it is useful to briefly describe this market and to review some estimates of its size. As shown in the top panel of Figure 1, based on loan origination data, the interbank segment of the global syndicated loan market represents about 10 percent of total deal number and volume. In the last two decades, the largest lenders in this market, by volume, were banks in the U.S., U.K., Japan, France, and Germany. How large are the cross-border exposures created through this market in total interbank loan claims? Based on bilateral positions reported to the Bank of International Settlements by global banks, they are estimated to account for 12.5 percent (bottom panel of Figure 1).[8]

It is also possible to estimate the relative size of interbank exposures in our sample of banks, with the caveat that these figures are valid only for the subset of banks from the global banking network we were able to match to financial statement data and thus may not be representative of the population of participating banks. Table 1 (Panel A) lists the top 25 lender countries in terms of importance of this market as the average portion of gross loans, showing that foreign interbank exposures represent 3.2 percent of total gross loans during 1997-2012, with a high degree of variation across countries.[9]

During 1997-2012, the largest borrower countries in the interbank long-term lending market were the U.S., U.K., Australia, and France, and among emerging markets, Brazil, India, the Russian Federation, South Korea, and Turkey. In our matched subsample, foreign interbank loans represent

[7]Syndicated loans are extended by financial institutions organized in lending syndicates, and take the form of credit lines and term loans. They are originated by one or more "lead banks" who sell portions of the loan to other lenders. Most loans are issued in U.S. dollars and have floating interest rate based on the London Interbank Offered Rate. Syndicated loans are generally extended to creditworthy borrowers and are held to maturity, but there is an active secondary market for loans extended to leveraged borrowers (see, for instance, Irani & Meisenzahl (2016)). The syndication process allows banks to diversify their portfolios while meeting counterparty exposure limits.

[8]This estimate is obtained by comparing interbank loan exposures, from which we remove undrawn portions of credit lines following the methodology of Cerutti et al. (2015), with total cross-border loan exposures from the BIS. The remainder is accounted for by single-lender loans and intragroup transfers.

[9]Notice, for instance, that the share of long-term interbank in gross loans is almost 10 percent for U.K. banks, as London is an important financial center where many syndicated loans are booked.

5 percent of total liabilities and 8 percent of total liabilities less deposits (Panels B-C in Table 1). We can see that these loans are a more significant source of funding for banks from emerging market countries than for advanced economies, representing 12.5 percent of non-deposit liabilities for banks in Turkey, 20 percent for banks in Iceland, and as much as 40 percent for banks in Latvia.[10]

3 Shock Transmission Mechanism and Hypothesis Construction

In this section we describe a simple shock transmission mechanism in our global banking network with a view to developing empirical hypotheses.

3.1 Shock Transmission Mechanism

Assume that bank performance can be measured by Y, and let the exposure of bank i to bank j_1 be denoted by E_{ij_1}, where E is an indicator for the presence of an exposure. Let C_i denote an indicator for a financial crisis in the country of bank i and X_i denote the (1×K) matrix of bank i's K characteristics. We hypothesize that the returns of bank i can be written as follows (omitting the time subscript for simplicity):

$$Y_i = X_i\beta + \lambda C_i + \gamma \sum_{j_1} E_{ij_1} Y_{j_1}, \tag{1}$$

Note that the performance of bank i, Y_i, is a function of its own characteristics, X_i and C_i, and the performance of the banks (j_1s) to which it is exposed. Equation (1) can be expanded infinitely and simplifies to:

$$\begin{aligned} Y_i = {} & X_i\beta + \lambda C_i + \gamma \sum_{j_1} E_{ij_1} X_{j_1}\beta + \gamma \sum_{j_1} E_{ij_1} \lambda C_{j_1} \\ & + \gamma^2 \sum_{j_2} E_{ij_1} E_{j_1 j_2} X_{j_2}\beta + \gamma^2 \sum_{j_2} E_{ij_1} E_{j_1 j_2} \lambda C_{j_2} \\ & + ... + \gamma^n \sum_{j_n} E_{ij_1} E_{j_1 j_2} ... E_{j_{n-1} j_n} X_{j_n}\beta + \gamma^n \sum_{j_n} E_{ij_1} E_{j_1 j_2} ... E_{j_{n-1} j_n} \lambda C_{j_n}, \end{aligned} \tag{2}$$

where j_1 represents the direct, first-degree, connections of bank i, j_2 represents the indirect, second-degree connections of bank i_1, etc., and n is the highest degree connection of bank i. Note that the union of the sets of first-degree connections of all j_1 banks corresponds to the set of second-

[10] See Table A1 in Online Appendix for details on sample composition.

degree connections of bank i. Equation (1) naturally leads to a shock transmission mechanism that is described in Equation (2). The latter shows how the performance of bank i depends on its direct and indirect exposures to borrowers in countries that are experiencing a banking crisis.

Based on Equation (2), a complete empirical specification would link measures of bank performance to bank-specific controls, an indicator for the location of a bank in a country experiencing a banking crisis, the bank's first, second, and higher-degree exposures, and the characteristics of all counterparty banks. The coefficient γ decays exponentially, drastically reducing the potential impact of higher-degree connections. For this reason, in the implementation of Equation (2) we include only first and second-degree exposures. (All variables are defined in the next section.)

Adding subscripts for time t and bank country h, and explicitly including bank country*year fixed effects (α_{ht}), the most complete specifications are as follows:

$$\begin{aligned} Y_{iht} = \alpha_{ht} + X_{iht}\beta_0 + \lambda_0 C_{iht} + \sum_{j_1} E_{ij_1t} X_{j_1t}\beta_1 + \lambda_1 \sum_{j_1} E_{ij_1t} C_{j_1t} \\ + \sum_{j_2} E_{ij_1t} E_{j_1j_2t} X_{j_2t}\beta_2 + \lambda_2 \sum_{j_2} E_{ij_1t} E_{j_1j_2t} C_{j_2t} + \varepsilon_{iht}, \end{aligned} \tag{3}$$

where X_{iht} is a vector of bank characteristics and C_{iht} is the indicator for systemic banking crisis in bank i's home country. Subsequent terms refer to bank-level control variables and the number of bank borrowers in countries with systemic banking crises to which bank i is exposed through its first- and second-degree connections. All variables enter the regressions contemporaneously.

When we estimate Equation (3), we find that the characteristics of counterparty banks yield coefficients that are jointly statistically insignificant under most specifications. Therefore, we estimate parsimonious specifications that exclude these characteristics, but our regression results are robust to their inclusion.[11] Furthermore, although in the equations above we focus only on the effects of exposures vis-a-vis banks, in reality a bank's performance is also affected by its exposures to non-bank borrowers (such as non-financial firms and sovereigns). To capture these effects, we control for foreign exposures to non-banks as well as for bank size as components of X_{iht}. The bank performance specifications, reported in their parsimonious form below, are estimated using Ordinary Least Squares (OLS), with bank country*year fixed effects (α_{ht}), and with standard errors clustered at the bank level:

$$Y_{iht} = \alpha_{ht} + X_{iht}\beta_0 + \lambda_0 C_{iht} + \lambda_1 \sum_{j_1} E_{ij_1t} C_{j_1t} + \lambda_2 \sum_{j_2} E_{ij_1t} E_{j_1j_2t} C_{j_2t} + \varepsilon_{iht}. \tag{4}$$

[11] See Table A2 in Online Appendix for baseline results controlling for these characteristics.

Next, we hypothesize that crisis exposures also affect a bank's ability to extend new loans. For this purpose, we use empirical specifications that are similar to Equation (4), as follows:

$$L_{ihjt} = \alpha_{ht} + X_{iht}\beta_0 + \lambda_0 C_{iht} + \lambda_1 \sum_{j_1} E_{ij_1t} C_{j_1t} + \lambda_2 \sum_{j_2} E_{ij_1t} E_{j_1j_2t} C_{j_2t} + \gamma_{jt} + \varepsilon_{ihjt}, \tag{5}$$

where L_{ihjt} denotes (log-transformed) total loan volume extended by bank i from country h to individual borrower j in year t, and γ_{jt} is a set of borrower*year fixed effects. The borrower*year fixed effects control for credit demand shifts that occur at the individual borrower level within any given year and thus help isolate the credit supply effect of crisis exposures (Khwaja & Mian, 2008). The lending regressions, too, are estimated using OLS with standard errors clustered at the bank level.

3.2 Hypotheses

Our coefficients of interest, representing the impact of first- and second-degree *crisis* connections on bank profitability and loan supply, are λ_1 and λ_2 from the profitability Equation (4) and the lending Equation (5). Negative shocks via foreign interbank exposures are expected to have a negative impact on bank earnings, translating into lower net income and returns. This effect may occur directly through valuation effects and write-downs on non-performing exposures, or indirectly, through a loss of other business. We also expect bank lending to be negatively affected by such shocks, as they may erode capital through write-offs and lower earnings, or lead to a higher cost of funds for the bank. Therefore, we expect the number of direct crisis exposures to be negatively associated with bank returns and lending. In financial systems modelled as networks, shocks to a particular financial firm affect not only directly linked firms, but also indirectly linked firms, that is, through higher-order exposures. Put differently, negative shocks can have "cascading" effects through the chain of lending relationships. Therefore, even if direct exposures do not experience crises, there may be spillover effects from downstream impacts, and our specifications will flexibly allow for this possibility.

4 Data

For our empirical analysis, we rely on four main ingredients, namely bank-level estimates of foreign exposures, bank balance sheet data and profitability measures, loan origination data, and financial crisis dates. We describe each data source and the main variables below.

4.1 Constructing Foreign Interbank Exposures

The data on individual loan deals comes from Dealogic's Loan Analytics, a database with extensive international coverage that reports single-lender and syndicated loans issued since the early 1980s. To construct interbank exposures for the 1997-2012 period, we obtain information for 170,274 syndicated loan deals signed between 1990 and 2012. For each loan we observe the identities of the borrower and lender(s), the loan amount in U.S. dollars (which we express at 2005 prices using the U.S. consumer price index),[12] and loan origination and maturity dates. Using these data, we construct for each year the global banking network of bank-level foreign exposures among 6,083 banks. (See Data Appendix for details on the construction of the network.) An important caveat is that we only observe loans at origination and do not have data on credit line drawdowns, liquidation, prepayments, side-arrangements, or loan sales made by lenders to reduce or remove these exposures from their balance sheets (Lee et al., 2015; Bord & Santos, 2012). Therefore, to limit the problem of possible measurement error in the estimated dollar exposures, we use the *number* of exposures rather than their dollar value in the empirical analysis.

Direct and indirect exposures are defined as follows. Direct exposures represent the number of banks to which bank i has direct exposures at time t. The sum of these exposures is simply a bank's number of direct counterparties (also known as out-degree in the networks literature). Indirect, or second-degree, exposures are defined as the number of banks to which the banks to which bank i has direct exposures at time t. These are two-step away exposures because they represent the number of direct counterparties of a bank's direct counterparties. To compute crisis and non-crisis exposures, we simply add up exposures to all banks in countries that experience crises in year t and in all other countries. From the same data source, we use individual loans to non-financial sector borrowers (firms and sovereigns) to construct exposures to non-banks. Since non-bank borrowers are rarely involved in lending, we only compute direct exposures and use them as control variables in our regressions.

The global banking network thus obtained is quite sparse. Figure 2 depicts network density (defined as the number of observed connections in the network divided by the total number of possible connections) and the number of participating banks during the period of analysis. Network density ranges between a minimum of 0.3 percent in 1998 and a maximum of 0.48 percent in 2007,

[12] For 40 percent of the loan deals we observe individual loan shares by each syndicate participant. For the remainder, we estimate them using a regression-based approach as in Kapan & Minoiu (2014) and de Haas & van Horen (2013). See Data Appendix for details.

which is comparable to domestic interbank markets.[13] Visualizations of the network in 2007 and 2010 for the largest 100 banks are provided in Figure A1, showing reduced network density after the global financial crisis as many loans were not rolled over during the crisis (Cerutti et al., 2015).

4.2 Other Data

Bank balance sheet information comes from Bankscope. Due to the lack of common unique identifiers in Dealogic and Bankscope, we match each bank in the global banking network with its financial information from Bankscope by name and nationality (on a locational basis). Prior to the match we adjust lender names in Loan Analytics to account for name changes, mergers, and acquisitions over the sample period. Furthermore, we inspect all automatic matches and then manually match the remaining banks. (See Data Appendix for details.) The final (unbalanced) panel dataset comprises about 2,000 banks and the regression sample contains 1,869 banks due to missing balance sheet information for some banks.[14]

Our main outcome variable is bank ROA for the bank performance results but we also consider ROE as an alternative measure of performance and NIMs as a potential channel.[15] Our control variables are bank capital (equity/assets), size (log-total assets), exposures to non-banks, indicators for bank type, and indicators for bank business model.[16]

Data on the incidence of systemic banking crises comes from the Laeven & Valencia (2013) dataset. Systemic banking crises are defined as periods during which the domestic banking system experiences significant stress and at least three of the following six interventions are implemented by public authorities: guarantees on bank liabilities, extensive liquidity support, significant asset

[13] The Italian interbank market has density of 0.3 percent (Gabrieli, 2011) and the German interbank market has density of 0.7 percent (Alter et al., 2015).

[14] Note that our analysis is subject to survival bias, as some of the banks experiencing large losses in a period may fail subsequently. However, survival bias works against us finding results.

[15] Another meaningful dependent variable is bank stock market returns, but analyzing it would require constructing the network at the bank holding company level. We are hindered in doing so by several limitations. First, reliable time-series historical data on the composition and ownership of international banking groups is unavailable. Even if the data were available, defining the network at the parent level (that is, on a consolidated rather than locational basis) would reduce the probability of finding results because global banks make extensive use of internal capital markets to buffer local shocks (Cetorelli & Goldberg, 2012a,b). This may lead losses at the subsidiary level not to be visible at the parent level. Third, limiting the sample to listed bank holding companies would significantly reduce its size.

[16] For bank type, the categories are controlled subsidiary, global ultimate owner, and other (branch locations, independent companies, and single location banks). For bank business model, the categories are commercial banks (cooperative banks, saving banks, real estate and mortgage banks, and other credit institutions), investment banks, and other (bank holding companies, finance companies, investment and trust corporations, securities firms, private banking and asset management companies, and group finance companies).

purchases, public takeovers of financial institutions, large restructuring costs, and deposit freezes or bank holidays.

Finally, to examine the impact of stress in foreign markets on lending decisions, we gather detailed data on banks' granting of large corporate loans each year. For this we rely once again on Dealogic's Loan Analytics, from which we extract loans to individual borrowers (financial and non-financial firms) and aggregate them at the bank-borrower-year level by adding up loan volumes. Summary statistics for all variables used in the regression analysis are reported in Table 2.

4.3 Correlation with Total Foreign Exposures

One interpretation of our approach is that shocks propagate through the global banking network via foreign interbank exposures. However, shock propagation could also occur through banks' exposures to foreign markets that are not directly captured by our analysis, but are correlated with interbank exposures. For instance, a bank's exposure to a foreign country through the interbank market may indicate that the bank also has exposures to the corporate sector of that country. Since detailed information on banks' exposures to each foreign country is not publicly available, we cannot provide a precise test of this idea for all banks in our sample. However, for U.S. banks we are able to gather the data and examine the correlation of foreign interbank exposures with other types of exposures.

We obtain bank-level data on total foreign exposures (loans, securities, derivatives, and other claims) from the Federal Reserve reporting form FFIEC009a for the 1997-2012 period. (See Data Appendix for details.) The data are available for 214 individual U.S. banks vis-a-vis 183 destination countries. We are able to match 114 banks with interbank exposures. We regress total cross-border exposures on exposures to banks and non-banks from the syndicated loan market, measured in dollars and as counts, also aggregated at the bank-destination country-year level, controlling for bank*destination country and year fixed effects.

The results are reported in Table 3. We notice that the coefficients on syndicated loan exposures to banks are positive and statistically significant. The estimated elasticity of total cross-border exposures with respect to foreign interbank exposures measured in dollars is 0.09 percent (column 1). The semi-elasticity of total exposures with respect to the *number* of bank borrowers is 32 percent (column 2). We conclude that long-term interbank exposures are a good proxy for total exposures to foreign markets, even after controlling for non-bank exposures to those markets. Furthermore,

the estimates indicate that exposures to banks are more strongly correlated with total exposures than are exposures to non-banks, suggesting they are more informative about total foreign activity despite their relatively smaller size.

While we can only conduct this exercise for U.S. banks, previous studies offer additional insight about the predictive ability of these exposures. Cerutti et al. (2015) show that long-term interbank exposures and total cross-border banking activity are positively correlated at the bilateral country level in a large sample of countries. Gadanecz & von Kleist (2002) document that half of the variation in international bank lending to emerging market countries can be explained by changes in syndicated loan flows, arguing that these flows predict bank lending with a significant lead. Taken together, these findings further support the interpretation of long-term interbank exposures as capturing country risk in addition to idiosyncratic risk.

5 Results

We begin with an empirical model for bank profitability according to Equation (4), which links bank returns to direct and indirect foreign interbank exposures, as well as banks' own characteristics. We then discuss several mechanisms through which exposures to banks in countries affected by systemic banking crises can affect ROA. Finally, we examine the real effects of cross-border crisis exposures with a series of lending specifications.

5.1 Crisis Exposures and Bank Profitability

5.1.1 Main Findings

In Tables 4-5 we report the results of our baseline profitability regressions, in which the regressors of interest are crisis exposures (measured as counts). The effect of home financial crises, as well as that of unobserved macroeconomic factors that may be affecting financial sector profits in any home country and year, are subsumed in bank country*year fixed effects. Column 1 in Table 4 shows that a higher number of direct exposures to banks in countries experiencing systemic banking crises reduces bank profitability. The coefficient estimate indicates that keeping the total number of connections constant and increasing the number of direct crisis exposures by one reduces ROA by 0.03 percent.[17] To put this number in perspective, consider that for a bank balance sheet that is

[17] Given that the coefficient on total number of exposures is statistically insignificantly different from zero, the point estimates suggest that adding one more direct crisis exposure to the existing exposures also reduces ROA by 0.03

leveraged 30 times, which was not uncommon before the global financial crisis, an ROA reduction of 0.03 percent becomes an ROE reduction of 0.9 percent. This corresponds to 11 percent of a mean ROE of 8.4 percent and is an economically significant effect. For a bank with total assets of one trillion U.S. dollars, an additional crisis connection would translate into a reduction in annual returns of 300 million U.S. dollars.[18]

In columns 2-3 of Table 4 we add indirect exposures. To begin with, we use the number of crisis and non-crisis exposures of the first-degree counterparty banks (column 2). The coefficients on these second-degree exposure variables are not statistically significant. However, these measures ignore the network structure of bank connections, where the strength of a node can influence the transmission of shocks along a chain of lending relationships. For example, a second-degree crisis exposure could have a significant effect on bank returns only if the first-degree exposure is also a crisis exposure. To explore this possibility, in column 3 we condition on a first-degree crisis exposure and consider two paths: exposures *through* crisis banks to (i) crisis banks (C-C) and to (ii) non-crisis banks (C-NC). The coefficient estimates suggest that on top of the baseline negative and significant effect of direct crisis exposures on ROA (-0.022 in this case), there are negative effects stemming from the presence of second-degree crisis exposures. Specifically, an additional indirect exposure through a crisis-country bank to a *crisis* country bank further reduces ROA by 0.007 (32 percent of the base effect). By contrast, an additional indirect exposure through a crisis-country bank to a *non-crisis* country bank dampens the negative effect on ROA by 0.005 (23 percent of the base effect). In subsequent analysis, we use the model in column 3 as our preferred baseline specification.

So far we have examined the impact of crisis exposures on bank profitability for the average bank in the sample. However, bank size may be an important determinant of banks' ability to withstand shocks (see, e.g., Demirguc-Kunt et al. (2013)). For instance, large and interconnected banks may better be able to hedge foreign credit risk or adjust their positions in anticipation of profitability shocks. Large banks may also be perceived as "too big to fail" and therefore experience a smaller loss of business when foreign markets to which they are exposed are in turmoil. In the last column of Table 4, we ask if the effects identified above are heterogenous according to bank size by interacting first and second-degree exposures with log(total assets).[19] The coefficient estimates

percent. By contrast, adding a non-crisis exposure does not affect ROA. A possible explanation for the latter effect being zero is that the syndicated lending business has traditionally had small profit margins due to steep competition between commercial and investment banks (Gadanecz, 2004; Allen, 1990).

[18] According to 2014 data from Bankscope, there are 30 banks with total assets of at least 1 trillion U.S. dollars.

[19] In unreported specifications we also sought differential effects by bank business model, entity type, and bank

reveal no differential effect of direct crisis exposures for large banks, but indirect crisis exposures have a lower effect on larger balance sheets.

As seen in Table 5, our results hold up when profitability is measured with ROE. In column 1 of Table 5 we notice that, for the same number of direct exposures, turning a non-crisis exposure into a crisis exposure reduces ROE by 0.3 percent.

Taken together, our baseline results suggest that systemic banking crises around the world reduce the profitability of banks with exposures to affected foreign markets, controlling for banks' own characteristics. Thus, global interbank exposures are a channel of international shock transmission, which means that diversification across financial partners can turn into a vulnerability when the countries where these partners operate experience financial stress. The magnitudes of the estimated impacts are economically meaningful in the context of large and highly leveraged bank balance sheets, which are common in modern financial systems and for which small ROA and ROE movements can imply large dollar losses. Moreover, correlated exposures across banks may lead to the amplification of otherwise small shocks to profitability (Borio, 2003).

5.1.2 Tackling Endogeneity

An important issue in our econometric analysis is the potential endogeneity of crisis exposures. Endogeneity can arise in several ways. One possibility is that banks react to past or anticipated negative shocks from foreign counterparty banks by reducing their exposures to them. Another concern may be that banks recognize that being interconnected is risky and try to form links in ways that mitigate this risk. The result would be an endogenous network in which the banks position themselves in a way that helps reduce the impact of shocks. It is also possible that banks hedge some of the credit risk in their interbank exposures; for instance, by buying credit default swaps. If credit portfolio management tools such as hedging, loan sales, and securitization are more likely to be employed by sophisticated, larger, and more interconnected banks, there may be systematic measurement error in interbank exposures. These various mechanisms would attenuate our estimates, reducing the probability of finding significant effects of banking crises on bank performance. Nevertheless, we would like to tackle the issue of potential endogeneity to improve the accuracy of our estimates.

We address this issue in two ways. First, we decompose an interbank exposure at time t into

capital, but we did not find any evidence of such effects.

a "stock" exposure that was in place as of the end of $t-1$ and a "flow" exposure based on loans originated during t. In the face of negative shocks, banks may have a harder time adjusting their stock exposures than their flow exposures. This is because unwinding existing positions requires appropriate market conditions, willing buyers, and the avoidance of large haircuts, whereas adjusting the flow of activity simply requires not extending new loans. For this reason, the stock exposures are less likely to be contaminated by endogeneity concerns than are the flow exposures.

In a second attempt to address endogeneity, we exploit differences in bank size and business model. We conjecture that larger and more sophisticated banks are more likely to utilize credit portfolio management tools to reduce exposures to risky counterparties. Bank size is a good predictor of business model in that most of the largest 5 percent of banks in our sample are also universal, globally-active banks with complex organizational structures. Therefore, we examine the robustness of our results to removing these banks from the sample. Alternatively, we remove from the sample global systemically important banks (G-SIBs).

The results are reported in Table 6 for our preferred baseline specification. For the stock-flow comparison, we focus on the impact of direct exposures (column 1). Splitting interbank exposures into their stock and flow components yields statistically significant results only for the stock exposure. This result reinforces our prior that the crisis transmission mechanism is present in the portion of exposures that is predetermined and hence hardest to endogenously adjust. In columns 2-3 we remove the largest banks (falling in the 5th percentile of the size distribution) and G-SIBs (both holding companies and individual entities of each G-SIB) and notice that doing so leaves the results broadly unchanged.

5.1.3 Potential Mechanisms

A potential channel through which crisis exposures reduce bank profits would be direct balance sheet losses due to individual borrower defaults. It is important to note that the syndicated loan market exhibits lower default rates and higher loan recovery rates than do other segments of the credit market.[20] This is especially true for financial borrowers. Furthermore, borrower distress in this market typically leads to renegotiations that result in an amendment to the terms of the loan such as a principal write-down, a lower interest rate, a grace period, or a lengthening of maturity (Standard & Poor's, 2011). Loan restructuring effectively reduces the cash outlays of the borrower

[20] During 2011-2012, loan default rates were 2 percent. Over five years, the default rate for firms rated AAA was 0.38 percent while that for firms rated B was 21.76 percent during 1981-2010. Loan recovery rates have been 71 percent compared to 43.5 percent for unsecured lending during 1989-2009 (Standard & Poor's, 2011).

and the present value of the loan for the lender, resulting in lower NIMs.

Lending banks' profit margins may also be squeezed because of "information contagion" whereby exposure to crisis countries would lead to a loss of business and higher funding costs. The finance literature highlights the negative effects of corporate borrower distress on creditors' market valuation. For instance, Saunders et al. (2003) show that borrower default or bankruptcy announcements lead to significantly negative abnormal stock market returns for the borrower's main lender; this effect is larger for lenders with greater exposure to the distressed firm. Furthermore, large-scale corporate bankruptcies have repercussions for lending banks' reputation and long-run ability to syndicate loans. Gopalan et al. (2011) find that lead banks that experience borrower bankruptcies are less likely to subsequently syndicate loans and to attract participant lenders. These results are suggestive of an indirect effect of non-performing exposures on lending banks through a loss of business, which in turn may put pressure on the bank's funding costs and hence its profit margins.[21]

Given that we do not observe the performance of individual loans in our dataset, we test for these effects indirectly by looking at NIM both contemporaneously and in subsequent years (see Table 7). The results show that a larger number of direct crisis exposures is associated with lower NIMs. The magnitude of coefficients on direct exposures in columns 1-4 indicate that turning a non-crisis exposure into a crisis exposure, while keeping the total number of exposures constant, reduces NIMs by about 20 basis points. An additional 40 crisis exposures, the maximum number of crisis exposures in our sample—corresponding to the Hong Kong subsidiary of Long-Term Credit Bank of Japan in 1998—would reduce NIMs by a third of a standard deviation. This effect is not economically very large but it is consistent with the presence of a loan restructuring channel with persistent effects on banks' profit margins.

A natural question asks to what extent the squeezed profit margins caused by loan restructurings and other factors can account for the decline in bank returns. We carry out a back-of-the-envelope calculation using our coefficient estimates for direct crisis exposures for NIMs (0.02) and ROA (between 0.02 and 0.03), and an estimated ratio of interest bearing assets to total assets of 62 percent. This is a rough estimate from Laeven et al. (2014) who report the average ratio of interest income to total income across the largest banks in the U.S., U.K., France, and Germany. The

[21] Yet another mechanism behind our results could be losses in banks' securities portfolio. Losses would occur if banks placed their syndicated loans in the securities book and marked them to market using secondary market prices. This is more likely to happen for high-yield loans for which there is an active secondary market. To the extent that these loans are designated as "held for trading," marked-to-market losses and gains would affect net income and hence profitability ratios. Unfortunately, we do not have information on the accounting designation of syndicated exposures, so we cannot test for this channel directly.

calculation indicates that the impact of direct crisis exposures on NIMs accounts for 41-56 percent of their impact on ROA, suggesting the idiosyncratic and country risk channels each account for about one half of the crisis transmission mechanism estimated here.

5.2 Crisis Exposures and Bank Lending

Next we examine the lending effects of exposures to banks in crisis countries. While bank profitability is important in its own right given that unprofitable banking systems are associated with impaired financial intermediation and low economic growth, we are able to take advantage of our detailed loan origination data to directly examine the loan supply effects of crisis exposures. For this purpose, we use data on loans extended by the banks in our sample during the period of analysis 1997-2012. We aggregate the data by summing loan volumes at the bank-borrower-year level, where borrowers are individual firms. This data structure is advantageous because it allows us to control for time-varying shifts in demand at the individual borrower level by including borrower*year fixed effects in our specifications (Khwaja & Mian, 2008). We estimate regressions akin to Equation (5) and allow for a different effect for domestic versus cross-border loans to test whether banks with troubled exposures abroad retrench lending differentially.

The results are similar to those for bank profitability (see Table 8). They also paint the same picture for the subsample of lead banks (columns 1-3), which account for the bulk of loan deal volume, and for the full sample of banks (columns 4-6). The coefficient estimates in column 1 (-0.0024) suggests that ten additional direct crisis exposures reduce the supply of loans by 2.4 percent. On top of this effect, indirect crisis exposures further reduce the ability of banks to extend new loans, and indirect non-crisis exposures dampen it (column 2). In addition, the positive and statistically significant coefficients on the total number of exposures (to banks and non-banks alike) suggest that a larger number of *non-crisis* exposures is associated with an *increase* in loan supply. When it comes to differential effects for domestic versus cross-border loans (columns 3-4), we notice direct exposures are as harmful for both types of loans, but indirect ones have statistically insignificant effects on domestic loans (the p-values for F-tests that the coefficients on indirect exposures C-C and C-NC are jointly insignificant in column 4 are 0.3095 and 0.3671). This suggests that domestic and foreign lending respond similarly to direct crisis exposures, but cross-border lending is more sensitive to higher-degree exposures. This result adds to a large literature documenting the "flight-home" tendency of global banks facing balance sheet shocks, that is, the tendency to curtail the supply of loans to distant foreign markets before doing so in the domestic market (de Haas & van

Horen, 2013; Giannetti & Laeven, 2012).

5.3 Robustness tests

We subject our findings to several robustness tests reported in the Online Appendix. In Figure A2 we plot the estimated coefficients on direct and indirect crisis exposures (together with their 90 percent confidence intervals) from "leave-one-year-out" regressions for bank ROA. In these regressions we sequentially drop from the sample the year indicated on the horizontal axis. The results show that the confidence bounds for these key coefficients never cross zero, suggesting our results are robust to removing select years of clustered crises from the sample (such as 2001-2002 and 2008-2009). Table A3 shows that the profitability results are not driven by countries with few banks (column 1) or by banks with few observations (column 2). Finally, Table A4 reveals that the lending regressions for the subsample of non-financial borrowers yield the same broad findings as do those for the full sample of borrowers.

6 Conclusions

In this paper we analyze the role of bank connections in the transmission of financial sector shocks across countries. Using detailed data on long-term interbank loans, we construct foreign interbank exposures, and hence a global banking network for the 1997-2012 period. These interbank exposures, which are positively correlated with total foreign exposures, capture both idiosyncratic risk and country risk. Our global banking network comprises more than 6,000 banks. Of these, we have financial statement data for a sample of 1,869 banks, which enables us to document the impact of exposures to banks in countries experiencing crises on bank profitability and loan supply.

We find that a larger number of direct loan exposures to bank borrowers in countries experiencing systemic banking crises reduces bank returns and the granting of large corporate loans, controlling for time-varying borrower demand. On top of this negative effect, indirect, second-degree exposures to borrowers in crisis countries have an additional negative impact, while exposures to borrowers in non-crisis countries have a dampening effect. A possible mechanism for reduced bank returns stems from loan restructuring, a common method of dealing with impaired syndicated loans, which squeezes banks' net interest margins. In the face of shocks to asset values and possible information contagion stemming from troubled exposures abroad, banks also reduce the supply of loans, especially that of cross-border loans.

Our results, which suggest that banks are unable to shield their balance sheets fully from foreign risk, may be interpreted as evidence of market incompleteness. Furthermore, they illustrate how interactions in the long-term interbank market affect bank profitability and the flow of credit in the global economy, thereby supporting the notion that interconnected financial systems enable shock transmission.

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Data Appendix

To construct our dataset we proceed as follows:

- Step 1. We download from Dealogic's Loan Analytics data on 170,274 loan deals signed between January 1990 and December 2012. To construct the global network of foreign interbank exposures, we retain only the 16,526 loans extended from banks to banks. We drop the deals for which the lender is recorded as "unknown", "undisclosed syndicate", or "undisclosed investor (unknown)" and the deals that involve multiple borrowers (representing less than 1 percent of the sample). We also drop the deals with missing maturity information, so we are left with 148,378 deals. We remove deals from territories without an International Financial Statistics (IFS) code, namely Guernesey, Isle of Man, Jersey, and occupied Palestinian Territory. For lender country we use the variable "Lender nationality" as reported in Loan Analytics; for borrower country we use the variable "Deal nationality" after checking that the variable is correct by comparing banks that appear both as borrowers and lenders. Bank borrowers are identified using the general industry group "Finance" and the sub-classifications commercial and savings banks, provincial banks, municipal banks, savings and loans, and investment banks. This means that foreign interbank exposures are not computed for financial firms classified as investment managers, special purpose vehicles, development banks, multilateral agencies, and miscellaneous.

- Step 2. Given that some bank names are recorded in Loan Analytics with typos, refer to banks that have changed name over time, or have been acquired by or merged with other banks, we clean up the bank names as follows:

  - If a bank changed name during 1990-2012, we retain its Bankscope name (as of end-2012) throughout the entire sample period.
  - If two or more banks merged during the sample period to form a new bank, they are kept as distinct banks until the year of the merger and cease to exist after the merger; the bank resulting from the merger is kept subsequent to the merger.
  - If a bank was acquired by another bank, it appears as a distinct bank until the year of the acquisition.
  - Lending from multiple branches of the same bank in a foreign country is aggregated.
  - Lending from off-shore branches of a bank is aggregated.

- Step 3. After cleaning the bank names, we match all the banks on a locational basis, by name and country, with balance sheet data from Bankscope. For the banks that are not matched automatically, which we carefully inspect for consistency, we perform matches manually. We use various sources to learn the institutional history of banks and make appropriate matches, including bank websites, the Federal Reserve Board National Information Center website[22] and Bloomberg Businessweek.[23] Subsidiaries, branches, and other banking group entities for which there is balance sheet information in Bankscope are treated as distinct entities and are not linked to their parent financials.

[22] http://www.ffiec.gov/nicpubweb/nicweb/SearchForm.aspx

[23] http://investing.businessweek.com/research/company/overview/overview.asp

The global banking network is constructed using the full set of 6,083 banks that appear as lenders or borrowers in the loans recorded by Dealogic Loan Analytics during 1990-2012. The sample of banks recorded in Dealogic Loan Analytics and merged to their financial statement information in Bankscope contains about 2,200 distinct banks. The final regression sample comprises 1,869 banks due to missing data on balance sheet variables.

To construct foreign interbank exposures, we use information on lender and borrower identity, loan amount, and loan maturity. Loans are treated, for simplicity, as (non-amortizing) bullet loans. We use the same approach to construct foreign exposures for each bank-borrower pair where borrowers are non-financial firms or sovereigns. In our empirical analysis we use the *number* of (crisis and non-crisis) exposures as opposed to their *dollar value* because we only observe individual loan amounts contributed by each lender in the syndicate for 40 percent of the loan deals. For the empirical analysis that requires dollar exposures or loan amounts (Tables 3 and 8), we estimate the individual loan amounts for the remaining loans as follows. We estimate a regression model on the sample of loans with reported shares over 1990-2012 and use the model to predict bank-specific loan amounts out of sample, similar to the approaches in de Haas & van Horen (2013) and Kapan & Minoiu (2014). Specifically, we regress log-shares contributed to each loan deal on the log-loan amount, indicators for original loan currency, number of syndicate participants, indicators for borrower country and industry, indicators for lender role in the syndicate (bookrunner, mandated arranger, arranger, and participant) and lender country, an indicator for prior lending/borrowing relationship, an indicator for the lender and borrower being from the same country, and year*quarter dummies.[24] The regression has an R-squared of 74 percent.

For U.S. banks, we correlate foreign interbank exposures constructed above with total foreign exposures (Table 3). The data are extracted from the Federal Reserve RSSD lookup form on the Federal Reserve Board National Information Center website.[25] For foreign exposures we use form FFIEC 009a Column 4 representing the "Total Amount of Cross-Border Claims and ForeignOffice Claims on Local Residents," which is the sum of "Amount of Cross-border Claims Outstanding After Mandated Adjustments for Transfer of Exposure (excluding derivative products)," "Amount of ForeignOffice Claims on Local Residents (excluding derivative products)," and "Amount of Gross Claims Outstanding from Derivative Products after Mandated Adjustments for Transfer of Exposure." These exposures are reported by U.S. banks with international operations and for which the exposures represent more than 1 percent of total assets or more than 20 percent of capital.

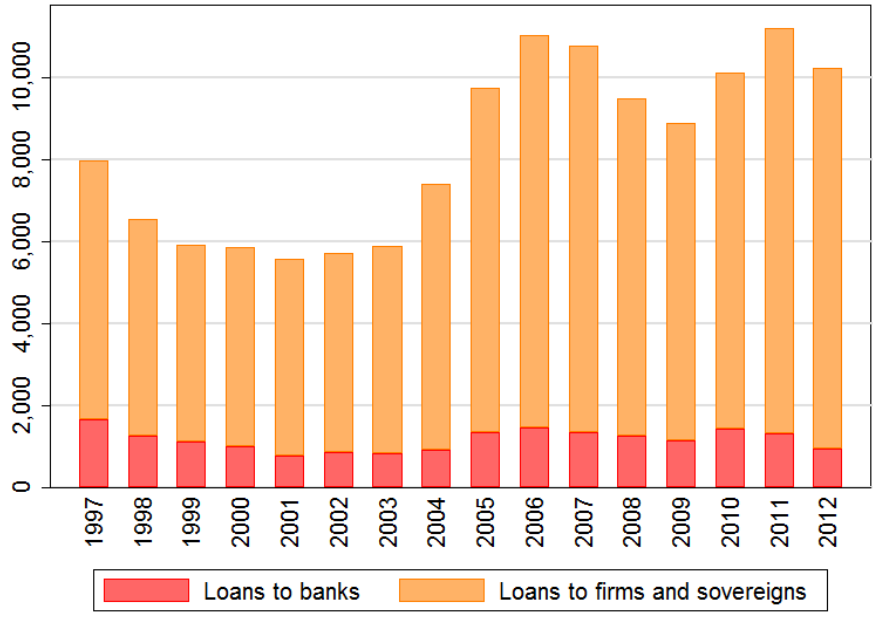
[24]The exact specification is reported in the Online Appendix of Kapan & Minoiu (2014), see page 5 on http://www.camelia-minoiu.com/bankstrength-appendix.pdf.

[25]https://www.ffiec.gov/nicpubweb/nicweb/SearchForm.aspx

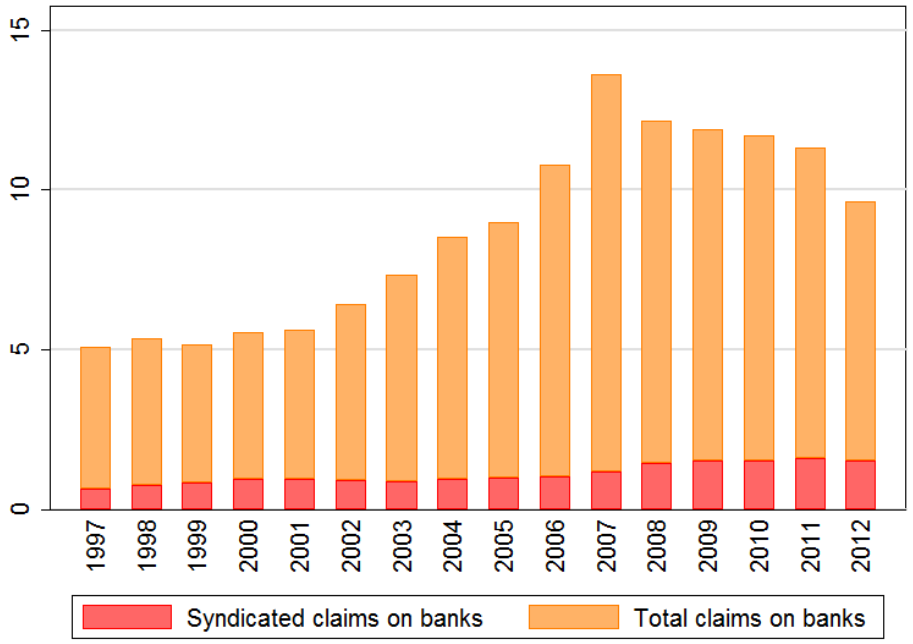
Tables and figures

Figure 1: Size of the interbank long-term lending market, 1997-2012

A. Number of loan deals

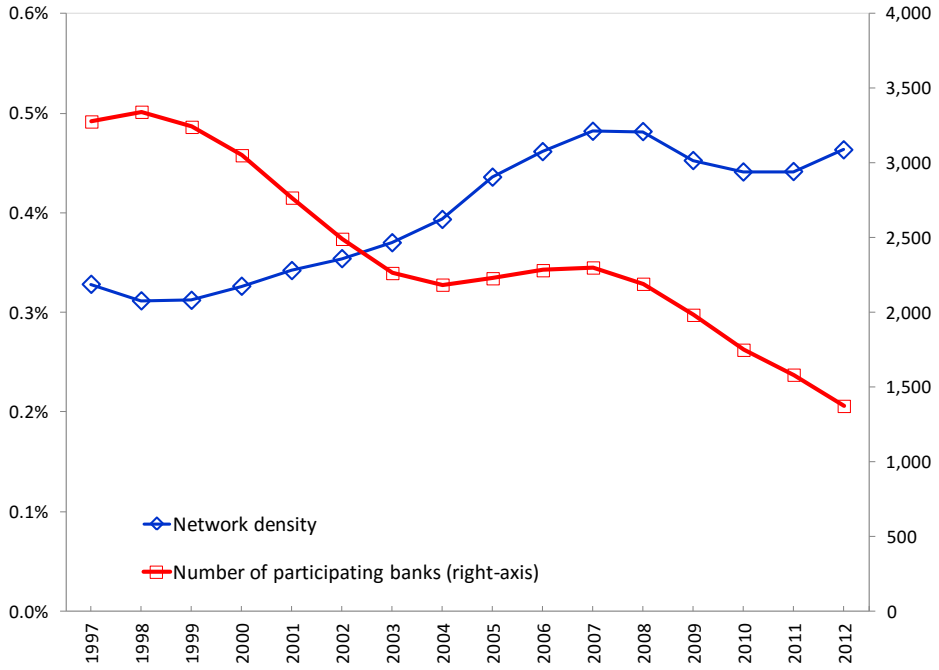


B. Cross-border interbank loan claims (trillions of U.S. dollars at 2005 prices)



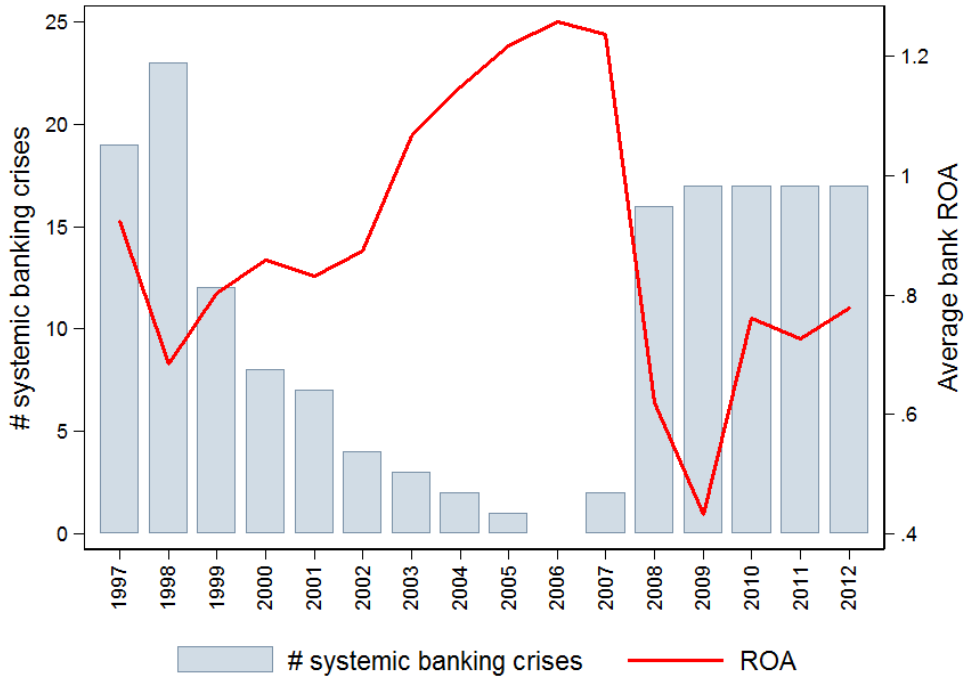
Notes: Panel A shows the number of loans issued to bank and non-bank (corporate and sovereign) borrowers during 1997-2012. Panel B shows syndicated interbank exposures and *total* interbank exposures for 35 banking systems vis-á-vis banking systems in 197 countries. Syndicated interbank exposures refer to on-balance sheet loan exposures. These comprise drawn credit lines and term loans and are estimates using the methodology described in Cerutti et al. (2015). Data sources: BIS locational banking statistics and Dealogic Loan Analytics.

Figure 2: Connectivity and number of banks in the global banking network, 1997-2012



Notes: Network density is given by the number of edges (exposures) divided by the total number of possible edges in the directed global banking network. Data sources: Dealogic Loan Analytics.

Figure 3: Bank profitability and systemic banking crises, 1997-2012



Data sources: Bankscope and Laeven and Valencia (2013).

Table 1: Long-term interbank exposures on bank balance sheets

For lender banks		For borrower banks			
% gross loans		% total liabilities		% total liabilities - deposits	
Malta	15.4	Iceland	12.2	Latvia	41.2
Luxembourg	9.9	Kazakhstan	9.5	Azerbaijan	25.2
United Kingdom	8.6	Azerbaijan	9.2	Slovenia	22.5
Netherlands	5.9	Slovenia	7.9	Iceland	20.4
Singapore	5.3	Georgia	7.3	Malta	18.7
Belgium	5.3	Latvia	6.6	Kazakhstan	15.3
Ireland	5.0	Turkey	6.3	Turkey	12.3
France	4.0	Algeria	5.9	Croatia	11.7
Hong Kong	3.7	El Salvador	5.1	Algeria	10.2
Germany	3.6	Norway	5.0	Oman	10.2
Libya	3.1	Denmark	5.0	Mauritius	10.0
Switzerland	3.1	Croatia	4.4	Denmark	9.5
Bahrain	2.9	Ukraine	4.0	Hungary	9.4
Australia	2.5	Bahrain	4.0	Bulgaria	9.3
Kuwait	2.2	Hungary	3.9	Norway	8.6
Egypt	2.2	Oman	3.3	Sri Lanka	8.2
Cyprus	1.9	Ireland	3.2	Australia	7.5
Portugal	1.8	South Korea	3.2	Bahrain	7.3
Canada	1.8	Estonia	2.9	Romania	7.2
Qatar	1.8	Argentina	2.8	Estonia	7.1
United Arab Emirates	1.5	Russia	2.6	Hong Kong	7.1
Saudi Arabia	1.4	Hong Kong	2.5	Argentina	6.7
Argentina	1.1	Romania	2.5	United Arab Emirates	6.6
Oman	1.1	Australia	2.4	Ukraine	6.5
Italy	1.0	Bulgaria	2.3	Namibia	6.4
Top 25 average	3.8	Top 25 average	5.0	Top 25 average	12.2
Full sample average	3.2	Full sample average	3.2	Full sample average	8.0

Notes: The table reports the top 25 countries by average share of long-term interbank exposures in total gross loans, share of long-term interbank liabilities in total liabilities, and share of long-term interbank liabilities in total liabilities less deposits, during 1997-2012. The full sample average refers to the 50 countries for which bank-level data on long-term interbank liabilities and total liabilities are available for at least 5 observations. Data sources: Dealogic Loan Analytics and Bankscope.

Table 2: Descriptive statistics

Variable	N	Mean	St. Dev.	Min	Max
BANK LEVEL BALANCE SHEET VARIABLES					
Return on assets (ROA)	14,448	0.809	1.560	-6.850	8.850
Return on equity (ROE)	14,445	8.398	16.44	-78.09	53.17
Net interest margins (NIM)	14,315	2.759	2.238	-0.910	15.87
Equity/Assets	14,448	8.753	9.333	0.320	81.51
Assets (USD bn)	14,448	72.34	236.4	0.450	3,808
Log(Assets, USD mn)	14,448	16.32	1.711	13.02	22.06
Business model: Commercial bank	14,448	0.808	0.394	0	1
Business model: Investment bank	14,448	0.0697	0.255	0	1
Business model: Other	14,448	0.122	0.327	0	1
Bank type: Sybsidiary	14,448	0.507	0.500	0	1
Bank type: Global ultimate owner	14,448	0.304	0.460	0	1
Bank type: Other	14,448	0.188	0.391	0	1
BANK LEVEL SYNDICATED LOAN EXPOSURES (NUMBER)					
Nonbanks: # direct exposures	14,448	7.276	41.67	0	895
Nonbanks: # direct crisis exposures (C)	14,448	1.968	19.32	0	582
Banks: # direct exposures	14,448	4.339	13.84	0	191
Banks: # direct crisis exposures (C)	14,448	0.251	1.553	0	40
Banks: # direct non-crisis exposures (NC)	14,448	4.083	13.20	0	190
Banks: # indirect exposures	14,448	15.62	68.19	0	1,981
Banks: # indirect crisis exposures (C)	14,448	1.611	10.64	0	500
Banks: # indirect non-crisis exposures (C)	14,448	14.01	61.37	0	1,481
Banks: # indirect crisis exposures through crises (C-C)	14,448	0.694	7.237	0	415
Banks: # indirect non-crisis exposures through crises (C-NC)	14,448	1.585	17.25	0	938
BANK-DESTINATION COUNTRY EXPOSURES (USD mn)					
Banks: Syndicated loan exposures	8,397	8	42	0	1,773
Nonbanks: Syndicated loan exposures	8,397	177	876	0	16,881
Total foreign exposure (US banks)	8,397	960	3048	0	42,088
Trade credit exposure (US banks)	7,171	156	781	0	26,203
OTHER VARIABLES					
Log-lending	279,993	3.662	1.37	0	10.80
Domestic loan	279,993	0.436	-	0	1
Systemic banking crisis	14,448	0.209	0.407	0	1

Notes: All the bank balance sheet variables are winsorized at the 1st and 99th percentiles of their respective distributions. Data sources: Dealogic Loan Analytics, Bankscope, Federal Reserve (reporting form FFIEC009a) and Laeven and Valencia (2013).

Table 3: Correlation of interbank exposures with total foreign exposures

	(1)	(2)
Log(U.S. dollar syndicated exposure to banks)	0.095***	
	(0.013)	
Log(U.S. dollar syndicated exposure to non-banks)	0.035***	
	(0.010)	
# syndicated exposures to banks		0.279***
		(0.076)
# syndicated exposures to non-banks		0.017
		(0.015)
Observations	8,397	8,397
R-squared	0.662	0.657
Year FE	Yes	Yes
Bank*destination country FE	Yes	Yes

Notes: The dependent variable is log(total foreign exposure in U.S. dollars) during 1997-2012. The regressions are run at the bank-destination country-year level. The sample comprises solely U.S. banks. Standard errors are clustered at the bank-destination country pair level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Data sources: Dealogic Loan Analytics and Federal Reserve (reporting form FFIEC009a).

Table 4: Effect of crisis exposures on bank performance - Baseline (ROA)

	(1)	(2)	(3)	(4)
Equity/Assets	0.055***	0.055***	0.055***	0.055***
	(0.007)	(0.007)	(0.007)	(0.007)
Log-Assets	0.071***	0.071***	0.071***	0.071***
	(0.012)	(0.012)	(0.012)	(0.012)
Business model: Commercial bank	0.154*	0.154*	0.150*	0.147*
	(0.080)	(0.080)	(0.080)	(0.079)
Business model: Investment bank	0.169	0.169	0.165	0.163
	(0.148)	(0.148)	(0.148)	(0.148)
Bank type: Subsidiary	0.153***	0.153***	0.151***	0.149***
	(0.057)	(0.057)	(0.057)	(0.057)
Bank type: Global ultimate owner	0.233***	0.233***	0.232***	0.231***
	(0.051)	(0.051)	(0.051)	(0.051)
Nonbanks: # direct exposures	0.000	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Nonbanks: # direct crisis exposures (C)	-0.001	-0.002	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Banks: # direct exposures	-0.000	0.000	0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Banks: # direct crisis exposures (C)	-0.029***	-0.031***	-0.022**	-0.143*
	(0.009)	(0.009)	(0.009)	(0.077)
Banks: # indirect exposures		-0.000	-0.001	-0.001
		(0.000)	(0.000)	(0.000)
Banks: # indirect crisis exposures (C)		0.001		
		(0.001)		
Banks: # indirect crisis exposures through crises (C-C)			-0.007**	-0.062**
			(0.003)	(0.028)
Banks: # indirect non-crisis exposures through crises (C-NC)			0.005***	0.068*
			(0.002)	(0.039)
Size * Banks: # direct crisis exposures (C)				0.007
				(0.005)
Size * Banks: # indirect crisis exposures through crises (C-C)				0.003**
				(0.001)
Size * Banks: # indirect non-crisis exposures through crises (C-NC)				-0.003*
				(0.002)
Observations	14,448	14,448	14,448	14,448
R-squared	0.440	0.440	0.441	0.442
Bank nationality*year FE	Yes	Yes	Yes	Yes
# banks	1869	1869	1869	1869

Notes: The dependent variable is bank return on assets (ROA). A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table 5: Effect of crisis exposures on bank performance - Baseline (ROE)

	(1)	(2)	(3)	(4)
Equity/Assets	0.071	0.072	0.071	0.068
	(0.045)	(0.045)	(0.045)	(0.042)
Log-Assets	0.800***	0.805***	0.802***	0.807***
	(0.150)	(0.150)	(0.149)	(0.150)
Business model: Commercial bank	1.440*	1.451*	1.415*	1.389*
	(0.777)	(0.778)	(0.776)	(0.771)
Business model: Investment bank	1.459	1.466	1.427	1.411
	(1.211)	(1.212)	(1.211)	(1.215)
Bank type: Subsidiary	1.634**	1.618**	1.606**	1.579**
	(0.639)	(0.639)	(0.639)	(0.639)
Bank type: Global ultimate owner	2.643***	2.623***	2.618***	2.615***
	(0.607)	(0.607)	(0.607)	(0.606)
Nonbanks: # direct exposures	0.009*	0.007	0.009*	0.011**
	(0.005)	(0.005)	(0.005)	(0.005)
Nonbanks: # direct crisis exposures (C)	-0.019*	-0.016	-0.024**	-0.021*
	(0.010)	(0.010)	(0.011)	(0.011)
Banks: # direct exposures	-0.004	-0.024	-0.016	-0.037
	(0.018)	(0.024)	(0.025)	(0.025)
Banks: # direct crisis exposures (C)	-0.305**	-0.270**	-0.199*	-0.402
	(0.130)	(0.132)	(0.117)	(0.997)
Banks: # indirect exposures		0.006	0.001	0.003
		(0.004)	(0.005)	(0.005)
Banks: # indirect crisis exposures (C)		-0.013		
		(0.017)		
Banks: # indirect crisis exposures through crises (C-C)			-0.098**	-1.151***
			(0.042)	(0.254)
Banks: # indirect non-crisis exposures through crises (C-NC)			0.049**	0.875***
			(0.021)	(0.294)
Size * Banks: # direct crisis exposures (C)				0.018
				(0.053)
Size * Banks: # indirect crisis exposures through crises (C-C)				0.057***
				(0.013)
Size * Banks: # indirect non-crisis exposures through crises (C-NC)				-0.043***
				(0.014)
Observations	14,445	14,445	14,445	14,445
R-squared	0.345	0.345	0.346	0.347
Bank nationality*year FE	Yes	Yes	Yes	Yes
# banks	1869	1869	1869	1869

Notes: The dependent variable is bank return on equity (ROE). A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table 6: Effect of crisis exposures on bank performance - Addressing endogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA			ROE		
	Stock vs. flow exposures	Drop 5th pct of size distribution	Drop G-SIBs	Stock vs. flow exposures	Drop 5th pct of size distribution	Drop G-SIBs
Equity/Assets	0.055***	0.056***	0.055***	0.070	0.073*	0.056
	(0.007)	(0.007)	(0.006)	(0.045)	(0.044)	(0.037)
Log-Assets	0.070***	0.089***	0.087***	0.795***	1.020***	0.979***
	(0.012)	(0.016)	(0.015)	(0.147)	(0.177)	(0.180)
Business model: Commercial bank	0.148*	0.151*	0.138*	1.396*	1.581*	1.280
	(0.080)	(0.084)	(0.081)	(0.775)	(0.815)	(0.797)
Business model: Investment bank	0.166	0.182	0.223	1.445	1.777	1.874
	(0.148)	(0.157)	(0.174)	(1.209)	(1.264)	(1.249)
Bank type: Subsidiary	0.151***	0.146**	0.103**	1.600**	1.527**	1.188*
	(0.057)	(0.059)	(0.050)	(0.639)	(0.654)	(0.644)
Bank type: Global ultimate owner	0.231***	0.233***	0.205***	2.611***	2.524***	2.331***
	(0.051)	(0.053)	(0.049)	(0.607)	(0.624)	(0.616)
Nonbanks: # direct exposures	0.000	0.004	-0.000	0.007	-0.030	-0.010
	(0.000)	(0.005)	(0.001)	(0.005)	(0.035)	(0.032)
Nonbanks: # direct crisis exposures (C)	-0.002*	-0.013*	-0.005*	-0.022**	-0.126	0.002
	(0.001)	(0.007)	(0.003)	(0.011)	(0.157)	(0.127)
Banks: # direct exposures - Stock	0.002			-0.006		
	(0.001)			(0.018)		
Banks: # direct crisis exposures (C) - Stock	-0.030***			-0.320**		
	(0.009)			(0.127)		
Banks: # direct exposures - Flow	0.000			0.008		
	(0.001)			(0.016)		
Banks: # direct crisis exposures (C) - Flow	0.025			0.318		
	(0.015)			(0.225)		
Banks: # direct exposures		-0.001	0.002		0.040	0.011
		(0.003)	(0.002)		(0.038)	(0.016)
Banks: # direct crisis exposures (C)		-0.026*	-0.018*		-0.067	-0.119**
		(0.014)	(0.010)		(0.050)	(0.052)
Banks: # indirect exposures	-0.001	-0.001	-0.001	-0.001	-0.000	-0.005
	(0.000)	(0.001)	(0.001)	(0.005)	(0.009)	(0.008)
Banks: # indirect crisis exposures through crises (C-C)	-0.005*	-0.010**	-0.009**	-0.075*	-0.186***	-0.194***
	(0.003)	(0.005)	(0.004)	(0.040)	(0.059)	(0.055)
Banks: # indirect non-crisis exposures through crises (C-NC)	0.004***	0.013**	0.006***	0.042**	0.133***	0.079**
	(0.002)	(0.005)	(0.002)	(0.021)	(0.050)	(0.031)
Observations	14,450	13,754	13,026	14,447	13,751	13,023
R-squared	0.441	0.442	0.451	0.346	0.350	0.363
Bank nationality*year FE	Yes	Yes	Yes	Yes	Yes	Yes
# banks	1869	1822	1703	1869	1822	1703

Notes: The dependent variable is bank return on assets (ROA). Global systematically important banks (G-SIBs) are identified based on the November 2014 Financial Stability Board classification (available on http://www.financialstabilityboard.org/wp-content/uploads/r_141106b.pdf). A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table 7: Effect of crisis exposures on bank performance - NIM channel

	(1) Contemporaneous	(2) 1 year later	(3) 2 years later	(4) Average next 3 years
Equity/Assets	0.016***	0.017***	0.018***	0.019***
	(0.004)	(0.004)	(0.005)	(0.005)
Log-Assets	-0.093***	-0.096***	-0.096***	-0.097***
	(0.022)	(0.023)	(0.024)	(0.024)
Business model: Commercial bank	0.244**	0.228**	0.189	0.197*
	(0.112)	(0.114)	(0.119)	(0.119)
Business model: Investment bank	-0.565***	-0.540***	-0.583***	-0.543***
	(0.182)	(0.191)	(0.201)	(0.204)
Bank type: Subsidiary	0.065	0.074	0.027	0.044
	(0.082)	(0.088)	(0.099)	(0.093)
Bank type: Global ultimate owner	0.091	0.087	0.026	0.059
	(0.084)	(0.089)	(0.099)	(0.094)
Nonbanks: # direct exposures	0.001	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Nonbanks: # direct crisis exposures (C)	-0.001	-0.000	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Banks: # direct exposures	-0.001	-0.001	-0.000	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)
Banks: # direct crisis exposures (C)	-0.023***	-0.017**	-0.018**	-0.018**
	(0.009)	(0.008)	(0.008)	(0.008)
Banks: # indirect exposures	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Banks: # indirect crisis exposures through crises (C-C)	-0.003	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Banks: # indirect non-crisis exposures through crises (C-NC)	0.003***	0.003**	0.002*	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	14,135	12,415	10,771	10,637
R-squared	0.659	0.664	0.664	0.698
Bank nationality*year FE	Yes	Yes	Yes	Yes
# banks	1849	1740	1527	1519

Notes: The dependent variable is bank net interest margins (NIM). In column 1, all regressors enter contemporaneously, in column 2 they are lagged one year, and in column 3 they are lagged 2 years. In column 4 the dependent variable is calculated as the average over the current and subsequent two years. A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table 8: Effect of crisis exposures on banks' supply of corporate loans

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lead banks				All banks			
Equity/Assets	0.0083***	0.0079***	0.0081***	0.0078***	0.0047***	0.0045***	0.0045***	0.0044***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Log-Assets	0.1231***	0.1199***	0.1210***	0.1178***	0.0678***	0.0666***	0.0668***	0.0658***
	(0.015)	(0.014)	(0.015)	(0.014)	(0.008)	(0.008)	(0.008)	(0.007)
Business model: Commercial bank	-0.0199	-0.0236	-0.0177	-0.0177	-0.0016	-0.0030	0.0006	0.0006
	(0.034)	(0.034)	(0.033)	(0.032)	(0.018)	(0.018)	(0.018)	(0.018)
Business model: Investment bank	0.1801***	0.1731**	0.1791***	0.1758***	0.0912**	0.0881**	0.0913**	0.0898**
	(0.070)	(0.069)	(0.069)	(0.067)	(0.038)	(0.037)	(0.037)	(0.037)
Bank type: Subsidiary	-0.0416	-0.0429	-0.0468	-0.0500	-0.0152	-0.0158	-0.0181	-0.0193
	(0.048)	(0.048)	(0.047)	(0.048)	(0.025)	(0.025)	(0.025)	(0.025)
Bank type: Global ultimate owner	-0.1744***	-0.1777***	-0.1722***	-0.1707***	-0.0927***	-0.0942***	-0.0903***	-0.0897***
	(0.056)	(0.056)	(0.055)	(0.054)	(0.029)	(0.030)	(0.029)	(0.029)
Nonbanks: # direct exposures	0.0003*	0.0004**	0.0003**	0.0004***	0.0001	0.0001*	0.0001	0.0002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nonbanks: # direct crisis exposures (C)	-0.0003	-0.0004	-0.0003	-0.0005	-0.0001	-0.0002	-0.0001	-0.0002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Banks: # direct exposures	0.0008***	0.0009**	0.0007**	0.0007*	0.0004**	0.0004	0.0004**	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Banks: # direct crisis exposures (C)	-0.0024**	-0.0025**	-0.0040***	-0.0041***	-0.0013*	-0.0014*	-0.0018***	-0.0017*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Banks: # indirect exposures		-0.0001		-0.0001		-0.0000		-0.0000
		(0.000)		(0.000)		(0.000)		(0.000)
Banks: # indirect crisis exposures through crises (C-C)		-0.0013***		-0.0032***		-0.0006**		-0.0015***
		(0.001)		(0.001)		(0.000)		(0.001)
Banks: # indirect non-crisis exposures through crises (C-NC)		0.0009***		0.0019***		0.0004***		0.0010***
		(0.000)		(0.000)		(0.000)		(0.000)
Domestic loan * Banks: # direct crisis exposures (C)			0.0005	-0.0023			-0.0000	-0.0006
			(0.001)	(0.003)			(0.001)	(0.001)
Domestic loan * Banks: # indirect crisis exposures through crises (C-C)				0.0028***				0.0014**
				(0.001)				(0.001)
Domestic loan * Banks: # indirect non-crisis exposures through crises (C-NC)				-0.0017***				-0.0009***
				(0.000)				(0.000)
Observations	167,958	167,958	167,958	167,958	295,204	295,204	295,204	295,204
R-squared	0.889	0.889	0.889	0.890	0.906	0.906	0.906	0.906
Borrower*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank nationality*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# banks	1211	1211	1211	1211	1333	1333	1333	1333
# borrowers	22527	22527	22527	22527	30301	30301	30301	30301

Notes: The dependent variable is log(loan amount) at the bank-borrower-year level, where the borrower is an individual firm. Loans to both financial and non-financial sector borrowers are included. Borrower*year fixed effects and bank nationality*year fixed effects are included in all regressions. A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Online Appendix (<u>not for publication</u>)

Table A1: Sample composition

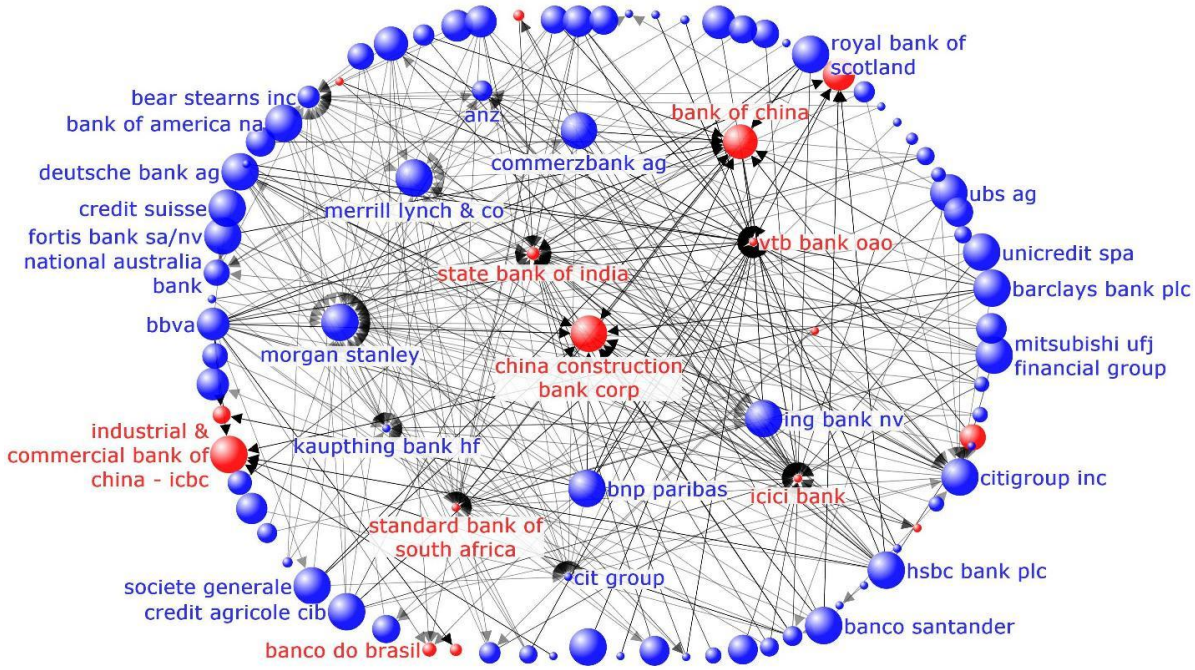
Country	IFS code	3-letter code	# lenders	# borrowers	# banks in regression sample
ALBANIA	ALB	914	1	0	1
ALGERIA	DZA	612	1	4	5
ANDORRA	AND		2	1	0
ANGOLA	AGO	614	0	2	0
ARGENTINA	ARG	213	6	23	12
ARMENIA	ARM	911	0	4	1
AUSTRALIA	AUS	193	66	59	31
AUSTRIA	AUT	122	71	9	41
AZERBAIJAN	AZE	912	1	10	7
BAHAMAS	BHS	313	11	2	1
BAHRAIN	BHR	419	50	20	18
BANGLADESH	BGD	513	0	3	4
BARBADOS	BRB	316	1	0	0
BELARUS	BLR	913	0	11	6
BELGIUM	BEL	124	60	10	22
BENIN	BEN	638	0	1	1
BERMUDA	BMU	319	3	1	0
BOLIVIA	BOL	218	0	5	3
BOSNIA AND HERZEGOVINA	BIH	963	0	1	0
BRAZIL	BRA	223	14	54	29
BRUNEI DARUSSALAM	BRN	516	1	0	0
BULGARIA	BGR	918	2	13	7
BURUNDI	BDI	618	1	0	0
CANADA	CAN	156	40	16	12
CAYMAN ISLANDS	CYM	377	24	16	0
CHILE	CHL	228	5	15	11
CHINA	CHN	924	45	34	27
COLOMBIA	COL	233	6	12	7
COOK ISLANDS	COK	815	0	1	0
COSTA RICA	CRI	238	1	6	1
COTE D'IVOIRE	CIV	662	1	0	0
CROATIA	HRV	960	6	10	6
CUBA	CUB	928	1	3	0
CYPRUS	CYP	423	8	4	5
CZECH REPUBLIC	CZE	935	22	7	6
DENMARK	DNK	128	28	40	25
DOMINICAN REPUBLIC	DOM	243	1	1	0
ECUADOR	ECU	248	1	4	2
EGYPT	EGY	469	14	9	12
EL SALVADOR	SLV	253	1	7	2
ESTONIA	EST	939	1	7	3
ETHIOPIA	ETH	644	0	1	1
FINLAND	FIN	172	19	11	8
FRANCE	FRA	132	125	30	49
GABON	GAB	646	1	0	0
GAMBIA	GMB	648	1	0	0
GEORGIA	GEO	915	0	3	2
GERMANY	DEU	134	201	28	65
GHANA	GHA	652	3	6	2
GREECE	GRC	174	18	10	12
GUATEMALA	GTM	258	0	2	1
HONDURAS	HND	268	1	1	1
HONG KONG	HKG	532	408	176	31
HUNGARY	HUN	944	25	18	14
ICELAND	ISL	176	10	18	6
INDIA	IND	534	16	36	29
INDONESIA	IDN	536	18	55	6
IRAN (ISLAMIC REPUBLIC OF)	IRN	429	3	6	0
IRAQ	IRQ	433	1	1	1
IRELAND	IRL	178	65	12	33
ISRAEL	ISR	436	9	6	7
ITALY	ITA	136	165	87	100
JAMAICA	JAM	343	1	2	0
JAPAN	JPN	158	312	67	125
JORDAN	JOR	439	9	3	9
KAZAKHSTAN	KAZ	916	11	16	9
KENYA	KEN	664	0	3	3
KOREA REPUBLIC OF	KOR	542	132	69	45
KUWAIT	KWT	443	21	14	10

digitcode3	IFS code	3-letter code	# lenders	# borrowers	# banks in regression sample
LATVIA	LVA	941	12	13	6
LEBANON	LBN	446	15	6	11
LIBYAN ARAB JAMAHIRIYA	LBY	672	1	0	1
LIECHTENSTEIN	LIE		3	0	0
LITHUANIA	LTU	946	4	6	1
LUXEMBOURG	LUX	137	121	10	44
MACAU	MAC	546	17	4	0
MACEDONIA	MKD	962	0	2	0
MALAYSIA	MYS	548	72	29	26
MALDIVES	MDV	556	0	1	0
MALTA	MLT	181	7	3	5
MAURITIUS	MUS	684	4	2	4
MEXICO	MEX	273	10	23	7
MOLDOVA REPUBLIC OF	MDA	921	0	2	1
MONGOLIA	MNG	948	2	3	1
MOROCCO	MAR	686	4	8	7
NAMIBIA	NAM	728	0	2	2
NETHERLANDS	NLD	138	74	24	31
NETHERLANDS ANTILLES	ANT	353	1	2	0
NEW ZEALAND	NZL	196	4	7	4
NIGERIA	NGA	694	5	10	11
NORWAY	NOR	142	23	33	25
OMAN	OMN	449	9	6	5
PAKISTAN	PAK	564	6	5	5
PANAMA	PAN	283	22	9	12
PARAGUAY	PRY	288	0	3	1
PERU	PER	293	2	14	4
PHILIPPINES	PHL	566	14	20	14
POLAND	POL	964	29	19	16
PORTUGAL	PRT	182	28	13	23
PUERTO RICO	PRI		3	3	0
QATAR	QAT	453	10	4	6
ROMANIA	ROU	968	7	13	6
RUSSIAN FEDERATION	RUS	922	84	106	61
SAN MARINO	SMR	135	1	0	1
SAUDI ARABIA	SAU	456	18	6	12
SENEGAL	SEN	722	0	1	1
SERBIA	SRB	965	0	3	0
SEYCHELLES	SYC	718	0	1	0
SINGAPORE	SGP	576	257	29	16
SLOVAKIA	SVK	936	6	6	4
SLOVENIA	SVN	961	9	12	10
SOUTH AFRICA	ZAF	199	15	15	10
SPAIN	ESP	184	86	21	58
SRI LANKA	LKA	524	1	5	5
SUDAN	SDN	732	1	0	0
SWEDEN	SWE	144	21	14	6
SWITZERLAND	CHE	146	76	20	21
SYRIAN ARAB REPUBLIC	SYR	463	1	0	0
TAIWAN	TWN	528	94	45	49
TAJIKISTAN	TJK	923	0	1	0
TANZANIA UNITED REPUBLIC OF	TZA	738	0	1	0
THAILAND	THA	578	45	42	15
TOGO	TGO	742	1	1	1
TRINIDAD AND TOBAGO	TTO	369	1	3	0
TUNISIA	TUN	744	3	5	6
TURKEY	TUR	186	46	56	29
TURKMENISTAN	TKM	925	0	1	1
UKRAINE	UKR	926	4	34	14
UNITED ARAB EMIRATES	ARE	466	38	15	16
UNITED KINGDOM	GBR	112	455	99	126
UNITED STATES OF AMERICA	USA	111	680	454	240
URUGUAY	URY	298	1	2	0
UZBEKISTAN	UZB	927	0	2	1
VENEZUELA	VEN	299	3	10	6
VIETNAM	VNM	582	3	8	2
YEMEN	YEM	474	1	0	0
ZAMBIA	ZMB	754	0	1	1
ZIMBABWE	ZWE	698	0	3	1
Total			4,531	2,427	1,869

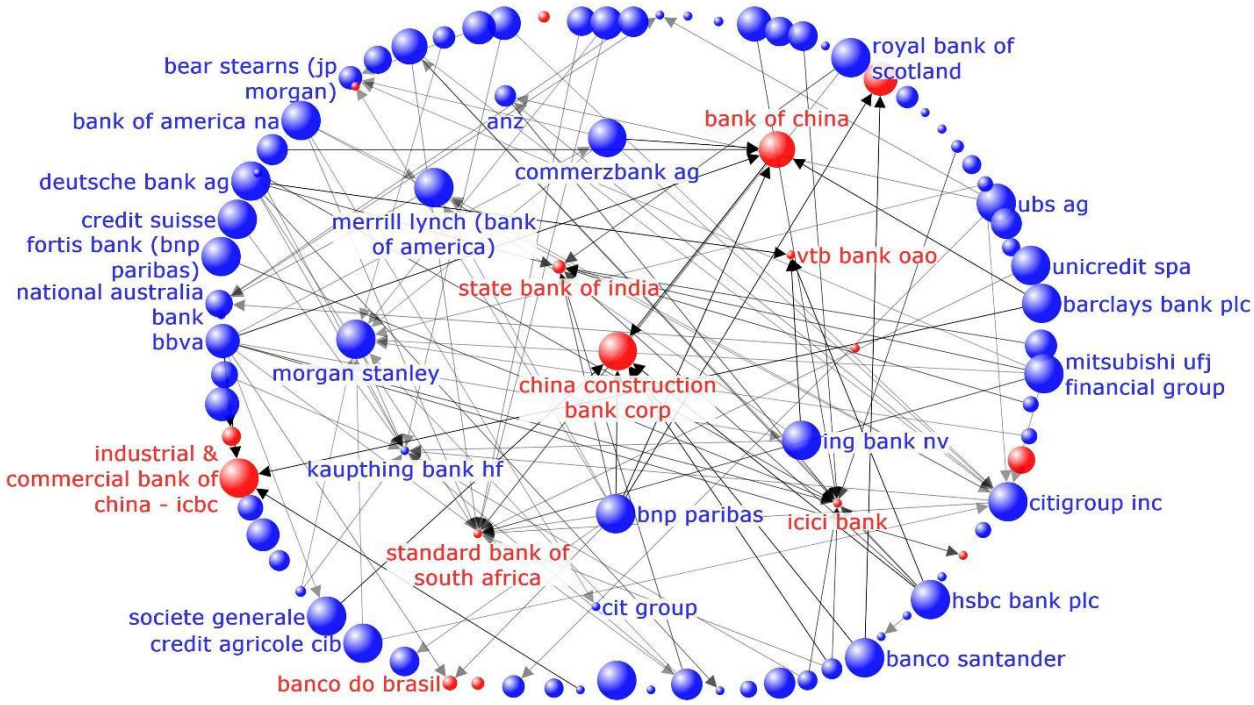
Notes: The table reports the number of lending and borrowing banks in the global banking network, and the number of banks in our regression sample, by country. Data sources: Dealogic Loan Analytics and Bankscope.

Figure A1: Global banking network

2007



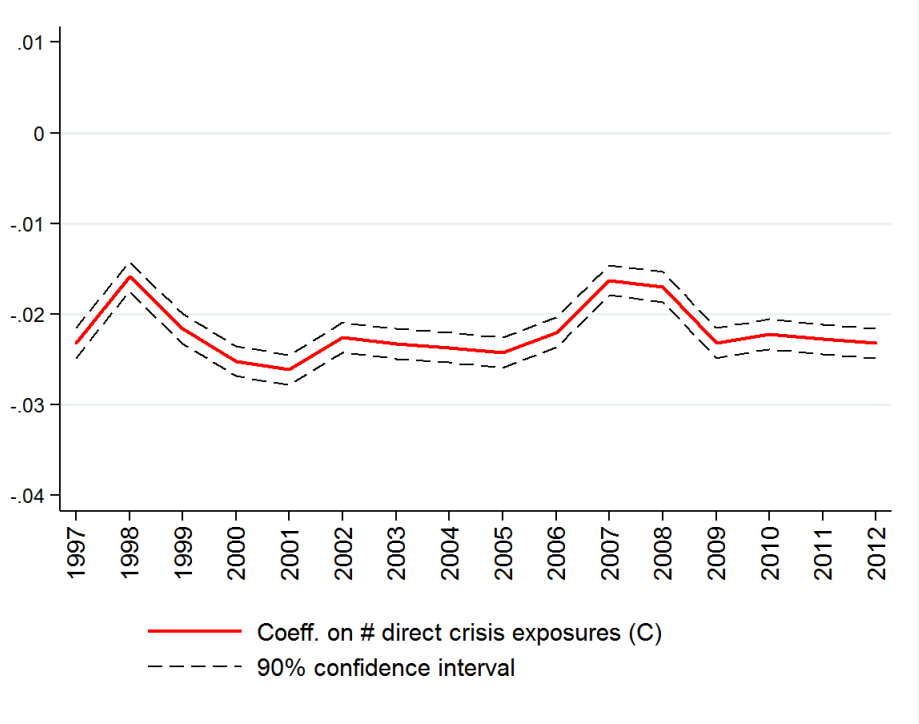
2010



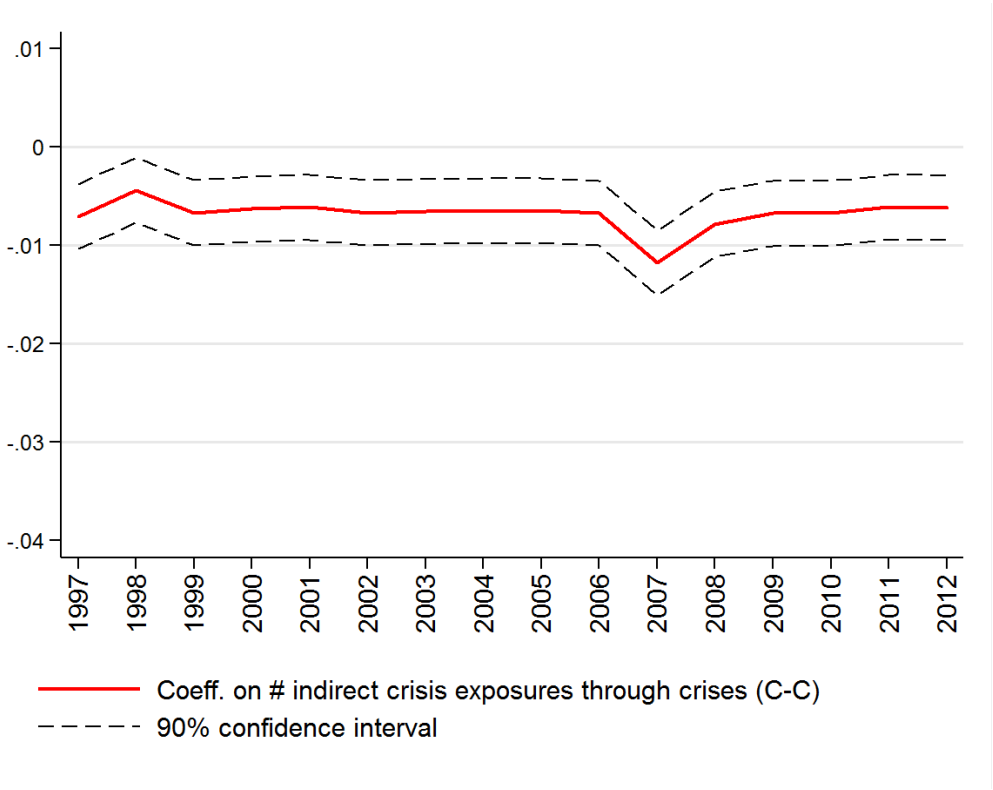
Notes: The figure depicts visualizations of the global banking network in 2007 and 2010 for the largest 100 banks (based on 2007 assets) that were lenders, borrowers, or both. Blue nodes are banks in OECD countries and red nodes are banks in non-OECD countries. Edge color is darker for larger exposures. Larger nodes indicate larger banks. For visibility, only the names of selected banks are shown. The position of the nodes in the network is ad-hoc. See Section 4.1 "Constructing foreign interbank exposures" for details on the construction of the network. Data sources: Loan Analytics and Bankscope.

Figure A2. Robustness of main coefficients to dropping each year from the sample

A. Coefficient on # direct crisis exposures to banks (C)



B. Coefficient on # indirect crisis exposures through crises (C-C)



Data sources: Loan Analytics and Bankscope.

Table A2. Profitability regressions: Robustness to controlling for characteristics of counterparty banks

	(1)	(2)	(3)	(4)
Equity/Assets	0.055***	0.055***	0.055***	0.055***
	(0.007)	(0.007)	(0.007)	(0.007)
Log-Assets	0.070***	0.070***	0.070***	0.070***
	(0.012)	(0.012)	(0.012)	(0.012)
Business model: Commercial bank	0.150*	0.148*	0.146*	0.144*
	(0.080)	(0.080)	(0.080)	(0.079)
Business model: Investment bank	0.164	0.163	0.161	0.159
	(0.148)	(0.148)	(0.148)	(0.148)
Bank type: Subsidiary	0.152***	0.152***	0.151***	0.148***
	(0.057)	(0.057)	(0.057)	(0.057)
Bank type: Global ultimate owner	0.232***	0.232***	0.232***	0.232***
	(0.051)	(0.051)	(0.051)	(0.051)
Nonbanks: # direct exposures	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Nonbanks: # direct crisis exposures (C)	-0.002	-0.002	-0.003*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Banks: # direct exposures	0.001	0.003	0.004*	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Banks: # direct crisis exposures (C)	-0.023**	-0.026***	-0.020**	-0.128*
	(0.009)	(0.010)	(0.009)	(0.077)
Banks: # indirect exposures		-0.000	-0.001*	-0.001
		(0.000)	(0.000)	(0.000)
Banks: # indirect crisis exposures (C)		0.001		
		(0.001)		
Banks: # indirect crisis exposures through crises (C-C)			-0.006**	-0.064**
			(0.003)	(0.031)
Banks: # indirect crisis exposures through non-crises (C-NC)			0.005***	0.069*
			(0.002)	(0.039)
Size * Banks: # direct crisis exposures (C)				0.006
				(0.004)
Size * Banks: # indirect crisis exposures through crises (C-C)				0.003**
				(0.002)
Size * Banks: # indirect non-crisis exposures through crises (C-NC)				-0.003*
				(0.002)
Observations	14,448	14,448	14,448	14,448
R-squared	0.441	0.441	0.441	0.443
Bank nationality*year FE	Yes	Yes	Yes	Yes
Controls for counterparty banks	Yes	Yes	Yes	Yes
No. banks	1869	1869	1869	1869
p-value F-test characteristics of counterparty banks do not matter	0.0667	0.0653	0.114	0.0317

Notes: The dependent variable is bank return on assets (ROA). A constant term is included in all specifications, but the coefficient is not shown Standard errors are clustered at the bank level. All regressions include characteristics of banks that are one and two steps away in the GBN. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table A3. Profitability regressions: Robustness to reducing sample size

	(1) Keep countries with >5 banks	(2) Keep banks with > 5 consecutive years data
Equity/Assets	0.055***	0.056***
	(0.007)	(0.008)
Log-Assets	0.071***	0.064***
	(0.012)	(0.013)
Business model: Commercial bank	0.148*	0.130
	(0.079)	(0.086)
Business model: Investment bank	0.162	0.115
	(0.147)	(0.164)
Bank type: Subsidiary	0.155***	0.158**
	(0.057)	(0.065)
Bank type: Global ultimate owner	0.229***	0.214***
	(0.051)	(0.057)
Nonbanks: # direct exposures	0.000	0.001
	(0.000)	(0.000)
Nonbanks: # direct crisis exposures (C)	-0.002*	-0.003*
	(0.001)	(0.001)
Banks: # direct exposures	0.001	0.001
	(0.002)	(0.002)
Banks: # direct crisis exposures (C)	-0.022**	-0.017*
	(0.009)	(0.010)
Banks: # indirect exposures	-0.001	-0.001
	(0.000)	(0.000)
Banks: # indirect crisis exposures through crises (C-C)	-0.007**	-0.006*
	(0.003)	(0.003)
Banks: # indirect non-crisis exposures through crises (C-NC)	0.005***	0.005***
	(0.002)	(0.002)
Observations	14,167	12,740
R-squared	0.430	0.453
Bank nationality*year FE	Yes	Yes
No. banks	1820	1230

Notes: The dependent variable is bank return on assets (ROA). A constant term is included in all specifications, but the coefficient is not shown. In column 1 we keep the countries with at least 5 banks. In column 2 we keep the banks with at least five consecutive years of data. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).

Table A4: Lending regressions: Robustness to dropping loans to financial sector borrowers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lead banks				All banks			
Equity/Assets	0.0087***	0.0081***	0.0084***	0.0080***	0.0049***	0.0047***	0.0048***	0.0047***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Log-Assets	0.1288***	0.1250***	0.1264***	0.1225***	0.0714***	0.0700***	0.0701***	0.0690***
	(0.017)	(0.016)	(0.016)	(0.015)	(0.009)	(0.008)	(0.009)	(0.008)
Business model: Commercial bank	-0.0152	-0.0169	-0.0126	-0.0105	-0.0001	-0.0005	0.0024	0.0035
	(0.036)	(0.036)	(0.035)	(0.034)	(0.019)	(0.019)	(0.019)	(0.019)
Business model: Investment bank	0.1800**	0.1742**	0.1792**	0.1767**	0.0917**	0.0894**	0.0918**	0.0909**
	(0.071)	(0.071)	(0.070)	(0.069)	(0.040)	(0.040)	(0.039)	(0.039)
Bank type: Subsidiary	-0.0555	-0.0564	-0.0602	-0.0628	-0.0207	-0.0209	-0.0233	-0.0244
	(0.052)	(0.051)	(0.051)	(0.051)	(0.027)	(0.027)	(0.027)	(0.027)
Bank type: Global ultimate owner	-0.1882***	-0.1913***	-0.1859***	-0.1843***	-0.1008***	-0.1024***	-0.0984***	-0.0980***
	(0.061)	(0.061)	(0.060)	(0.059)	(0.032)	(0.032)	(0.032)	(0.031)
Nonbanks: # direct exposures	0.0004**	0.0004***	0.0004**	0.0005***	0.0001	0.0002*	0.0001*	0.0002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Nonbanks: # direct crisis exposures (C)	-0.0004	-0.0005*	-0.0004	-0.0006*	-0.0002	-0.0002	-0.0002	-0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Banks: # direct exposures	0.0007**	0.0005	0.0005*	0.0003	0.0003**	0.0001	0.0003	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Banks: # direct crisis exposures (C)	-0.0021*	-0.0020*	-0.0037***	-0.0021**	-0.0011**	-0.0011*	-0.0018***	-0.0006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0006)	(0.000)	(0.001)
Banks: # indirect exposures		-0.0000		-0.0000		0.0000		0.0000
		(0.000)		(0.000)		(0.000)		(0.000)
Banks: # indirect crisis exposures through crises (C-C)		-0.0016***		-0.0031***		-0.0007**		-0.0015***
		(0.001)		(0.001)		(0.000)		(0.001)
Banks: # indirect non-crisis exposures through crises (C-NC)		0.0009***		0.0017***		0.0004**		0.0009***
		(0.000)		(0.000)		(0.000)		(0.000)
Domestic loan * Banks: # direct crisis exposures (C)			0.0006	-0.0001			0.0000	-0.0006
			(0.001)	(0.001)			(0.001)	(0.001)
Domestic loan * Banks: # indirect crisis exposures through crises (C-C)				0.0027***				0.0014**
				(0.001)				(0.001)
Domestic loan * Banks: # indirect non-crisis exposures through crises (C-NC)				-0.0016***				-0.0009***
				(0.000)				(0.000)
Observations	147,246	147,246	147,246	147,246	261,150	261,150	261,150	261,150
R-squared	0.894	0.894	0.894	0.894	0.908	0.908	0.908	0.908
Borrower*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank nationality*year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# banks	1110	1110	1110	1110	1236	1236	1236	1236
# borrowers	20633	20633	20633	20633	27911	27911	27911	27911

Notes: The dependent variable is log(loan amount) at the bank-borrower-year level, where the borrower is an individual firm. Loans to financial sector borrowers are dropped from the sample. Borrower*year fixed effects and bank nationality*year fixed effects are included in all regressions. A constant term is included in all specifications, but the coefficient is not shown. Standard errors are clustered at the bank level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 1% level. Data sources: Dealogic Loan Analytics, Bankscope, and Laeven and Valencia (2013).