Channels of Crisis Transmission in the Global Banking Network

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ECSB MaRs Concluding Conference
ECB, Frankfurt
June 24, 2014

*The views expressed herein are those of the authors and should not be attributed to the Federal Reserve System, Fannie Mae, the IMF, their Executive Boards, or their management.

In 2010, Citibank NA had syndicated loan exposures vis-à-vis 105 banks in 94 countries.
Motivation

• Complexity of financial linkages has been on the increase and raises questions about stability of global financial system during crises

• Financial linkages, especially cross-border may act as conduits of financial sector shocks
  — Ongoing efforts on banking regulation

Question

• Study the role of cross-border bank linkages in the transmission of financial sector shocks worldwide

• Estimate the impact of exposures to borrowers in countries experiencing financial turmoil on bank profitability
  — Why?
    • Key dimension of banking system soundness
    • It predicts bank survival
Aim

• Disentangle the channels through which systemic banking crises are transmitted through the global interbank market:
  – Direct exposures
    • First-degree (1 step away) connections
  – Indirect exposures
    • Higher-degree (> than 1 step away) connections
  – Relative position in the network
    • “Key intermediaries”

Contribution

• First paper to use loan-level data to examine the transmission of financial sector shocks through the global interbank network

• Steps:
  1. Construct global interbank network (EGBN) (for a large number of banks ~5,500 banks)
  2. Compute bank-level measures of interconnectedness
  3. Relate these measures to bank profitability (~2,000 banks are linked to their financials during 1997-2010)
Hypotheses

• Theory: interconnectedness carries both
  – Benefits: diversification, shock diffusion and
  – Risks: facilitates transmission of shocks/contagion

• Bank linkages may play a different role during normal and crisis periods
  – Normal times: portfolio diversification concerns, search for yield, advantageous market position
  – Crisis times: direct losses and contagion

Formally

• Bank performance $Y$ is affected by crises in its home country $C$ and the performance of banks to which it is exposed (directly or indirectly)

$$Y_i = \alpha_i + \beta C_i + \gamma \sum_j Y_j E_{ij} \delta(s)$$

• Substituting for $Y_j$

$$Y_i = \alpha_i + \beta C_i + \bar{\alpha} \gamma \sum_j E_{ij} + \beta \gamma \sum_j C_j E_{ij} + \frac{\bar{\alpha} \gamma^2}{1 - \gamma} \sum_j P_{ij} + \frac{\beta \gamma^2}{1 - \gamma} \sum_j C_j P_{ij}$$
... adding network measures

\[ Y_i = \alpha_i + \beta C_i + \mu N_i + \nu N_i C_i + \gamma \sum_j Y_j E_{ij} \delta(s) \]

Expanding,

\[ Y_i = \alpha_i + \beta C_i + \mu N_i + \nu N_i C_i + \bar{\alpha} \gamma \sum_j E_{ij} + \beta \gamma \sum_j C_j E_{ij} + \nu \gamma \sum_j N_j E_{ij} + \nu \gamma \sum_j N_j C_j E_{ij} + \frac{\bar{\alpha}^2 \gamma^2}{1 - \gamma} \sum_j P_{ij} + \frac{\beta^2 \gamma^2}{1 - \gamma} \sum_j C_j P_{ij} + \frac{\nu^2 \gamma^2}{1 - \gamma} \sum_j N_j P_{ij} + \frac{\nu^2 \gamma^2}{1 - \gamma} \sum_j N_j C_j P_{ij}. \]

Data Construction

- Loan-level data from syndicated loan market for 1990-2010 from Dealogic’s Loan Analytics
  - Carefully clean up bank names, adjust for bank name changes, mergers and acquisitions, etc.
  - Split total loan volumes by bank (pro-rata)
  - Construct interbank exposures and hence the binary and weighted EGBN
- Balance sheet data from Bankscope
Example: Syndicated loan to a British investment bank

**Participating banks (15):**
BayernLB; Bank of Montreal (London); Bank of Tokyo-Mitsubishi UFJ Ltd; Commerzbank
International Luxembourg SA; Dresdner Kleinwort Wasserstein; HSH Nordbank AG (London); ING Bank NV; KBC; Lloyds TSB Bank plc; Mizuho Corporate Bank Ltd; Royal Bank of Scotland plc; SG Corporate & Investment Banking; Standard Chartered Bank; Sumitomo Mitsui Banking Corp Europe Ltd; Wachovia Bank NA

**Nationalities (7):**
Germany, UK, Japan, Luxembourg, Netherlands, Belgium, France

**Borrower:**
Investec Bank (UK) Ltd.

**Industry:** Private sector bank

**Signing date:** March 28, 2006

**Deal type:** Investment grade

**Maturity:** 3 years

**Amount:** GBP 445 million

**Interest rate:** LIBOR + 120bps

Source: Loan Analytics

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Cross-border syndicated loan exposures = 12.5% of total loan interbank exposures, 1995-2012

![Graph showing cross-border syndicated loan exposures](image)
Global Banking Network (EGBN)

Represents Interbank Exposures created through syndicated loan contracts

Constructed using the amounts and maturities of interbank loans

Relatively sparse

Visualization of the EGBN in 2007 for the largest 100 banks by assets. Blue: banks in OECD countries. Red: banks in non-OECD countries. Edge width proportional to size of syndicated loan exposures. Node size proportional to bank size.

Measures of Interconnectedness

1. Direct exposures
   - USD exposures (out-strength)
   - Number of direct counterparties (out-degree)

2. Indirect exposures
   - Network proximity to the banks from each country (computed on binary EGBN)

3. Relative position in the network (“key intermediary”)
   - Betweenness Centrality
     - Key intermediaries borrow from and lend to many other banks; they tend to “lie at the cross roads”, to link groups of banks in the network (typically highly centric banks with peripheral banks)
   - Top EMs: China, Turkey, Russia, India, Brazil
Example: Arab Bank Plc (Jordan)

In 2010, Arab Bank PLC (Jordan) had syndicated loan claims on 16 banks and liabilities vis-à-vis 29 banks.

Example: Commonwealth Bank of Australia

In 2010, Commonwealth Bank of Australia had syndicated loan claims on 18 banks and liabilities vis-à-vis 11 banks.
Empirical Set-Up

Regressions

- Panel regressions:
  - Dataset: 2,000 banks from 88 countries over 1997-2010
  - Dependent variable: ROA

- Controls:
  - Bank size (log-assets)
  - Capital (equity/assets)
  - Indicator for crisis in bank’s home country
  - Type of entity dummies
  - Specialization dummies
  - Bank nationality FE
  - Year FE

- St. errors clustered on bank

Main Covariates

- Direct exposures:
  - To banks and non-banks in crisis vs. non-crisis country-years

- Indirect exposures:
  - To banks in crisis vs. non-crisis country-years

- Relative network position
  - Dummy for key intermediaries
  - Interacted with crisis in the bank’s home country and # crises elsewhere

Effect of Direct USD Exposures on ROA

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
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<tbody>
<tr>
<td>ROA</td>
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<tr>
<td>Direct US$ non-crisis exposure (total)</td>
<td>-0.000</td>
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<td></td>
<td>(0.000)</td>
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<tr>
<td>Direct US$ crisis exposure (total)</td>
<td>-0.003***</td>
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<td>(0.001)</td>
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<tr>
<td>Direct US$ non-crisis exposure (banks)</td>
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<td>-0.002</td>
<td>-0.003</td>
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<td>(0.002)</td>
<td>(0.004)</td>
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<td>Direct US$ crisis exposure (banks)</td>
<td></td>
<td>-0.026***</td>
<td>-0.038**</td>
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<td>(0.008)</td>
<td>(0.015)</td>
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<td>Direct US$ non-crisis exposure (non-banks)</td>
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<td>(0.001)</td>
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<td>Direct US$ crisis exposure (non-banks)</td>
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<tr>
<td></td>
<td></td>
<td>(0.003)</td>
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<tr>
<td>Observations</td>
<td>11,374</td>
<td>11,374</td>
<td>11,374</td>
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<tr>
<td>R-squared</td>
<td>0.336</td>
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### Effect of Direct & Indirect Exposures on ROA

<table>
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<tr>
<td>ROA</td>
<td>-0.000</td>
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<tr>
<td>ROA</td>
<td>(0.000)</td>
<td>(0.000)</td>
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<tr>
<td>Direct US$ non-crisis exposure (total)</td>
<td>0.002</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
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<tr>
<td>Direct 0-1 non-crisis exposure (banks)</td>
<td>0.000</td>
<td>-0.000</td>
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<td>(0.001)</td>
<td>(0.001)</td>
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<tr>
<td>Direct 0-1 crisis exposure (banks)</td>
<td>-0.019**</td>
<td>-0.016**</td>
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<td>(0.006)</td>
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<td>Indirect 0-1 non-crisis exposure (banks)</td>
<td>0.106</td>
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<td></td>
<td>(0.171)</td>
<td>(0.469)</td>
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<tr>
<td>Indirect 0-1 crisis exposure (banks)</td>
<td>-0.820*</td>
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<tr>
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<td>(0.069)</td>
<td>(0.469)</td>
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</table>

| Observations                   | 9,552        | 9,063        |
| R-squared                      | 0.343        | 0.339        |

### Potential mechanisms

- **Two mechanisms:**
  - **Losses due to defaults (bankruptcies)**
    - Syndicated loan market exhibits lower default rates and higher loan recovery rates than other segments of credit market (even more so for banks)
    - Typically, renegotiation to extend maturity
  - **Losses in the securities portfolio**
    - Only leveraged loans are traded (bank borrowers unlikely)

- **Challenges:**
  - Difficult to identify mechanisms using aggregate data
  - Syndicated loan exposures may be proxies for broader exposures to borrowers
Effect of Being Key Intermediary on Bank ROA

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<tr>
<th>Dependent variable: ROA</th>
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<tr>
<td>Direct US$ non-crisis exposure (total)</td>
<td>-0.001</td>
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<tr>
<td>Direct US$ crisis exposure (total)</td>
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<td>0.001</td>
<td>0.003</td>
<td>-0.783**</td>
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<td>(0.002)</td>
<td>(0.347)</td>
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<tr>
<td>Direct 0-1 non-crisis exposure (banks)</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.012</td>
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<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.012)</td>
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<tr>
<td>Direct 0-1 crisis exposure (banks)</td>
<td>-0.014**</td>
<td>-0.017**</td>
<td>-0.016**</td>
<td>-0.013*</td>
<td>0.011</td>
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<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.008)</td>
<td>(0.018)</td>
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<tr>
<td>Indirect 0-1 non-crisis exposure (banks)</td>
<td>0.100</td>
<td>0.089</td>
<td>0.085</td>
<td>0.284</td>
<td>-0.135</td>
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<tr>
<td></td>
<td>(0.174)</td>
<td>(0.173)</td>
<td>(0.174)</td>
<td>(0.206)</td>
<td>(0.437)</td>
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<tr>
<td>Indirect 0-1 crisis exposure (banks)</td>
<td>-0.832</td>
<td>-0.801</td>
<td>-0.806</td>
<td>-0.290</td>
<td>-2.168***</td>
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<tr>
<td></td>
<td>(0.549)</td>
<td>(0.552)</td>
<td>(0.551)</td>
<td>(0.690)</td>
<td>(0.573)</td>
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<tr>
<td>Key intermediary</td>
<td>-0.162***</td>
<td>-0.029</td>
<td>-0.010</td>
<td>-0.111</td>
<td>0.117</td>
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<td>(0.061)</td>
<td>(0.057)</td>
<td>(0.063)</td>
<td>(0.075)</td>
<td>(0.096)</td>
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<tr>
<td>Key intermediary * Crisis in home country</td>
<td>-0.535***</td>
<td>-0.517***</td>
<td>-0.012</td>
<td>-0.942***</td>
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<td>(0.157)</td>
<td>(0.159)</td>
<td>(0.123)</td>
<td>(0.239)</td>
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<tr>
<td>Key intermediary * No. of crises elsewhere</td>
<td>-0.003</td>
<td>0.001</td>
<td>-0.011</td>
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<tr>
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<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.007)</td>
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<tr>
<td>Observations</td>
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<td>8,734</td>
<td>8,734</td>
<td>2,866</td>
<td>4,715</td>
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<tr>
<td>R-squared</td>
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<td>0.344</td>
<td>0.344</td>
<td>0.418</td>
<td>0.342</td>
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</table>

Conclusions

- Built a global interbank network from granular data on syndicated loans during 1997-2010
- Results:
  - Controlling for exposures to non-bank sector, direct and indirect exposures to banks reduce bank profitability during crisis-years
  - “Key intermediaries” (especially from EMs) perform worse than other banks during crises in home countries
- Ongoing work on potential mechanisms