Assessing the Systemic Risk of a Portfolio of Heterogeneous Banks During the Recent Financial Crisis

Xin Huang\textsuperscript{1} Hao Zhou\textsuperscript{2} Haibin Zhu\textsuperscript{3}

\textsuperscript{1}University of Oklahoma
\textsuperscript{2}Federal Reserve Board
\textsuperscript{3}J.P. Morgan Chase Bank, N.A.

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November 17, 2011
Background

- The global financial crisis has led bank supervisors and regulators to rethink about the rationale of banking regulation.
- Complement “micro-” with “macro-” prudential approach.
  - National, regional and international levels.
  - Financial stability and economic performance.
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Objectives of this paper

- Measuring systemic risk: distress insurance premium (Huang, Zhou and Zhu (2009)).
- Decompose systemic risk into physical default risk and risk premia.
- Allocate systemic risk to individual banks. Or identify systemically important FIs.
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Market-based systemic risk indicator

Systemic importance of individual banks
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Main findings

- Both spillover effects and real economy affect the movement of the systemic risk indicator.
- Risk premia are the main driving factors of systemic risk.
- Size effect is important in determining the systemic importance of individual banks, supporting “too-big-to-fail”.
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Outlines of the presentation

- Construct the systemic risk indicator.
- Driving factors of systemic risk.
- Allocating systemic risk to each bank.
- Conclusion.
I. Construct the systemic risk indicator

- Distress insurance premium (DIP).
- Suppose that a hypothetic insurance contract is issued to protect distressed losses in a banking system (at least a significant portion of total liabilities in default), what is the fair insurance premium?
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Methodology: an overview

1. CDS spreads
   - Step 1
   - Individual PD

2. Equity prices
   - Step 2
   - Correlation

3. Simulate portfolio loss distribution
   - Step 3

4. Indicator: DIP
   - Step 4
Methodology: an overview

CDS spreads

Step 1

Individual PD

Equity prices

Step 2

Correlation

Step 3

Simulate portfolio loss distribution

Step 4

Indicator: DIP
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Step 1: estimating PDs from CDS spreads \((s_{i,t})\) (Duffie (1999) and Tarashev and Zhu (2008))

\[
PD_{i,t} = \frac{a_t s_{i,t}}{a_t LGD_{i,t} + b_t s_{i,t}}
\]  

- PDs are forward-looking.
- PDs are risk-neutral.

Risk-neutral PD

Actual PD

Risk premium

Default risk premium

Liquidity risk premium
Methodology

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Step 2: estimating asset return correlations.

- Use equity return correlations as a proxy (Hull & White): short time horizon.
- Use Dynamic Conditional Correlation (DCC) approach by Engle (2002).
  - Daily data for Asian and the Pacific region.
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- A hypothetical weighted portfolio of debt instruments of all banks, weighted by bank liabilities.

- \( L = \sum L_i \)

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The banking system in this study

- 22 major banks in Asia-Pacific.
  - Selection criteria.
    - Tier-1 capital > 2.5 billion USD in 2007 or the largest bank in its own jurisdiction.
    - Data availability: CDS, equity prices, EDF.
  - Australia (6), Hong Kong (2), India (2), Indonesia (1), Korea (4), Malaysia (2), Singapore (3) and Thailand (2).
- 22 banks combined held 3.95 trillion USD in 2007 (compared to the aggregate GDP of 4.2 trillion USD)
- "distress": total losses ≥ 10% of total liabilities.
- Sample period: January 2005 to May 2009, weekly frequency.
- CDS from Markit, Equity data from Bloomberg, EDF from Moody’s KMV.
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Systemic Risk Indicator for Asian-Pacific Banking Sector

New century failed
BNP Paribas froze funds
Lehman Brothers failed
Bear Stearns acquired
G20 Summit

Huang, Zhou and Zhu
Systemic Risk of Financial Institutions
Systemic Risk Indicator for 19 US Banks

- Jan 04: Hedge Funds Fail
- Jan 05: Bear Stearns Fails
- Jan 06: Lehman Bros. Fails
- Jan 07: Peak of VIX
- Jan 08: Stock Market Bottom
- Jan 09: SCAP Results Released

Graphs showing unit price (%) and billions USD from Jan 04 to Jan 10.
II. Driving factors of systemic risk

Approach 1:
- Substitute risk-neutral PDs with actual PDs (EDF) → DIP on an (expected) incurred cost basis.
- That is, the risk premium is set to be zero always.

Diagram:
- Equity prices
- Correlation
- EDF (actual PD)
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Diagram:
- **Equity prices**
- **EDF (actual PD)**
- **Correlation**
- **Indicator**
Systemic Risk Indicator Based on CDSs

Systemic Risk Indicator Based on EDFs

New century failed
BNP Paribas freed funds
Bear Stearns acquired
Lehman Brothers failed
G20 Summit

Date
Unit price (%)

Jan05 Jul05 Jan06 Jul06 Jan07 Jul07 Jan08 Jul08 Jan09
0 0.01 0.02 0.03 0.04

Huang, Zhou and Zhu
Systemic Risk of Financial Institutions
Approach 2: regression-based analysis.
- Actual default.
- Default risk premium.
- Liquidity risk premium.
### Dependent variables

<table>
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<tr>
<th>Dependent variables</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
<th>Regression 4</th>
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</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.061 (-1.9)</td>
<td>-0.49 (-12.5)</td>
<td>0.013 (0.2)</td>
<td>-0.31 (-7.1)</td>
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<tr>
<td>Average EDF (%)</td>
<td>3.44 (17.6)</td>
<td></td>
<td></td>
<td>1.50 (5.6)</td>
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<tr>
<td>Baa-Aaa spread (%)</td>
<td></td>
<td>0.64 (23.6)</td>
<td></td>
<td>0.33 (5.5)</td>
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<tr>
<td>LIBOR-OIS spread (%)</td>
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<td></td>
<td>0.68 (8.6)</td>
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<td>Adjusted-R²</td>
<td>0.86</td>
<td>0.92</td>
<td>0.60</td>
<td>0.95</td>
</tr>
</tbody>
</table>
III. Allocating systemic risk to each bank

- Marginal contribution of bank $i$ to the systemic risk.
  - Definition: $MC_i = \frac{\partial DIP}{\partial L_i} = E[L_i|L \geq L_{\min}]$
  - Computation: Importance sampling method (Glasserman and Li (2005)).
  - $DIP = \sum MC_i \Rightarrow$ additive property
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<td>St George Bank</td>
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<td>1.2026</td>
<td>1.2868</td>
<td>n.a.</td>
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<td><strong>Total</strong></td>
<td></td>
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<td>57.6092</td>
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<td>40.4308</td>
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<td>Bank Name</td>
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<td>Marginal contribution by bank</td>
<td>Memo: Bank equity in 2007</td>
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- Size matters most → “too big to fail”
- Correlation → common exposures, interconnection
- PD
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<tr>
<td>PD_{i,t} \times Weight_{i,t}</td>
<td>15.53</td>
<td>(0.9)</td>
<td>23.45</td>
<td>(1.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cor_{i,t} \times Weight_{i,t}</td>
<td>272.35</td>
<td>(4.9)</td>
<td>450.35</td>
<td>(6.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted-R^2</td>
<td>0.83</td>
<td></td>
<td>0.89</td>
<td></td>
<td>0.92</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Our approach provides a possible tool for macro-prudential regulation
  - To identify systemically important financial institutions
  - To understand sources of systemic risk
  - To impose capital surcharge for systemic banks

- Challenges remain
  - Time-dimension (counter-cyclical capital buffer)
  - A unified framework?
  - How banks may react to new regulatory regime?
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