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Measuring Systemicness in the U.S. Insurance Industry

Anton Badev

Board of Governors, U.S. Federal Reserve, anton.badev@gmail.com

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Measuring Systemicness in the U.S. Insurance Industry

Anton Badev  Nathan Foley-Fisher  Borghan Narajabad  Stéphane Verani

Federal Reserve Board

July 22, 2015
SEM Paris

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U.S. life insurers’ bond holdings: Overview

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Total Portfolio ($bn)</th>
<th>Mean No. Of Bonds</th>
<th>Mean Par Value ($mn)</th>
<th>Portfolio Share (bps)</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>2004</td>
<td>50,465</td>
<td>3,566</td>
<td>7.72</td>
<td>11.43</td>
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<tr>
<td>2008</td>
<td>56,833</td>
<td>3,276</td>
<td>8.08</td>
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<tr>
<td>2010</td>
<td>60,522</td>
<td>3,372</td>
<td>7.82</td>
<td>7.68</td>
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<tr>
<td>2013</td>
<td>65,897</td>
<td>3,464</td>
<td>7.53</td>
<td>6.09</td>
</tr>
</tbody>
</table>

*Source: U.S. Life Insurers’ Statutory Filing, Schedule D Part I, year-end.*

- On average, insurers’:
  - (i) total portfolio size has increased;
  - (ii) number of bonds held since 2008 increased;
  - (iii) mean and st. dev. of holding par value (size) decreased since 2008;
  - (iv) mean and st. dev. share of each bond in total portfolio has decreased.

- Individual life insurers appear to hold more diversified portfolios
A. Does individual portfolio diversification imply reduced systemic risk?

  ▶ Can we measure the systemicness of the industry's portfolio holdings?

B. Build measures of the overall industry risk (systemicness) grounded on the distance between the risk profiles of insurers’ portfolios—explore the similarity of insurers’ exposure to risk.

  ▶ Our framework takes a network (macro) perspective based on micro-data

C. Combine data on bond performance w.r.t. return and liquidity—used to create risk metric space, with regulatory data on insurers’ holdings.

Findings:

1. Insurers' idiosyncratic risk is not necessarily related to industry aggregate risk.

2. The systemicness of the industry increased after 2008.
Data

- **National Association of Insurance Commissioners**: U.S. Life Insurers Statutory Filings, Schedule D Part I (year-end bond holdings), 2004-2013
  - Each insurance company is linked to its parent
  - We take care to account for mergers and joint filings
  - Final set of insurance groups accounts for 90 percent of industry

- **FINRA TRACE**: Regulatory data on trades in corporate and agency fixed income securities

- **Mergent FISD**: Outstanding amounts of fixed income securities
Measures of similarity between bonds

- We focus on two measures of similarity between bonds:

  - **Yield:** monthly weighted average yields on all trades for each CUSIP

  - **Liquidity:** monthly average volume on all trades for each CUSIP, scaled by amount outstanding

- Two bonds are similar if the correlation between yield/liquidity is high
Measuring the distance between insurers’ portfolios

- We define a distance metric between insurers $i$ and $j$ as:
  \[ d_{t,i,j} = \sqrt{|A_{t,i} - A_{t,j}|^T W |A_{t,i} - A_{t,j}|} \]

- $A_{t,i}$, is the vector of portfolio share bond holdings of insurer $i$ in year $t$

- Each element of $W$ captures the correlation between bonds $k$ and $l$, where:
  \[ W_{k,l} := 1 - \text{Corr}_{k,l} \in [0, 2] \]

- We use two correlation matrices based on bond characteristics:
  i) yields
  ii) liquidity

**Intuition:** A smaller distance between two insurers means that their bond portfolios are more vulnerable to similar shocks
Modeling the community structure

- We construct the network matrix $D_t$, where each element $d_{t,i,j}$ is the distance between insurers $i$ and $j$

- Community structure is determined by the algorithm in Clauset, Newman and Moore (Physical Review E, 2004) which optimizes a modularity score

- Offers a measure of how distinct each community is given a partitioning when implicitly compared to a randomly generated graph

$$Q = \frac{1}{2m} \sum_{v,w} [A_{vw} - \frac{K_v K_w}{2m}] \delta(C_v, C_w)$$

Modularity Score

$A_{vw} = 1$ if $(v,w) \in E$ else 0

Link

$K_v = \sum_w A_{vw}$

In-degree

$\delta(C_v, C_w) = 1$ if $v,w \in C_i$ else 0

Same Community
### Network statistics for yield-distance metric

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<td>20</td>
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<td>904</td>
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<td>35.72</td>
<td>17.87</td>
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- Evidence that systemicness of the industry increased after 2008
  - (i) More concentration within communities
  - (ii) Greater number of significant network connections (edges)
  - (iii) Faster contagion speed (higher second eigenvalue)
Network dynamics I: yield-metric

**Yield: Average Shortest Path**

**Yield: Diameter**

**Yield: Second Eigenvalue**

**Yield: Number of Communities**
# Network statistics for liquidity-metric

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<tr>
<td>2013</td>
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<td>30</td>
<td>7.07</td>
<td>1,354</td>
<td>3</td>
<td>47.32</td>
<td>15.20</td>
</tr>
</tbody>
</table>

- Evidence that systemicness of the industry increased after 2008
  
  (i) More concentration within communities
  
  (ii) Greater number of significant network connections (edges)
Network dynamics I: liquidity-metric

Liquidity: Average Shortest Path

Liquidity: Diameter

Liquidity: Second Eigenvalue

Liquidity: Number of Communities
Concluding remarks

- We distinguish between (individual) insurer’s risk exposure and the industry (overall) systemicness:
  - Insurers’ level analysis suggest risk is diversified in the aftermath of the financial crisis
  - Industry level (network) perspective implies the contrary: industry systemicness has grown

- Insurance industry became more vulnerable to common shocks following the financial crisis

- Look for absolute measures of industry systemicness (current focus is on the dynamic). Note that the analysis is generalizable.