The Credit Quality Channel
A novel approach to model contagion in the interbank market
Ulrich Krüger, Deutsche Bundesbank
Motivation and general approach

• Analysis of contagion effects due to a deterioration in credit quality in the banking network
  – Credit event in the banking network
    ▪ Transmission of the shock to other banks via asset devaluation and deterioration in credit quality
  – Adverse effect on Tier 1 capital derived from Basel accords
  – Reduction in aggregated Tier 1 capital in the banking system due to an exogenous shock

• “Banking System Loss” (BSLoss) measures interconnectedness
  – Extends existing default cascade models (sensitivity to small shocks)
Illustration of the contagion process

External shock (k=1)

Bank 1

First round effects (k=2)

Bank 2

Second and higher order round effects (k≤3)

Bank 4

External shock (k=1)

Bank 1

First round effects (k=2)

Bank 2

Second and higher order round effects (k≤3)

Bank 4

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23 February 2016
Page 3
Conceptual description

- Capital ratios of banks in the network (bank 2, bank 3, bank 4 in the example) change through contagion
  - Change to Tier 1 capital is translated into an increase of the Probability of Default (PD)
  - Expected losses of the neighboring banks are deducted from their Tier 1 capital (consistent with Basel accord)

- “Banking System Loss” measures interconnectedness
  - Reduction in aggregated Tier 1 capital in the banking system due to the exogenous shock
Application
Network of German banks

- Data as of end of December 2013 from Deutsche Bundesbank’s credit register of large exposures (€1.5m or more)
## Application I
### Ranking of systemically important institutions

<table>
<thead>
<tr>
<th>Rank of Inst.</th>
<th>Total Effect</th>
<th></th>
<th>Indirect Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BSLoss</td>
<td>Defaults</td>
<td>BSLoss / direct Exp.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5.51</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>7.19</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4.68</td>
</tr>
<tr>
<td>4</td>
<td>0.34</td>
<td>0.69</td>
<td>1.23</td>
</tr>
<tr>
<td>5</td>
<td>0.11</td>
<td>0.02</td>
<td>0.94</td>
</tr>
<tr>
<td>6</td>
<td>0.09</td>
<td>0.02</td>
<td>0.76</td>
</tr>
<tr>
<td>7</td>
<td>0.08</td>
<td>0.03</td>
<td>0.73</td>
</tr>
<tr>
<td>8</td>
<td>0.07</td>
<td>0.12</td>
<td>0.69</td>
</tr>
</tbody>
</table>

- “BSLoss” normalised by BSLoss of the highest ranked bank (bank 1)
- Number of defaults of banks in the contagion process shown in relation to the number of defaults following the default of bank 1
Benchmarking with other measures of interconnectedness

<table>
<thead>
<tr>
<th></th>
<th>D-SIBs (Total score)</th>
<th>D-SIBs (Interconnectedness)</th>
<th>Bonacich centrality</th>
<th>In-Degree measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρ</td>
<td>39 %</td>
<td>66 %</td>
<td>96 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>

- ρ shows Spearman’s rank correlation coefficient between BSLoss and other measures
- Low correlation with D-SIBs’ methodology for interconnectedness due to restrictions to direct exposures
- High correlation with Bonacich eigenvector-based centrality underlines that both measures take into account the entire network structure
Application II
Shock to the real estate sector
Conclusion

• Merits
  – “BSLoss” easy to interpret (expressed in monetary units)
  – Sensitive to small shocks
  – Allows for different credit stress scenarios
    ▪ shock to one bank or a group of banks
    ▪ shock to the mortgage sector or to other sectors
  – Supports evaluation of macroprudential instruments (eg SIFI-buffer)

• Limitations
  – Ignores impact from other relevant contagion channels (liquidity channel, reputation channel etc.)
References

Appendix: The credit quality channel in the context of stress testing

- Scenario analysis
  - Exogenous shock
  - Economy: GDP-growth, interest rates, unemployment rates etc.

- Satellite models
  - Income components: net interest income, net fee income, trading income, operating expenses
  - Credit risk: credit losses, change in RWA

- Credit quality channel
  - Interbank contagion

- Financial stability
  - Losses of the financial sector

Impact on banks

Feedback effects
Appendix: Relationship between Tier capital ratio and Probability of Default

- Impact of banks’ Tier1 capital ratio on its PDs derived from a univariate logit-regression

\[ PD_{i,t} = F(\alpha + \beta \cdot \ln(CapRat_{i,t-1})) \]

- \( PD_{i,t} \): Probability that bank \( i \) will fail in time \( (t - 1; t) \)
- \( CapRat_{i,t} \): Tier 1 Capital Ratio \( (Tier1_{i,t}/RWA_{i,t}) \)
- \( F(z) \): Cumulative logistic distribution \( (e^z/(1 + e^z)) \)
Appendix: Assessing shock transmission for different types of banks

Comparison of system loss for various situations in % of the aggregated Tier 1 capital

<table>
<thead>
<tr>
<th></th>
<th>Typical large institution</th>
<th>Group of regional institutions</th>
<th>Individual small institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second-order effects</td>
<td>3%</td>
<td>13%</td>
<td>0,0%</td>
</tr>
<tr>
<td>First-order effects</td>
<td>12%</td>
<td>4%</td>
<td>0,1%</td>
</tr>
</tbody>
</table>

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23 February 2016
Page 13