Measuring Default Contagion and System Risk: insights from network models

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Main points of the paper

- How to measure *stability* of a financial system
- How to improve stability in an *efficient* way

- The authors work on a unique set of data (Brazil Banks, June 07 - Dec 08).
- Different measures are developed and show intuitive results on this dataset.

On the methodological side, the goal is to represent the financial system as a *network*.

- n nodes; the *exposure* of node i to node j is E_{ij}.
- Node i has *capital* c_i and liquidity l_i.
- If $c_i = 0$ then the node i *defaults*.
- *Contagion:* If i defaults, then node j also defaults if

$$c_j < (1 - R_i)E_{ji}.$$

Introduce stochastic *market shocks*:

- Consider $\epsilon_i, \dots, \epsilon_n$ which reduce capital to $(c_i + \epsilon_i)_+$.
- If i defaults, then node j defaults if

$$(c_j + \epsilon_j)_+ < (1 - R_i)E_{ji}$$

  or derivative payouts are larger than the liquidity

$$l_i + \sum_j \pi_{ij}(c + \epsilon, E) < 0.$$

This induces a *default cascade:* $D_0(A) \subset D_1(A) \subset \cdots \subset D_{n-1}(A)$.

- *Static:* Set $\epsilon = 0$. Leads to the *default impact* $DI(i, c + \epsilon)$ (loss by $D_{n-1}(\{i\})$).
- *Stochastic:* Choose model for ϵ and define the *contagion index*

$$\mathbb{E}(DI(i, c + \epsilon) | c_i + \epsilon_i \leq 0).$$

For asessing *systemic risk* the authors only consider a subset $\mathbb{C} \subset \{1, \ldots, n\}$ of all banks. Then they define analogously

- *Static* Set $\epsilon = 0$ and define *systemic risk index* $I_{\mathbb{C}}$ as default index only of those nodes in $\mathbb{C}$.
- *Stochastic* Choose model for ϵ and define the *systemic risk index*

$$\mathbb{E}(I_{\mathbb{C}}(i, c + \epsilon) | c_i + \epsilon_i \leq 0).$$

Main assumption

- Gaussian one-factor model, $Z_0, Z_1, \dots$ iid $N(0,1)$ and

$$\epsilon_i = \sqrt{\rho} Z_0 + \sqrt{1-\rho} Z_i$$

- Heavy tailed factor model $Z_0, Z_1, \dots$ iid α-stable and

$$\epsilon_i = \rho^\alpha Z_0 + (1-\rho)^\alpha Z_i$$

- c_i are chosen such that the default probability is met.

Questions

- What are the requirements for a good distribution of ϵ_i?
- What is the model risk?
- Should one incorporate feedback effects?

Target immunization

Susceptibility ratio:

$$\chi_i = \max_{j \neq i} \frac{E_{ij}}{c_i}$$

(maximal fraction of wiped out capital on default of node i)

- Capital requirement: Impose a cap on χ for the most systemic nodes.

- Are the results stable amongst distributions of ϵ?
- Time between defaults is not taken into account.
- Relatively short interval of data (stability of the results/outcome)?
- The measures are estimates! Can you give confidence bounds?