

## Apply It.

### The math behind...

# Systemic Risk in Finance



#### Technical terms used:

Random graphs, contagion, complex system stability, correlations, regulation

#### Uses and applications:

The recent global financial crisis highlighted the interconnectedness of the banking system: The fate of one institution can affect others and potentially the whole sector. The study of the stability of banking *networks* allows regulators to better understand and design policies so as to minimize the risk for the whole system.

#### How it works:

Banks and other financial institutions lend money to each other. This creates a network of liabilities, where the banks are seen as nodes and the money owed by one to another as directed links. The exact structure of this network is often not fully known, but its main characteristics are, so randomized simulations are used to understand which characteristics affect the global stability.

When one institution goes bankrupt, it does not repay its loans. This induces losses for its creditors, and a second bank might in turn go bankrupt. A third party that had lent to both might have retarded the failure of each alone, but might not stand the cumulated loss and also become bankrupt.

With respect to this contagion mechanism, banking networks are often found to be *robust-yet-fragile*: The probability that a contagion will start is small, but when it happens it takes down a very large part of the system, because as the contagion spreads it reinforces itself.

Additionally, banks may have invested in the same assets. The bankruptcy of a bank triggers the sudden sale of its investment in those assets, which drives the prices down and further impacts other institutions holding the same assets.

A paradigm is slowly shifting: Investment diversification—not putting all your eggs in the same basket—has long been known as good for minimizing the risk, from the perspective of a single institution. At the global level, a crowd of institutions diversifying in the same way creates asset correlations and interconnectedness which affect the systemic risk in a nontrivial way.

#### Interesting fact:

Unlike social networks, banking networks are *disassortative*: Little connected banks are more likely to be connected to highly connected banks, which act as hubs. This tends to reduce the probability of contagion, though not its extent when it happens.

#### References:

- F. Caccioli, T. Catanach, and D. Farmer; Heterogeneity, correlations and financial contagion. *Advances in Complex Systems*, 15 (2012).
- F. Caccioli, M. Shrestha, C. Moore, and D. Farmer; Stability analysis of financial contagion due to overlapping portfolios. *Journal of Banking & Finance*, 46 (2014).
- "The maths behind ... online social networks." *Maths matters ... apply it!* (2011).

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