How resilient is your organisation? From local failures to systemic risk
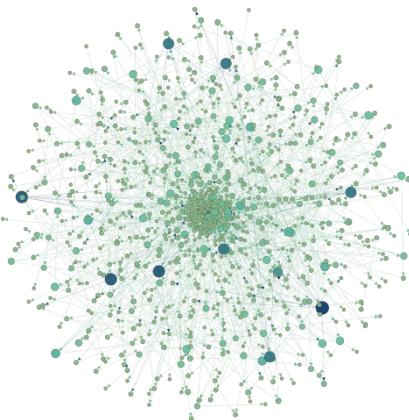
Presented by Christos Ellinas
Paper by Christos Ellinas, Neil Allan and Neil Cantle

Take-away message

"We like complexity. Yet, it has serious consequences – systemic risk being one of them. Complex Networks can provide a quantitative framework to tackle practical challenges in an objective, evidence-based way"

What it's all about

- Preamble
  - Complexity and Networks
  - Emergence of Systemic Risk
  - Signs of systemic risk in the insurance domain
- Modelling systemic risk
  - Brief description of model
  - Theoretical Implications
- From Theory to Practice
  - The case of firm acquisition

Why networks? Well, it's complex..
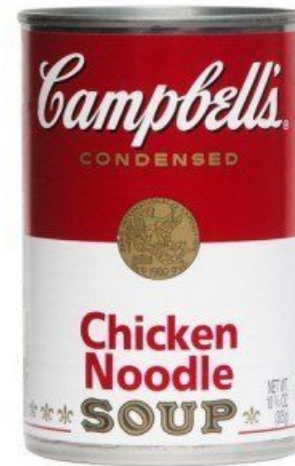
- **Complexity**: both contain the same components, yet distinctly different.
- Its all about the **connections** ..
- Importantly, it is not about the extent of connectedness but rather on the **way it manifests**
- **Complex networks** form an ideal framework for exploring the implications of this complexity

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Analogy courtesy of Dr. Thilo Gross

The emergence of Systemic Risk
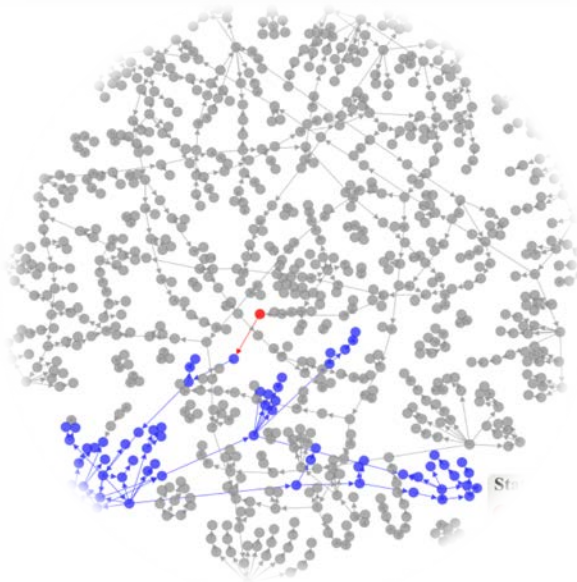
- **Systemic risk** emerges if underpinning interactions are **sufficiently complex**
- The process that fuels it (**cascading process**) can be equated to the domino effect
- For ex. if a domino (firm) fails, and certain conditions are satisfied, its neighbouring dominos (firm) will also fail.
- Its effect **captured by** enumerating the **number of nodes** affected

Signs of systemic risk within the insurance domain
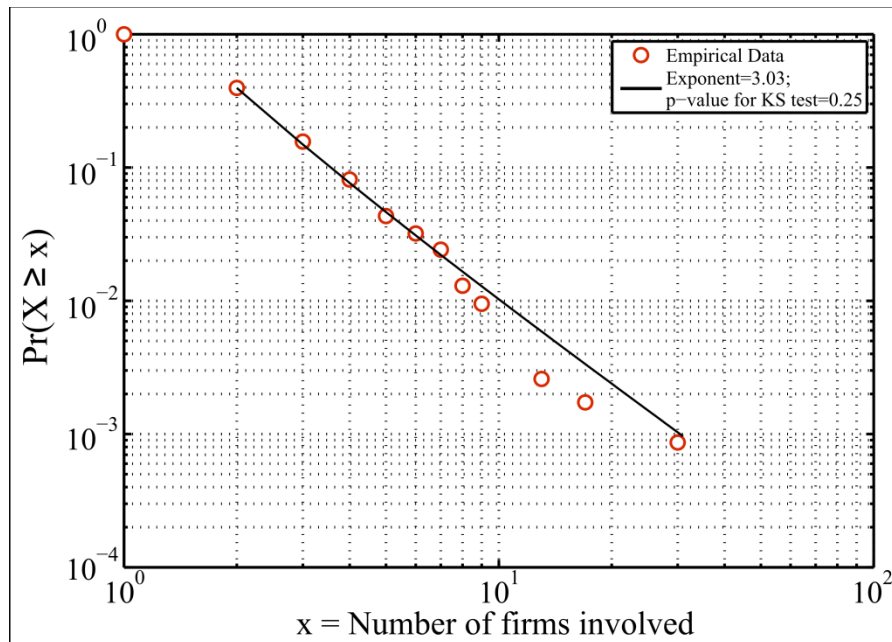
Data from 1155 loss events across 6 years. Distribution is heavy-tail; straight line on log-log resembles a power-law.

- Number of firms involved (or **cascade size**) was plotted as a cumulative probability distribution

- Extreme heterogeneity observed, indicative of:
  - Systemic risk is a real possibility
  - Non-trivial interactions underpin the insurance domain

Model Description

Network Structure

- Two firms are likely to be connected if they both have high Admissible Assets

- Resulting network structure lacks uniformity and null mixing patterns; in step with empirical observations

- An ensemble of 1,000 networks is generated and tested.

Cascading Process

- A threshold mechanism is set, based on each firms Excess Capital (EC) and Admissible Assets (AA).

- Control parameter (α) provides for a range of failures by adjusting the threshold value

- Process is self-contained i.e. no external input needed

ERM
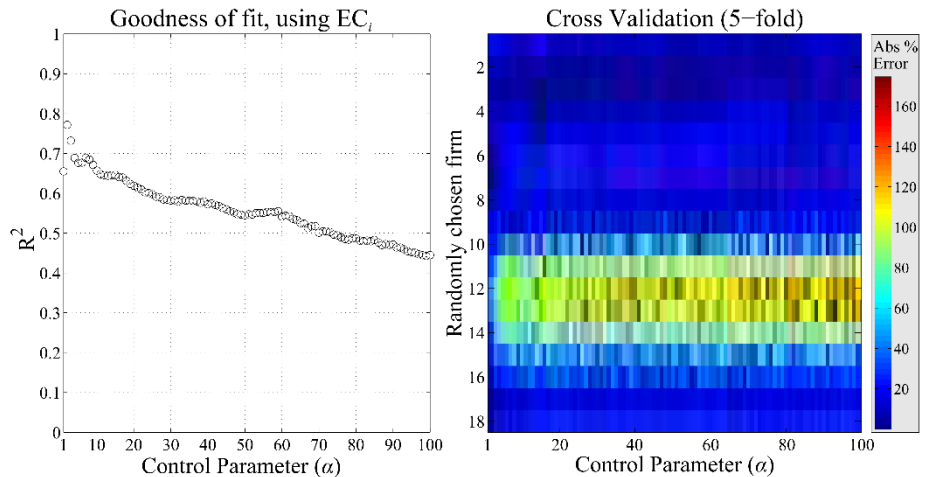ENTERPRISE RISK
MANAGEMENT SYMPOSIUM

Implications on Theory
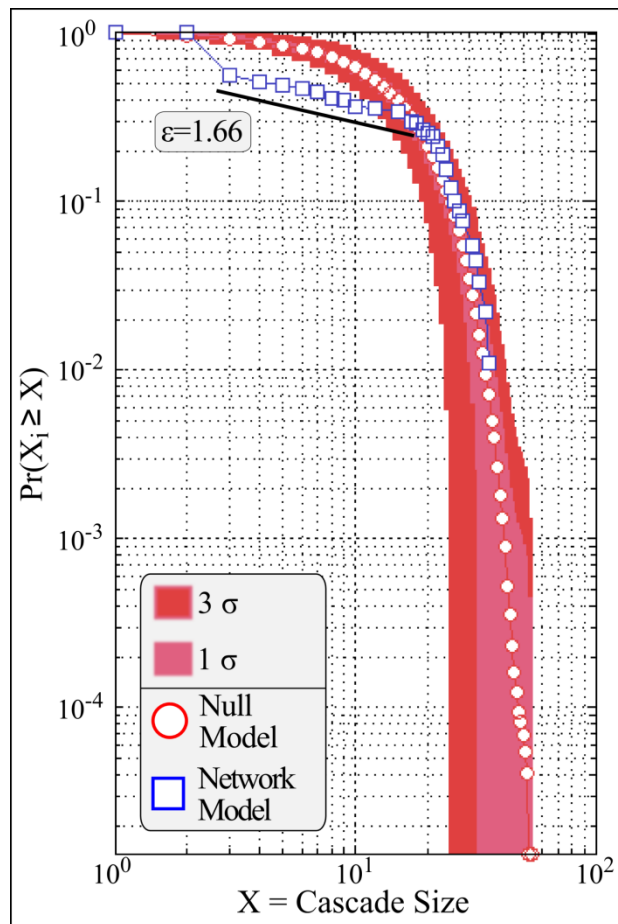
Cumulative probability distribution of cascade sizes

1. Both small and large failures follow the same dynamics. Hence, *a priori* resource expenditure on mitigation action is bound to be problematic

2. No typical cascade size. Hence, a uniform approach on regulation, monitoring etc. is irrelevant.

3. Scale of cascade is limited by system size rather than its low probability

ERM
ENTERPRISE RISK
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Implications on Theory (II)

R² of regression model (left), along with the absolute error using cross validation technique (right) across varying levels of the control parameter (α)

Definitions
Criticality IDX: The capacity of each node to trigger a large cascade
Sensitivity IDX: The probability of being affected by a cascade

1. Systemic role of each firm can be described by the Criticality IDX and Sensitivity IDX

2. Firm based information (i.e. AA and EC) is a poor proxy for both Criticality and Sensitivity IDX.

3. As the effect of interconnectivity increases (i.e. α), their utility deteriorates further.
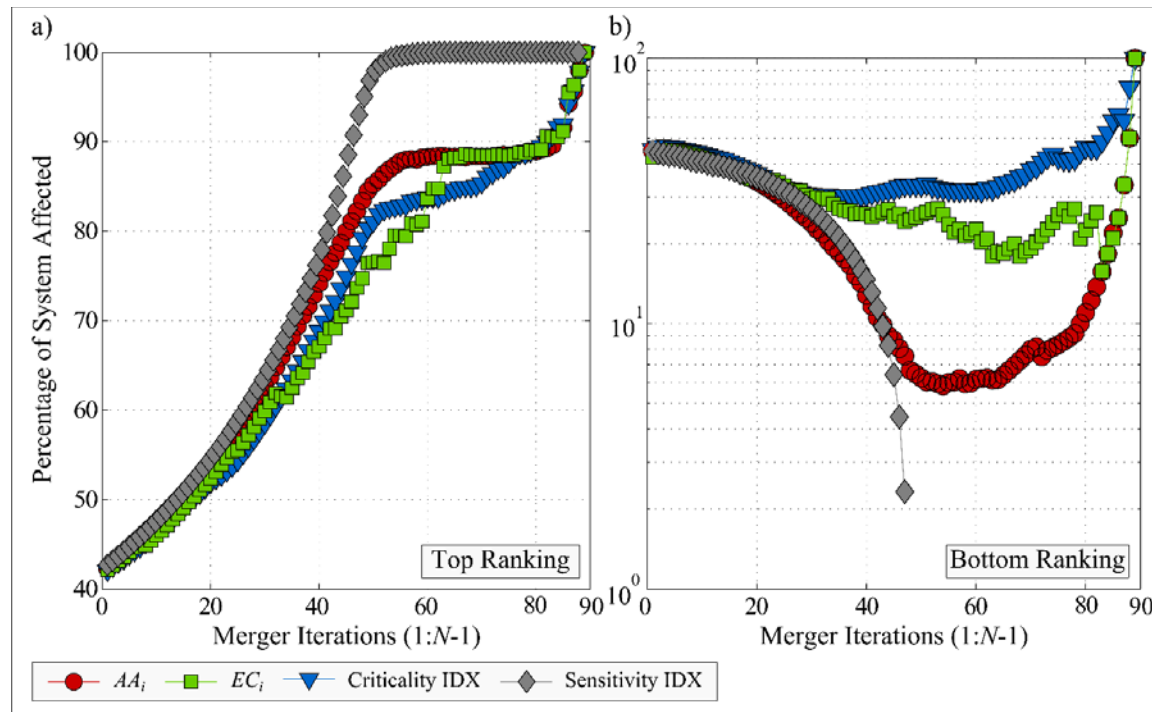
Firm acquisition for stability

*"In retrospect, I believe that our actions …that facilitated the consummation of Bank of America's acquisition of Merrill Lynch … have strengthened both companies while **enhancing the stability of the financial markets and protecting the taxpayers.**"*[1]

*The acquisition of Merrill Lynch "made sense for the **stability of the markets**"* [2]

[1]Federal Reserve Testimony http://www.federalreserve.gov/newsevents/testimony/bernanke20090625a.htm
[2]Bank of America CEO, on acquisition of Merrill Lynch, http://articles.latimes.com/2009/jun/12/business/fi-lewis12

Do mergers bring systemic stability ? It depends …

- Two firms are **merged**, **based on their ranking** (using EC, AA, Criticality IDX and Sensitivity IDX)
- The new network is tested and **maximum impact of systemic risk** recorded.
- **Repeat** for all N-1 times, unless stable

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Information efficiency for decision making
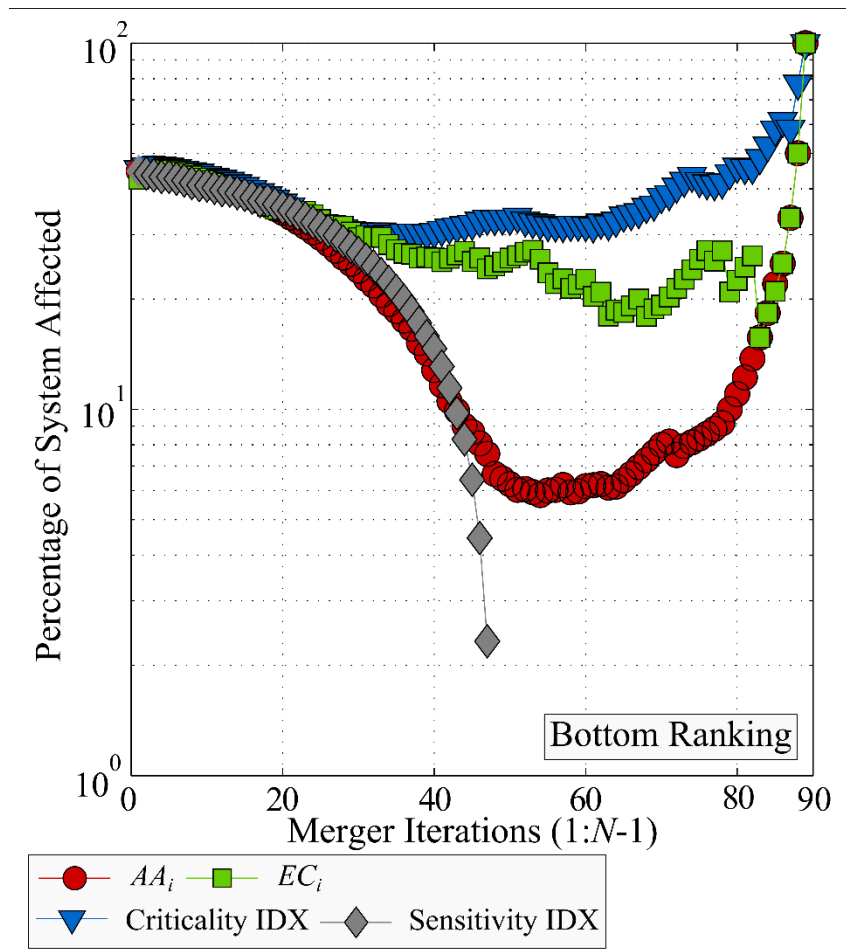
- Mergers take place between lowest ranking firms (e.g. two lowest EC)

- Network orientated information (Criticality IDX and Sensitivity IDX) **significantly outperforms** firm-level information (AA and EC)

- Such information can **greatly enhance decision making** when **systemic effect** must be taken into account

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Take-away message

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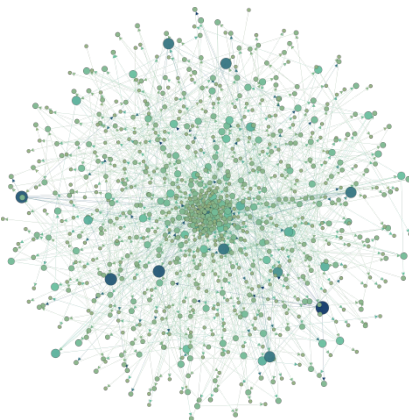
Thank you

Any questions ?
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