ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

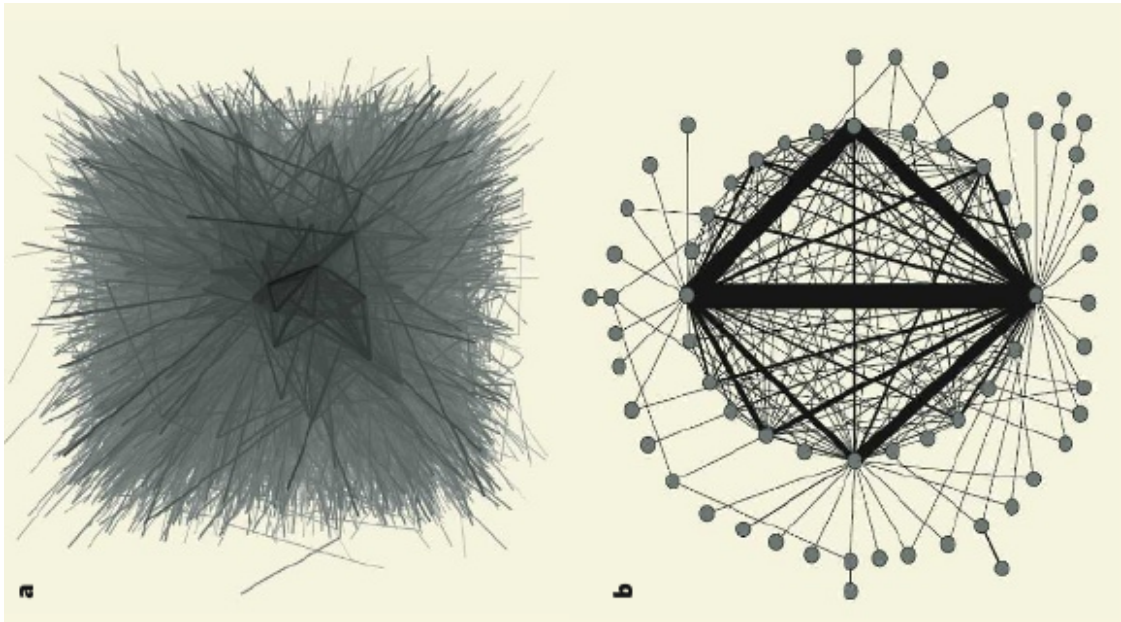
Systemic risk and network models

Frank Schweitzer

fschweitzer@ethz.ch

Topology: Financial Networks

- **weighted network**: links represent transaction volumes
- **existence of a backbone**: involves small number of nodes



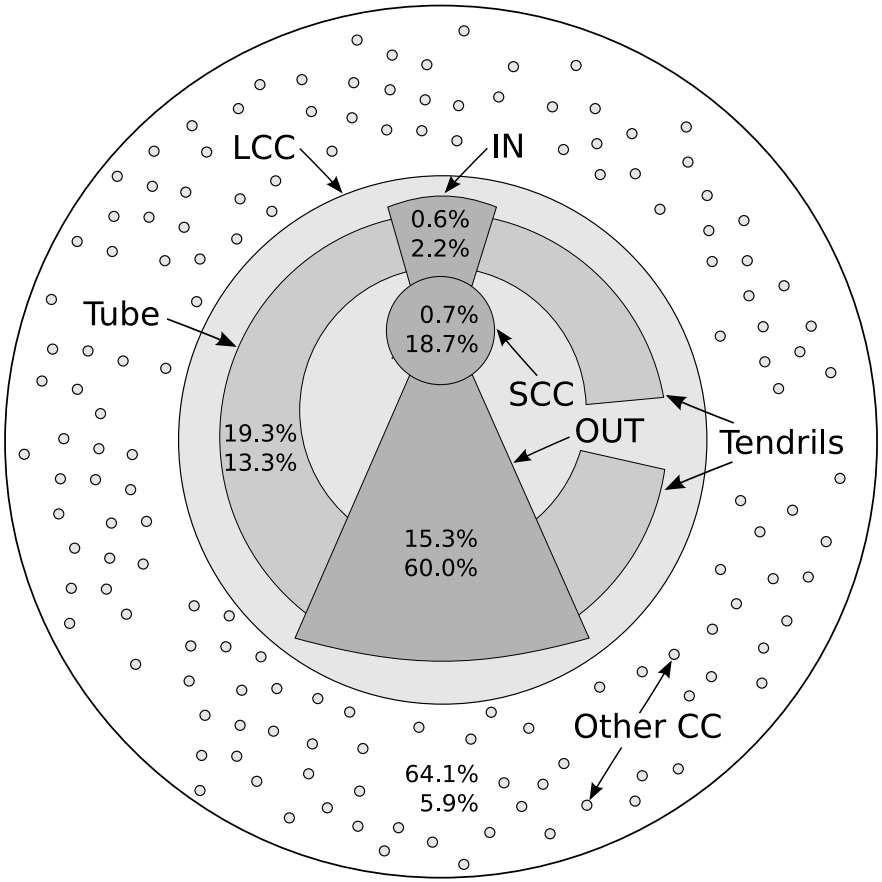
Example: Fedwire interbank payment network (K. Soramäki *et al.* Physica A **379** (2007) 317-333)

(left) Thousands of banks and tens of thousands of links representing USD 1.2 $\times 10^{12}$ in daily transactions

(right) Core of the network: 66 banks accounting for 75 % of transfers, 25 banks being completely connected.

Topology: The highly connected core

Ownership Network of Transnational Companies (TNCs)

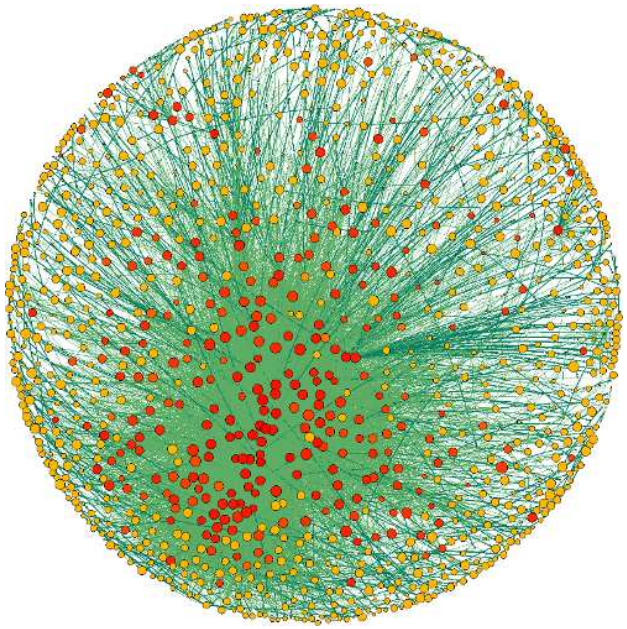


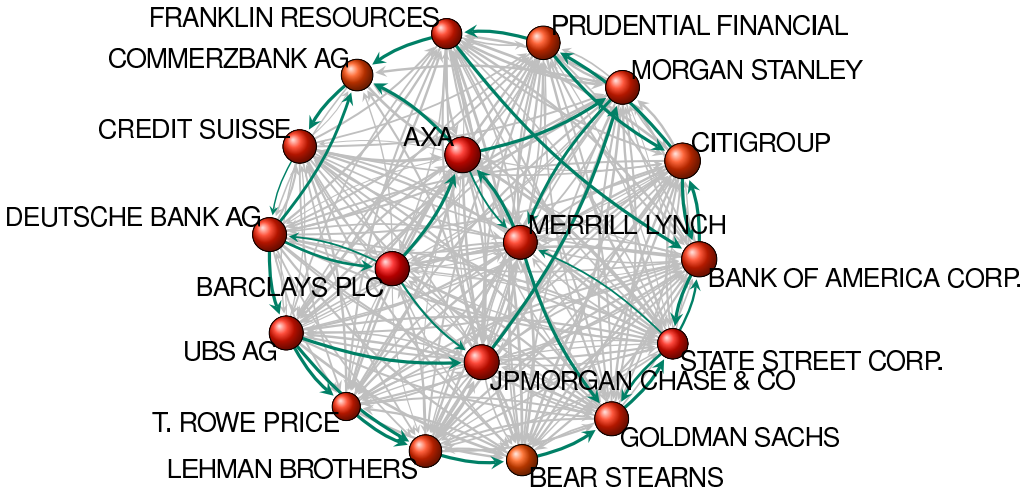
Size of components scaled by (log) number of TNC.

- Largest connected component (LCC) contains giant bow-tie:
  - IN-section, strongly connected component (SCC) core, OUT-section,
  - tubes and tendrils.
- Remaining small connected components (CC).
- Numbers refer to
  - percentage of contained TNC,
  - total TNC operating revenue.

S. Vitali, J. Glattfelder, S. Battiston: *The network of global corporate control*, PLoS ONE (2011)
http://arxiv.org/abs/1107.5728

Problem: Self-Ownership





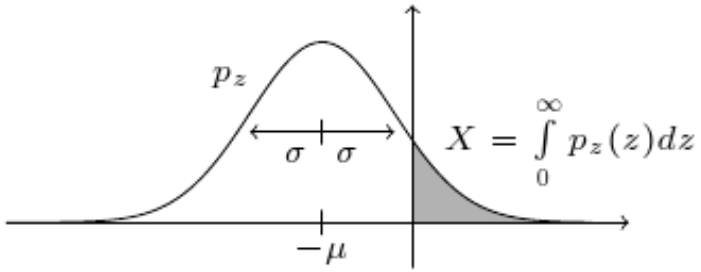
(left) SCC (1318 nodes, 12191 links). Node size scales logarithmically with operation revenue, node color with network control (from yellow to red). Link color scales with weight.
(right) Zoom on some major TNCs in the financial sector. Some cycles are highlighted.

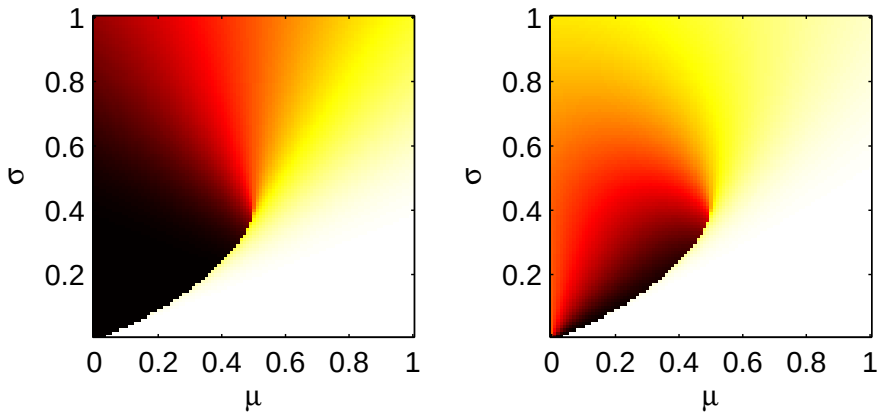
- 75% of the ownership of the SCC firms stays within the SCC
  - propagation of financial distress increases systemic risk
  - cross-ownership decreases competition $\Rightarrow$ market failure

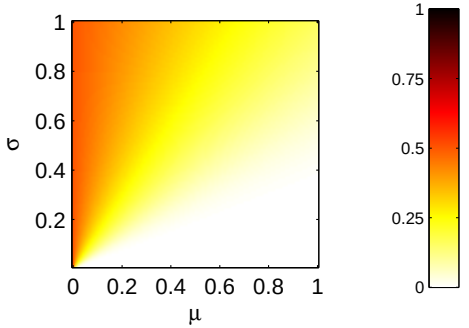
S. Vitali, J. Glattfelder, S. Battiston: *The network of global corporate control*, PLoS ONE (2011)
http://arxiv.org/abs/1107.5728

Systemic risk as a phase transition

- initial conditions normally distributed: $\theta \sim \mathcal{N}(-\mu, \sigma)$,
  - σ: measure of *initial heterogeneity* in θ across nodes
  - initial failure: $X(0) = \Phi_{\mu,\sigma}(0)$ (cumulative normal distribution)







- **First-order phase transition:** small variations in initial conditions lead to complete failure
- non-monotonous behavior: intermediate σ most dangerous
- **(right)** systemic risk resulting from *cascades* only

J. Lorenz, S. Battiston, F.S. Eur Phys J B **71** (2009) 441-460

Links of interest

ETH Risk Center

- http://www.riskcenter.ethz.ch/
  - focus on *integrative risk management*
  - 10 Chairs involved: finance, economics, conflict research, ...

EU Project: Forcasting Financial Crises

- http://www.focproject.net/
  - integrated network-oriented approach to systemic risk
  - 10 universities + ECB involved

SNF Project: OTC Derivatives and Systemic Risk

- http://www.sg.ethz.ch/projects/
  - interdependence of financial robustness, financial acceleration
  - Chair of Systems Design + external collaborations