The formation of core-periphery structure in heterogeneous financial networks

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- With some exceptions, theoretical and simulation stress test analysis assumed that the network of financial interconnections is *exogenously fixed*
- Despite helping to diagnose the causal relation between network structure and systemic risk, static analysis is not enough. The dynamic nature of the financial relations may create biases that this literature does not account for.

Main ideas (cont.)

Two questions

1. What is the structure of financial networks - core-periphery
2. How are financial networks formed, in particular how are core-periphery structures obtained endogenously

Objective of the paper

To provide a **theoretical** foundation for the empirical finding of a core-periphery network structure in financial networks.

Summary of the Results

Homogeneous banks

- The efficient star network with one central counterparty becomes unstable if the linking costs decrease.
- The dynamics converges to structures that range from the empty to the complete network as linking costs decrease.
- Core-periphery network cannot be stable.

Heterogenous banks

- Big/small banks
- Big banks have more frequent trading oportunities.
- Core-periphery structure emerges because it is beneficial for large banks to have direct lending relationships with all other large banks in the core.

Model

- N banks form an undirected network G where $g_{ij} = 1, i, j \in N$ if there is a link between i and j and $g_{ij} = 0$ otherwise.
- Each pair (i, j) in the network creates a potential trade surplus of α_{ij}. This trade surplus can only be realized if i and j are connected directly, or indirectly through a path with one middleman.
- m_{ij} represents the number of middlemen between i and j.
- Connection has a cost of c for both i and j.

Model (cont.)

- **Surplus division**(Siedlarek 2012)
  - If (i, j) are directly connected, then the the trade surplus of i and j is split in half.
  - If i and j are indirectly connected by m_{ij} middlemen, then the endnodes i and j each receive a share of $f_e(m_{ij}; \delta)$, whereas each of the m_{ij} middlemen receives a share of $f_m(m_{ij}; \delta)$.
  - $\delta \in [0, 1]$ captures the level of competition between the number of middlemen m_{ij} of a certain trade between i and j.
- **Payoffs**

$$\pi_i(g) = \sum_{j \in N_i^1(g)} \left(\frac{1}{2} \alpha_{ij} - c \right) + \sum_{j \in N_i^2(g)} \alpha_{ij} f_e\left(m_{ij}, \delta\right) + \sum_{j,l \in N_i^1(g) | g_{jl}=0} \alpha_{ij} f_m\left(m_{ij}, \delta\right)$$

Model (cont.)

Several network structures are considered:

- Empty network (a)
- Complete network (b)
- Star network (c)
- Core-periphery network (d)
- Multipartite network (e)

Properties of the interbank network

Stability

A network is unilaterally stable if no agent i in the network has a profitable unilateral deviation: a change in its links by either deleting existing links such that i benefits, or proposing new links such that i and all the agents to which it proposes a new link benefit.

Efficiency

A network g is efficient if there is no other network g', such that:

$$\sum_{i \in N} \pi_i(g') > \sum_{i \in N} \pi_i(g)$$

Efficient and stable networks - Results

Table: Efficiency

	Efficiency
c **low**	Star network
c **high**	Empty network

Table: Stability

	Stability
c **low**	Complete network
c **intermediate**	Star network
c **high**	Empty network

Core-Periphery networks

Homogeneous banks

- No core-periphery network other than the star is efficient.
- Complete core-periphery networks with $k \geq 2$ are not pairwise stable.
- Incomplete core-periphery networks with $k \geq 1$ are not unilaterally stable if n is sufficiently high.

Heterogeneous banks

- There are big banks and small banks.
- trade between big banks generates higher surplus.
- for intermediate levels of cost and α high enough, the complete core-periphery network is unilaterally stable.

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5. Endogeneize the bank size heterogeneity. (maybe a bank is small because it traded less in the past)

Thank You!
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