The effect of the interbank network structure on contagion and common shocks

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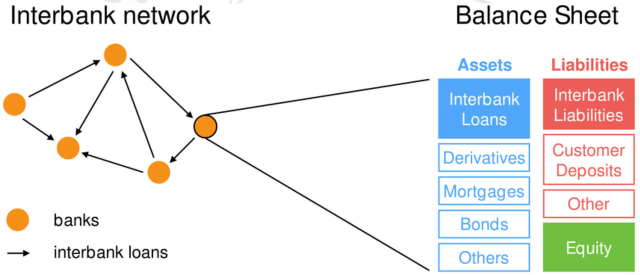
Interbank Network

- Through the interbank market, banks which suffer liquidity shortages can borrow from banks with liquidity surpluses. Thus, the interbank market can have a stabilizing effect on the financial system by redistributing funds in an effective way among banks, however, at the same time it can make the system prone to financial contagion through the existing interbank linkages.
- According to Pericoli and Sbracia (2003), a country's banking system can contribute to the transmission of contagion due to moral hazard caused by the presence of institutionally enforced guarantees on deposits and by fluctuations in asset values used as collateral by banks.



Contagion and Common Shocks Effect

- Contagion and Common Shocks are concepts to understand the spread of problems in the financial system.

Contagion Effect	Common Shock Effect
• Refers to the way financial problems in one bank or financial institution can spread to others	• Events that affect many banks simultaneously, rather than spreading from one to another
If Bank A has a lot of loans from Bank B and Bank A starts to fail, Bank B might also face problems because it won’t get its money back	A sudden economic downturn, like a recession, where many banks lose money because their customers can’t pay back loans

- Previous papers focussed on risk-free investment options and deposits as residual, but here the author allows the possibility of risky investments and deposit fluctuations. Other paper focusses on impact of individual bank to overall systemic risks while this paper analyze the impact of interbank network structure on financial stability.

Purpose of the Paper: The idea

- The paper introduces a dynamic multi-agent model of a banking system that includes the central bank, focusing on how banks manage their portfolios of risky investments and riskless excess reserves based on their preferences for risk, return, and liquidity

- It highlights the interconnectedness of banks through interbank loans which leads to fluctuations in liquidity

- The research compares different interbank network structures, revealing that money-centre networks are more stable than random networks. This finding suggests that the structure of interbank connections plays a crucial role in financial stability

- Additionally, the paper discusses systemic risk, contrasting contagion effects with common shocks. It concludes that these two forms of systemic risk necessitate different optimal policy responses, indicating the complexity of managing financial stability in varying conditions

Introduction

- Interbank network exhibits robust yet fragile property, showing contrasting impacts during normal times (leading to enhanced liquidity allocation and risk sharing) as compared to times of distress (Insolvency issue: Lehman Brother)
- The Contagion and common shocks as systemic risks lead to search for a network structure that are more resilient to financial distress.
- Counterparty Externality: When a bank lends to a number of other banks it is oblivious to any links between those banks and might underestimate its portfolio correlation.
- Correlation Externality: Arises when a bank is oblivious to the asset holdings of other banks.
- Banks face a stochastic supply of household deposits and stochastic returns from risky investments. This gives rise to liquidity fluctuations and initiates the dynamic formation of an interbank loan network.

Model Formation

- A dynamic model of a banking system that can be used to analyze the impact of the interbank network structure on financial stability

1) Deposit Fluctuations are included

2) Fluctuations in investment returns have to be compensated by banking capital, risky investments are a major cause of bank insolvencies. Thus, The balance sheet of the bank k looks like:

$$I_t^k + E_t^k = (1-r)D_t^k + BC_t^k + L_t^k + LC_t^k$$

- A constant relative risk aversion (CRRA) utility function is assumed to model the bank's preferences:

$$u^k = \frac{1}{1-\theta^k}\left(V^k(1+\lambda^k\mu^k - \frac{1}{2}\theta^k(\lambda^k)^2(\sigma^k)^2)\right)^{(1-\theta^k)}$$

Network Theory

- A financial network consists of a set of banks (nodes) and a set of relationships (edges) between the banks. Even though many relationships exist between banks, this paper focuses on relationships that stem from interbank lending.
- The matrix of bilateral exposures $W(G) = [w_{ij}]$ of an interbank market G with n banks is the n x n matrix whose entries w_{ij} denote bank i's exposure to bank j. The assets a_i and liabilities l_i of bank I are given by

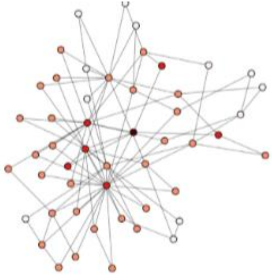
$$a_i = \sum_{j=1}^{n} w_{ij} \text{ and } l_j = \sum_{j=1}^{n} w_{ji}$$

- The entries a_{ij} of the adjacency matrix A(G) are 1 if there is an exposure between I and j and zero otherwise.
- The in-degree $d_{in}(i)$ and out-degree $d_{out}(i)$ of a node i are defined as:

$$d_{in}(i) = \sum_{j=1}^{n} a_{ji}, \quad d_{out}(i) = \sum_{j=1}^{n} a_{ij}$$

Give a measure for the interconnectedness of the node I_{in} a directed graph G(V,E). The two degrees are equal for directed graphs.

Figures and Observations



❑ Fig. 1 shows a small-world network

N=50 , k = 4, β = 0.05

(A value of 0.05 means less chance that connections can be randomly rewired)

Note: Small-world networks are known for having a high degree of clustering and short average path lengths

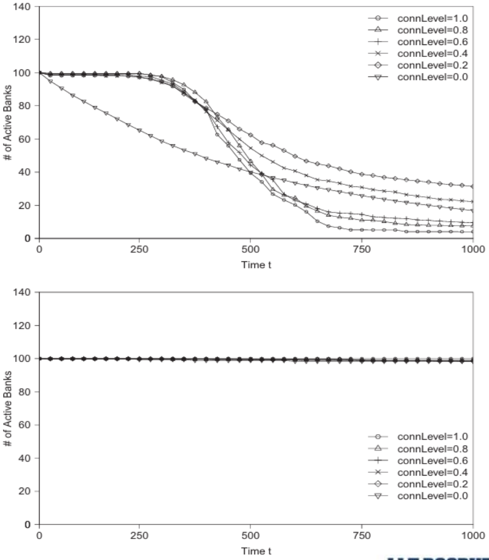
❑ Fig. 2 shows a scale free network

N=50 , m = 2

(each new node added to the network connects to 2 existing nodes. This process leads to some nodes becoming very well-connected (hubs), while others have fewer connections)

Figures and Observations

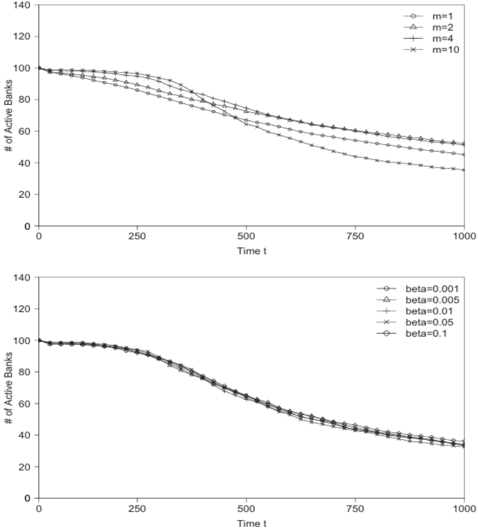
- Fig 3 shows the effect of different network topologies on financial stability.
- Top: crisis scenario and random topology.
- Bottom: normal scenario and random topology.
- Connection levels of connLevel = 0.0,0.2,0.4,0.6,0.8,1.0 were used.



Figures and Observations

Network Structures affecting the stability of financial market

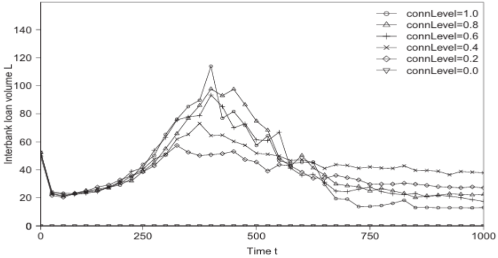
- Fig 4: Top: crisis scenario and scale-free (BA) network with m = 1, 2, 4, 10.
- Bottom: crisis scenario and small world (WS) network with b=0.001, 0.005, 0.01, 0.05, 0.1.

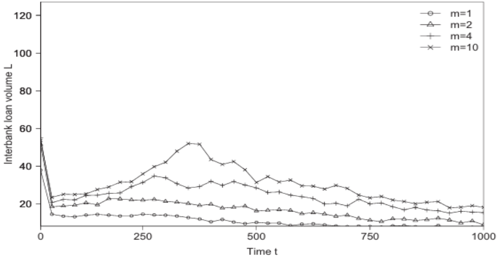


Figures and Observations

A visual representation showing how different types of connections (called "network topologies") between banks affect the amount of money they lend to each other

- Top: Crisis scenario and random topology, with connection levels of connLevel = 0.0, 0.2, 0.4, 0.6,0.8, 1.0.
- Bottom: Crisis scenario and scale-free network with m =1,2,4,10.





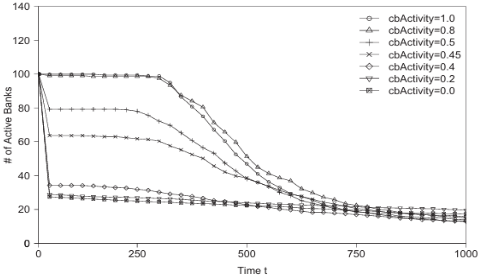
Figures and Observations

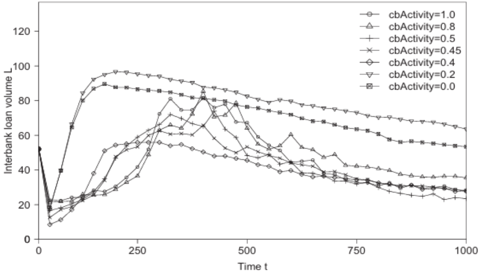
The effect of central bank activity for different scenarios.

Top: Number of active banks over simulation time for a random network with connectivity of 0.2.

Bottom: Interbank loan volume over simulation time for a random network with connectivity of 0.2.

The central bank activity a^k varied between $a^k = 0.0$ and $a^k = 1.0$





Results: Regime Switching Property

- Financial Systems changes its behavior based on different conditions.

- In tranquil times, liquidity demand-driven interbank lending is low and cascading defaults are thus contained.
- In times of distress, money centre networks (which are typically found in reality) are seen to be more stable than purely random networks.
- In times of crisis, individual banks suffer larger liquidity fluctuations and engage in higher liquidity-driven interbank lending. This drives the financial system into a contagious regime. When exactly the regime-switching behavior occurs depends on the interbank network structure.

- Central banks can stabilize the financial system in the short run. In the long run, however, the system always converges to a steady state which depends, amongst other things, on the interbank network structure. Central bank liquidity provision helps banks to withstand liquidity shocks for a longer time. This, however, allows banks that would otherwise be insolvent to engage in liquidity demand-driven interbank borrowing. The result is that the financial system as a whole is more highly interconnected and more likely to enter the contagious regime

Some Other Readings

Simulating financial contagion dynamics in random interbank networks by John et al

- The study assesses the resilience of financial systems to exogenous shocks using techniques drawn from the theory of complex networks
- They trigger a series of banking crises by exogenously failing each bank in the system and observe the propagation mechanisms that take effect within the system under different scenarios.
- Analyzed the interplay of several crucial drivers of interbank contagion, such as network topology, leverage interconnectedness, heterogeneity and homogeneity across bank sizes and interbank exposures.
- Considers the role of financial interconnectedness between the United States Subprime Mortgage crisis in 2008 as well as European sovereign debt crisis in 2009.

Thank You