Intermediation and Voluntary Exposure to Counterparty Risk

Maryam Farboodi

University of Chicago, Economics Department and Booth School of Business

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Motivation

- Degree of interconnectedness among financial institution
  - Systemic risk and contagion
  - Too-connected-to-fail
  - Bailout and regulation
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- Degree of interconnectedness among financial institution
  - Systemic risk and contagion
  - Too-connected-to-fail
  - Bailout and regulation
- Bank incentives to form connections in the first place
  - Vice Chairman FRB Donald Kohn (Senate testimony, 6/2008)
    “[…] Supervisors must also be even more keenly aware of the manner in which those relationships within and among markets and market participants can change over time […]”
  - What is too-connected?
This Paper

- Study the endogenous formation of linkages among financial institutions as a network
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1. Which types of networks endogenously arise?
   - Do they qualitatively match the patterns we observe?

2. Are some more efficient than others?

3. Are there policies to improve equilibrium efficiency?
FRAMEWORK

- Dispersed set of small savers
- Set of randomly distributed entrepreneurs
  - Stochastic investment opportunities
Framework

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- Set of randomly distributed entrepreneurs
  - Stochastic investment opportunities
- Incomplete markets
  - Savers need banks to invest on their behalf
  - Savers matched with some banks
  - Entrepreneurs matched with some other banks

Segmented financial market

- Some banks invest and some lend to investing banks
- Restriction on inter-bank contracts
- Market incompleteness preserved among banks
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Main Findings

- Equilibria:
  - Type 1: *core-periphery* equilibrium
    - Set of highly connected banks at core
    - Excessive exposure to counterparty risk
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- **Efficiency**
  - Centralized clearing house
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- Efficiency
  - Centralized clearing house

- Policy
  - Introduction of centralized clearing house
  - Limit on number of counterparties
OUTLINE

1 Model

2 Inter-bank Network

3 Generalization
ENVIRONMENT

- Three dates: \( t = 0, 1, 2 \)
- Two type of banks (\( \mathbb{N} \))
  - \( NI \): banks who can never invest
    - Raise one unit from a continuum of households (debt)
    - Each household matched to a single bank
  - \( I \): banks who can invest
    - Potential to make risky investment
    - Borrow on the inter-bank market
- Value of other businesses for each bank: \( V_j \)
  - Non-pledgable
  - Lost in case of default
- Risk neutrality, no discounting
**Risky Technology**

- **Date 1**
  - At each $I$, investment opportunity arrives with iid probability $q$
  - *Active investing bank*: $I \in \mathbb{I}_R$
  - Initial investment made

- **Date 2**
  - Per-unit iid return across investing banks $\tilde{R}$

\[
\tilde{R} = \begin{cases} 
  R & \text{with probability } p \\
  0 & \text{otherwise}
\end{cases}
\]

- Scalable
**Financial Network**

- Market incompleteness
  - Loans made after banks get investment opportunities
  - Relationship must be established before the realization of investment opportunities
    - Potential lending relationship \((E)\)
  - All contracts are debt

- **Financial network** \(G = (\mathbb{N}, E)\)
  - Collection of banks and their lending relationships
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- Financial network \(G = (N, E)\)
  - Collection of banks and their lending relationships

- Equilibrium concept: Group Stability
**Feasibility**

- Minimum size constraint
  - Minimum size on date one loans is 1
  - Lender must honor the promise ("conditionally")

- Feasibility

(A) Infeasible set of credit lines

(B) Feasible set of credit lines
**Division of Surplus**

- Banks borrow and lend to invest
- Not competitive
- Surplus division
  - Surplus allocation depends on endogenous network structure
  - Intermediators get positive share
  - Rents cannot be negotiated away
- Inherent rent seeking behavior
**Timing**

- **Date 0**
  - Funding raised from households
  - Network forms: banks establish potential lending relationships *(Subject to feasibility)*

- **Date 1**
  - Risky investment opportunities arrive
  - Loans made

- **Date 2**
  - Return realized
  - Debt paid back
  - Bank fails and loses $V_j$ if unable to pay back obligation
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1 Model

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Example ($t = 0$)

\[ \text{Wachovia} \quad \text{Lehman} \]

\[ \text{NI}_1 \quad \text{NI}_2 \]

\[ \text{NI}_1 \quad \text{NI}_2 \]

\[ \text{Return to lender} \]

\[ p(D_1 - D_2) \leq (1 - p)V \]

Intermediation spread versus cost of failure
**Example** \((t = 0)\)

\[
\begin{align*}
Wachovia & \leftrightarrow Lehman \\
NI_1 & \rightarrow NI_2 \\
NI_1 & \rightarrow NI_2 \\
HH & \rightarrow HH \\
HH & \rightarrow HH
\end{align*}
\]
Example ($t = 1$): Only Lehman has Investment
**Example (t = 2): Project Fails**

\[ D_1 > D_2 : \text{Return to lender} \]

\[ p(D_1 - D_2) \geq (1 - p)V_I : \text{Intermediation spread versus cost of failure} \]
Example \((t = 2)\): Project Succeeds

- \(D_1 > D_2\): Return to lender
- \(p(D_1 - D_2) \leq (1 - p)V_I\): Intermediation spread versus cost of failure
Stability versus Efficiency

(A) Inefficient Stable

\[
\frac{\text{Intermediation Rent}}{\text{Cost of Failure}} > Z
\]

(B) Efficient Unstable
**Misaligned Incentives**

- **Efficiency**: scale of investment versus loss in the event of failure
  - *Efficient Intermediator*: imposes minimal extra cost of failure
- **Individual incentives**: return versus loss of failure
  - *Intermediation spread* versus *cost of default*
  - *Redistribution* versus *Social Loss*
- *Equilibrium Intermediator*: offers highest rate of return
- Does he minimize the cost?
Outline

1 Model

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General Result

Theorem

When intermediation rents are sufficiently high, there is a family of equilibria that consist of a subset of I banks at the core, forming a digraph. Each I bank at the core borrows from a subset of NI banks, and lends to every I bank outside the core. These equilibria are all inefficient.

(A) Equilibrium

(B) Efficient
## Diversification

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{Y_1+Y_2}{2} \tilde{R}$</td>
<td>$Y_1 D_{11}$</td>
</tr>
<tr>
<td>$\frac{Y_1-Y_2}{2} D_{21}$</td>
<td>(A) Net Lender ($I_1$)</td>
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</tr>
<tr>
<td>$\frac{Y_1-Y_2}{2} D_{21}$</td>
<td>(B) Net Borrower ($I_1$)</td>
</tr>
</tbody>
</table>

- $Y_1 > Y_2$
- $y = \frac{Y_2}{Y_1}, \ 0 < y \leq 1$
Diversification

- Net lender

\[ R > \frac{2}{p(2-p)} \]

\[ R < \frac{2}{p(2-p)} \]
**Policy**

- **Central Clearing Party (CCP)**
  - Prevents exposure to counterparty risk among banks with investment opportunity
  - Fully funds all the projects

- **Cap on Number of Counterparties a bank can lend to**
  - Increases the length of intermediation chains
  - Shifts the composition of equilibrium family towards larger cores
  - Larger loss in the event of melt down

Diagram:

![Diagram showing equilibrium concept](attachment:equilibrium_diagram.png)
**Conclusion**

- **Endogenous formation of financial network has implications**
  - Overall structure of inter-bank network
    - Core-periphery
  - Inter-bank exposures
    - High gross and low net exposure among banks with risky investment at the core
  - **Efficiency**
    - Excessive exposure to counterpart risk
    - Inefficient intermediation (and dis-intermediation)

- **Policy Implications**
  - Central clearing house
  - Cap on number of counterparties
  - *Future work:* network-based capital requirements
Exposure to Counterparty Risk in the Financial Crisis

- September 15: Lehman filed for bankruptcy
- First wave: holders of unsecured CP and lenders in tri-party repo
  - Wachovia (Evergreens Investment)
  - Reserve Management Company (Reserve Primary Fund)
Exposure to Counterparty Risk in the Financial Crisis

- September 15: Lehman filed for bankruptcy
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- Havenrock
  - IKB ABCP conduit (Rhineland): RMBS and CDO investment
  - CaLyon: liquidity backstop; FGIC: senior credit risk protection
- CDO crashed \(\rightarrow\) FGIC unable to honor guarantee \(\rightarrow\) CaLyon
  significant credit loss \(\rightarrow\) capital injection by French government
Stylized Facts

- Liability structure among banks looks like a core-periphery graph
  - Federal funds market
  - International inter-bank markets
    - Germany, Austria, Netherlands, Brazil
  - Municipal bond market
- OTC derivative exposures
  - Dealer: High gross and small net positions
  - Aggregate trade quantity:
    - Dealer-to-dealer: \( \sim 60\% \)
    - Customer-to-dealer: \( \sim 40\% \)
    - Customer-to-customer: \(< 1\% \)
**General Rule for Division of Surplus**

- Every member of intermediation chain gets strictly positive share
- Elimination of each intermediary
  - Weakly increase every other bank’s share (along the chain)
  - Strictly increase lender’s share
- Anonymous and depends only on the chain
- Special case ($\alpha$-rule)
  - Each bank only cares about distance to final borrower
**General α-Rule**

- $j < K$ gets $(1 - \alpha)\alpha^j X$
- $K$ gets $1 + \alpha^K X$
- Shares only depend on distance from final borrower
- Face value of debt set to reflect shares
  - $D_j - D_k = \text{intermediation spread between } k \text{ and } j$

\[\alpha\text{-rule}\]
Date 1: Payoff Example

- $X = pR - 1$: expected net surplus of investing one unit

- $D_1 = D_{11} = D_{12} = \frac{\alpha X + 1}{p}$

- $D_2 = D_{22} = \frac{\alpha^2 X + 1}{p}$

- Intermediation spread = $D_1 - D_2$
  - Expected intermediation rent = $p(D_1 - D_2) = \alpha(1 - \alpha)X$
**Long Term Relationship Lending**

- **Theory**
  - Switching costs
  - Monitoring costs: costly information acquisition

- **Empirical evidence**
  - Fed fund market: %60 of inter-bank borrowing comes from the same lender over one month
  - Hedge funds: maintain at most two prime brokers and rarely switch
Disabling Diversification

- \( j \) has multiple active commitments
  - All of its funding allocated randomly to exactly one of them
- An \( I \) bank with an active investment opportunity
  - Invests only in own project
Efficient Direct Lending

Efficiency

\[ pR - 1 > (1 - p)(V_I + V_{NI}) \]

Borrower and lender participation constraint

\[ (1 - \alpha)(pR - 1) > (1 - p)V_I \]
\[ \alpha(pR - 1) > (1 - p)V_{NI} \]
**Robustness**

- Division of surplus
  - Partial renegotiation and side payments as long as not fully competitive
  - Default cost taken into account
- Market incompleteness
  - No minimum size constraint but loans made prior to realization of investment opportunities
- Correlated returns