Intermediation and Voluntary Exposure to Counterparty Risk

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6th Banco de Portugal Conference on Financial Intermediation

July 2015

Motivation

- Degree of interconnectedness among financial institution
  - Systemic risk and contagion
  - Too-connected-to-fail
  - Bailout and regulation

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  - 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?

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

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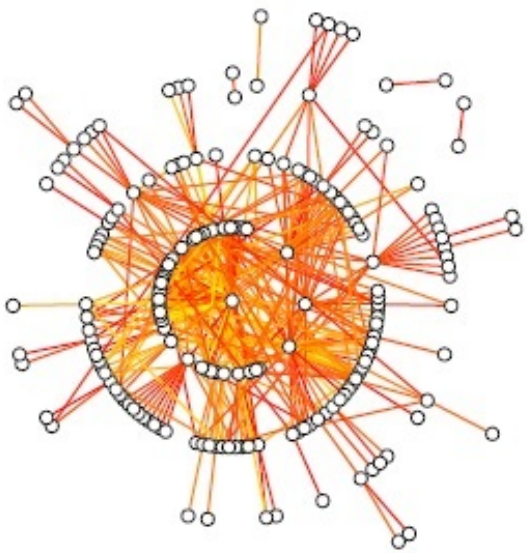
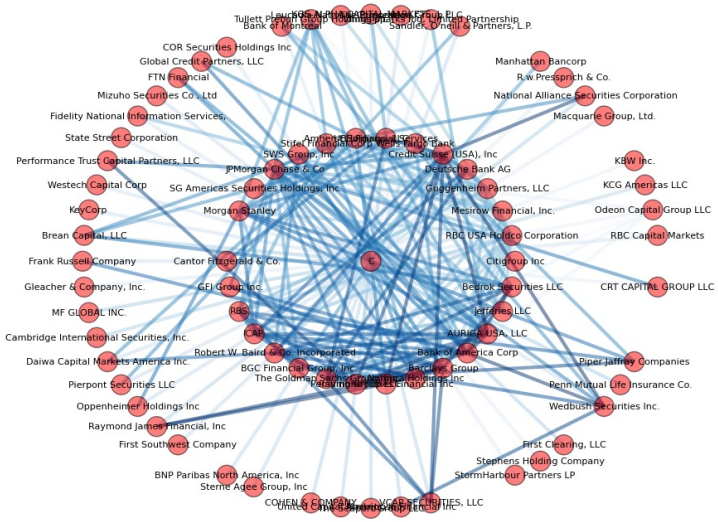
  - Some banks invest and some lend to investing banks
- Restriction on inter-bank contracts
  - Market incompleteness preserved among banks

Main Findings

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



[Bech and Atalay 2010]



[Di Maggio, Kermani and Song 2014]

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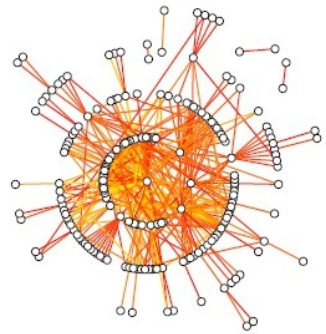

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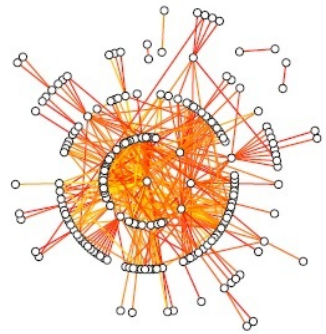

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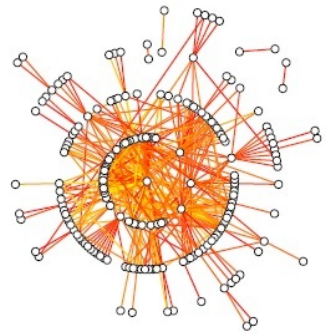
- Policy
  - Introduction of centralized clearing house
  - Limit on number of counterparties



▸ Exposure to Counterparty Risk ▸ Observed Inter-bank Structures

Outline

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 $\tilde{R}$

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

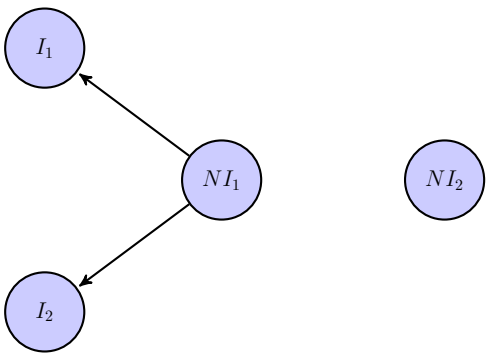
- Scalable

Financial Network

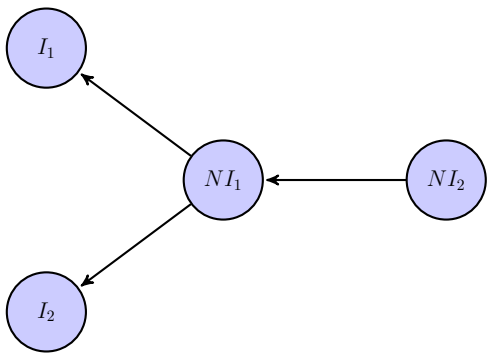
- Market incompleteness
  - Loans made after banks get investment opportunities
  - Relationship must be established before the realization of investment opportunities ▸ Evidence
    - Potential lending relationship (E)
  - All contracts are debt
- **Financial network** $G = (\mathbb{N}, E)$
  - **Collection of banks and their lending relationships**

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

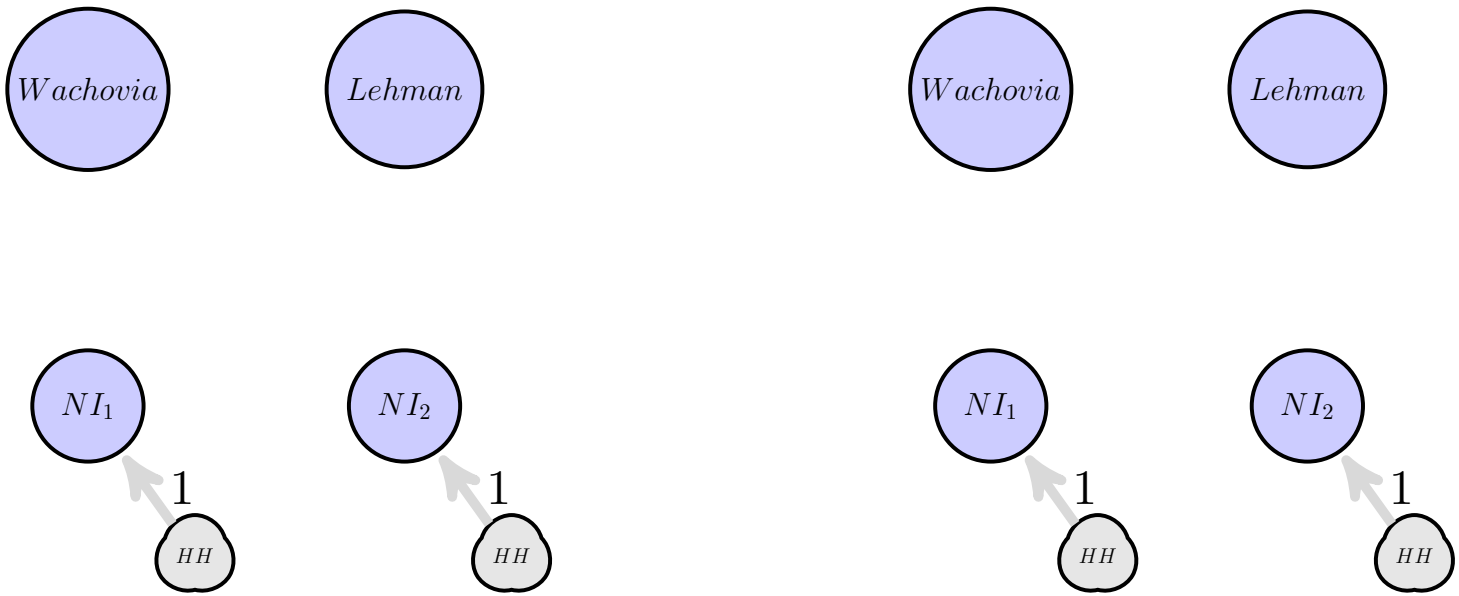
- Date 0
  - Funding raised from households
  - Network forms: banks establish potential lending relationships (*Subject to feasibility*)
- Date 1
  - Risky investment opportunities arrive
  - Loans made
- Date 2
  - Return realized
  - Debt paid back
  - Bank fails and loses V_j if unable to pay back obligation

Equilibrium Concept: Group Stability

- **Group Stable**
  - Generalization of pairwise stable, Jackson and Wolinsky (1996)
  - Strong Nash equilibrium for a network framework
  - *Intuition*: Not blocked by any coalition of players
- Blocking Coalition
  - Coalition of banks, who can jointly deviate
  - Bilateral deviation: add links
  - Unilateral deviation: break links
  - Every member of coalition strictly better off after deviation

Outline

Example ($t = 0$)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Lehman
NI1
NI2
1
1
HH
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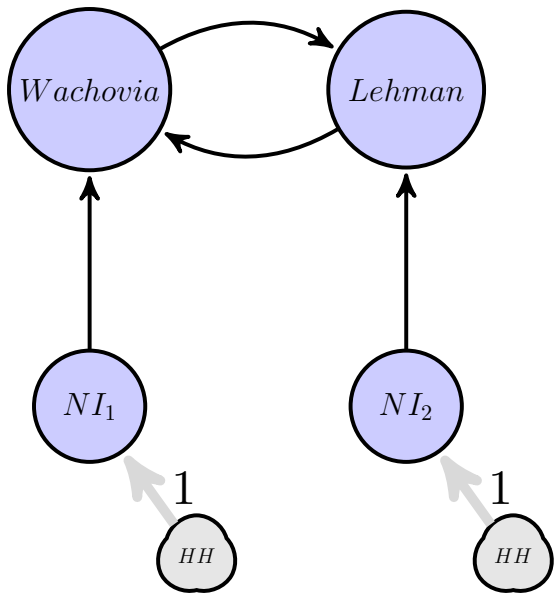
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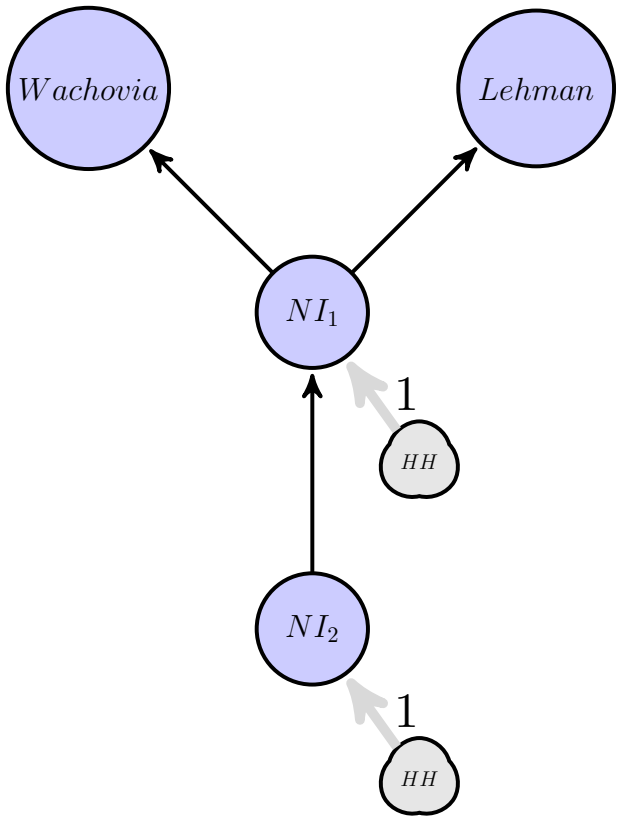
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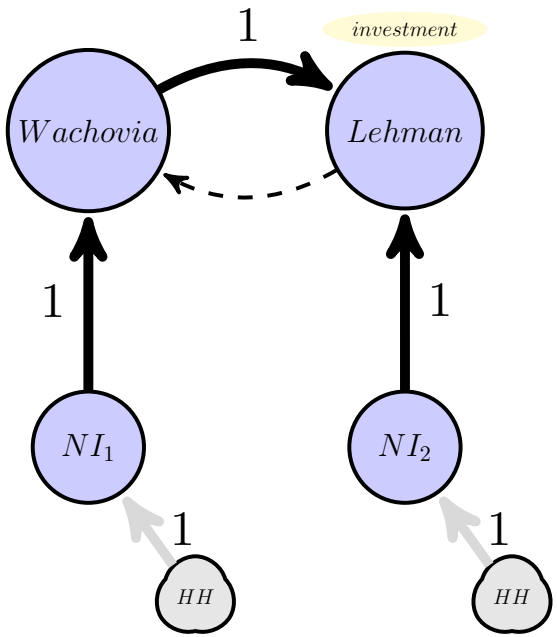
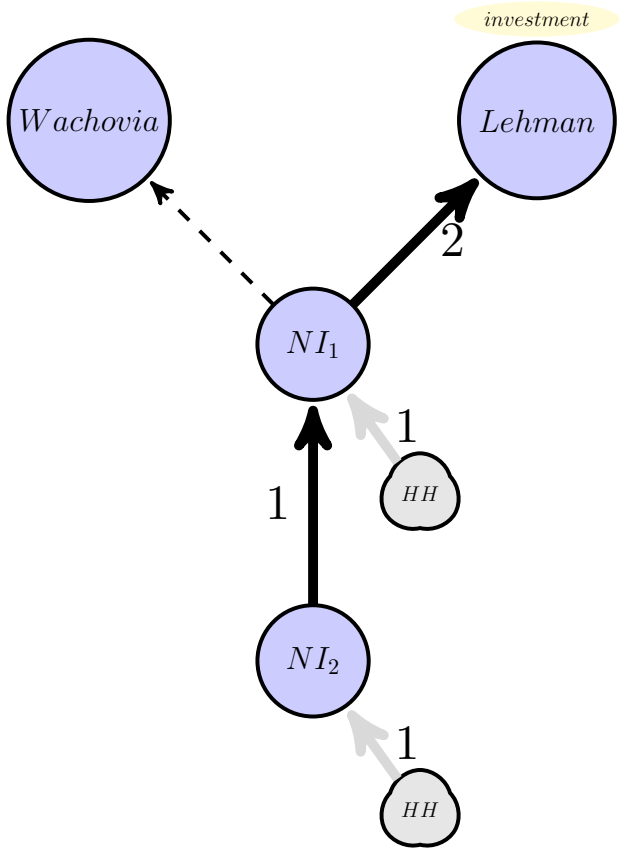
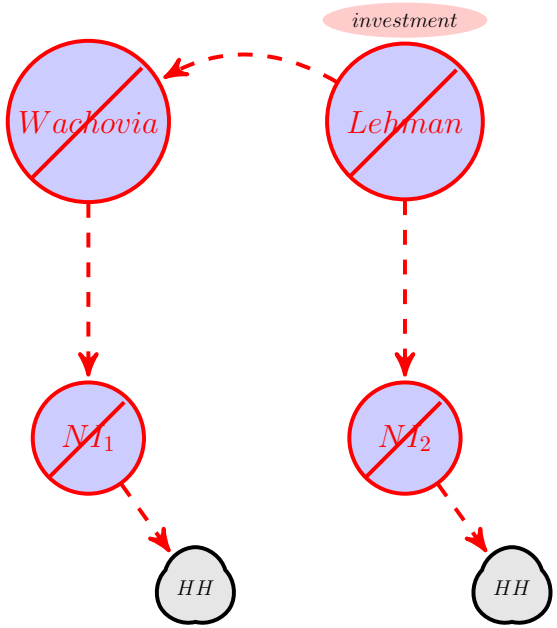
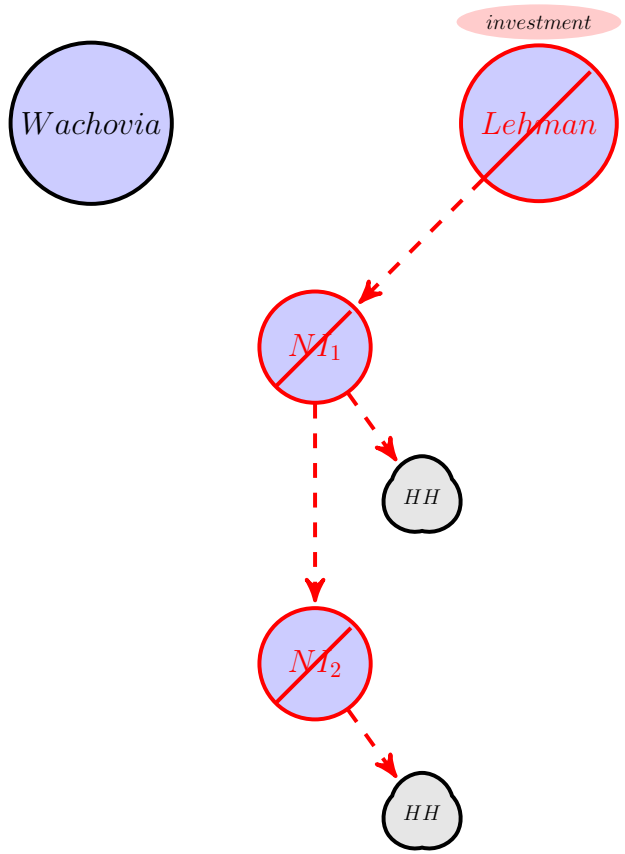
Example ($t = 1$): Only Lehman has Investment



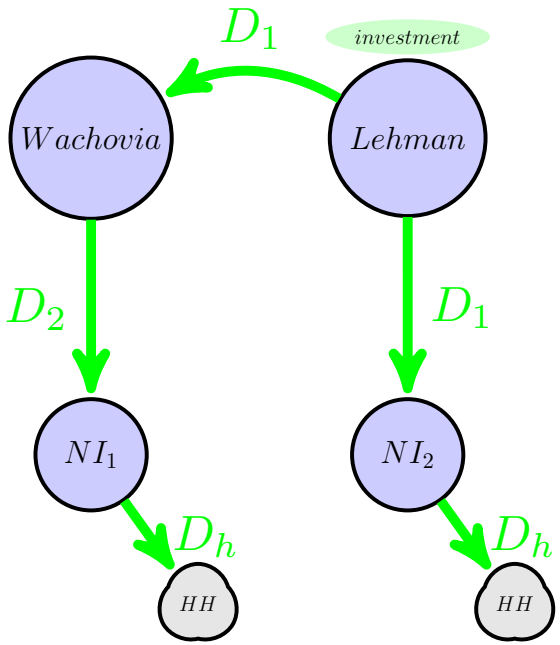


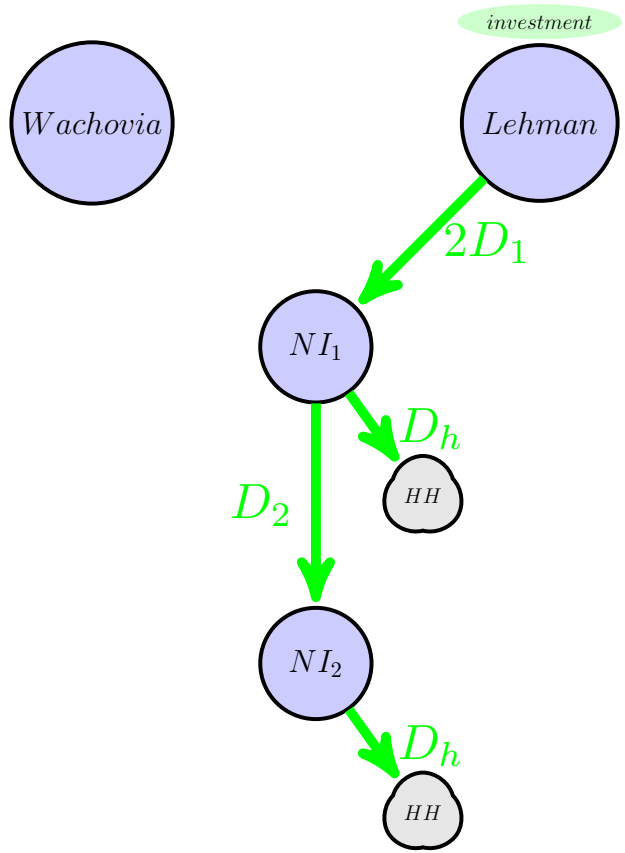
Example $(t = 2)$: Project Fails





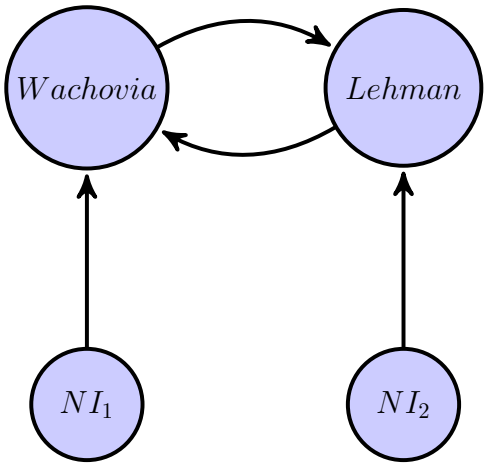
Example $(t = 2)$: Project Succeeds



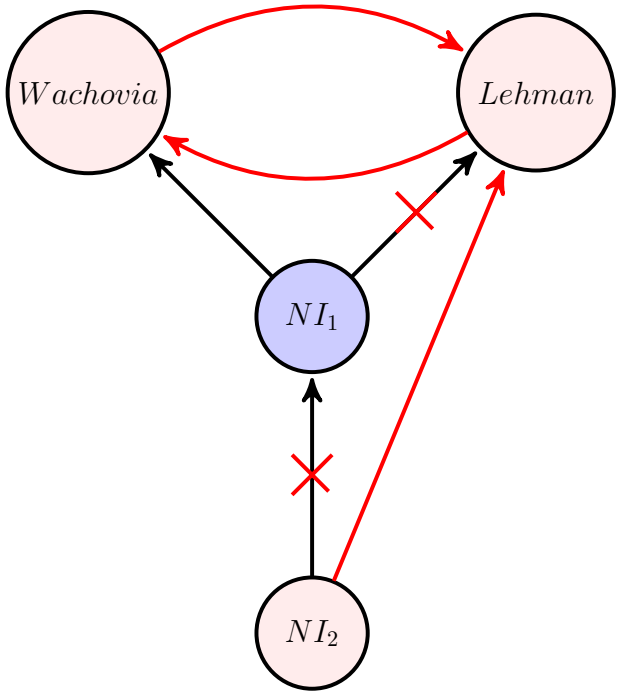


- $D_1 > D_2$: Return to lender
- $p(D_1 - D_2) \leqslant (1-p)V_I$: Intermediation spread versus cost of failure

Stability versus Efficiency



(A) Inefficient Stable



(B) Efficient Unstable

- $\frac{\text{Intermediation Rent}}{\text{Cost of Failure}} > Z$

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

Social Loss

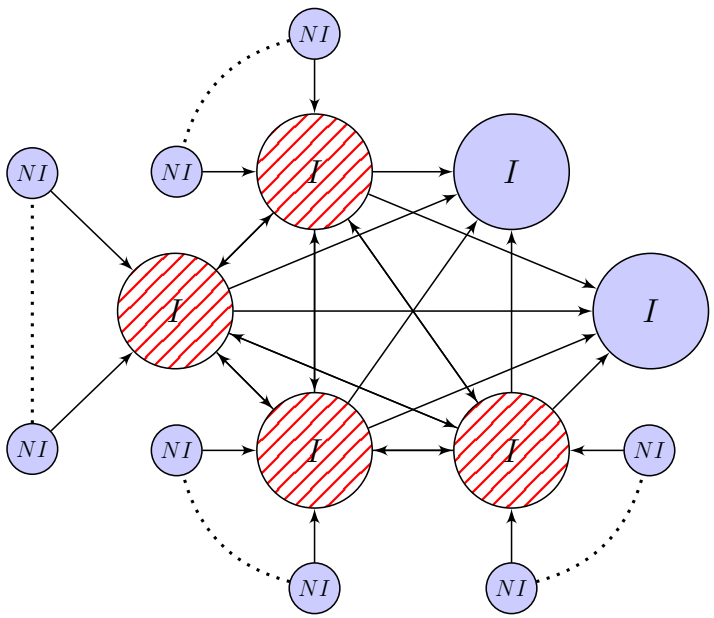
  - *Equilibrium Intermediator*: offers highest rate of return
  - Does he minimize the cost?

Outline

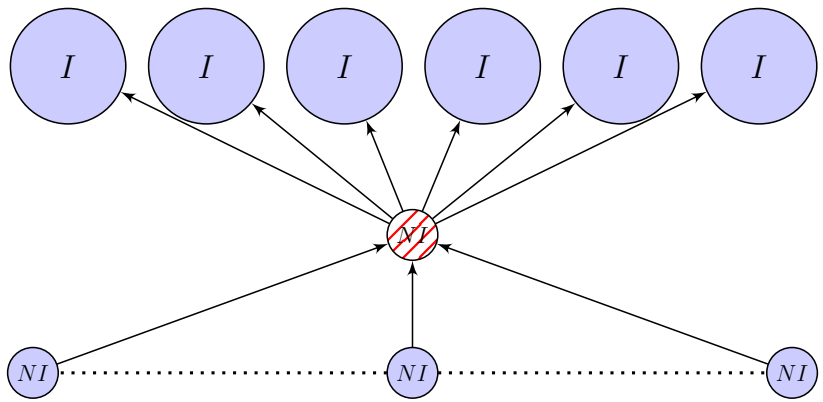
General Result

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

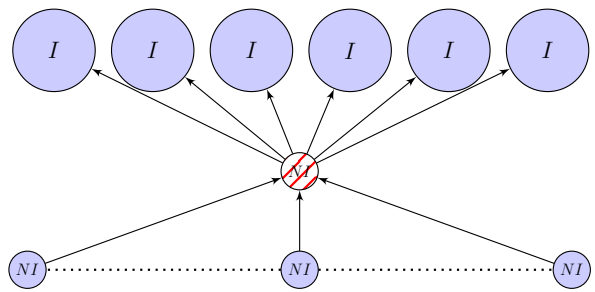


(B) Efficient

▸ Intuition ▸ Four Bank Economy ▸ Robustness

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

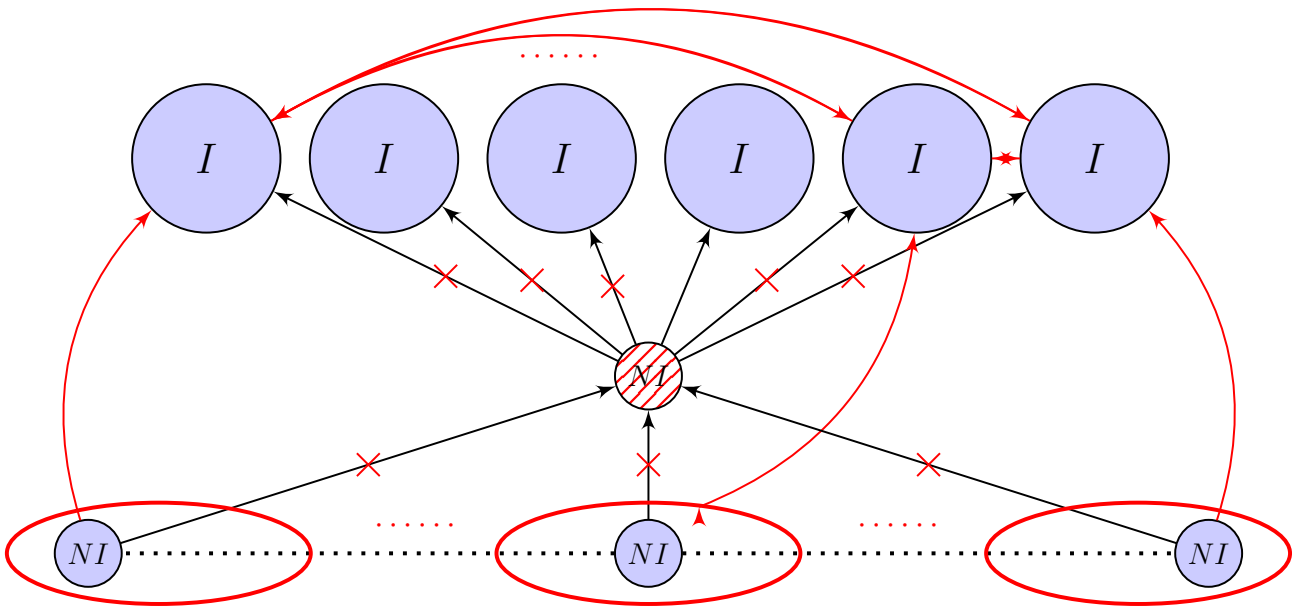
▸ Equilibrium

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*: Information Asymmetry

Intuition

- Joint deviation



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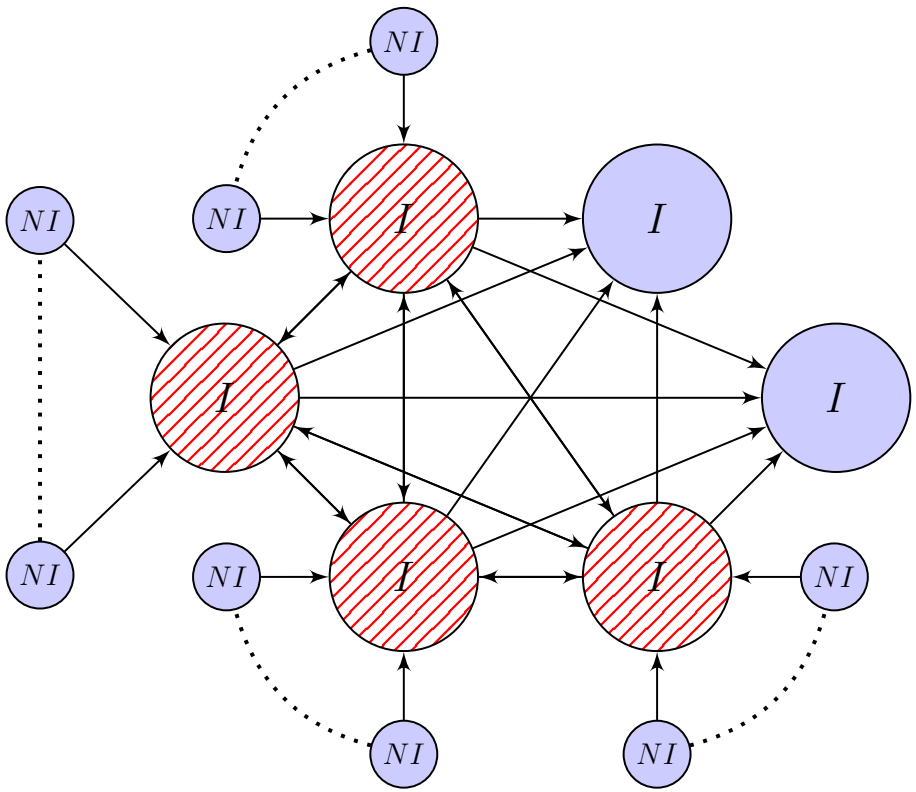
Intuition

- No joint deviation to networks with I banks at the core



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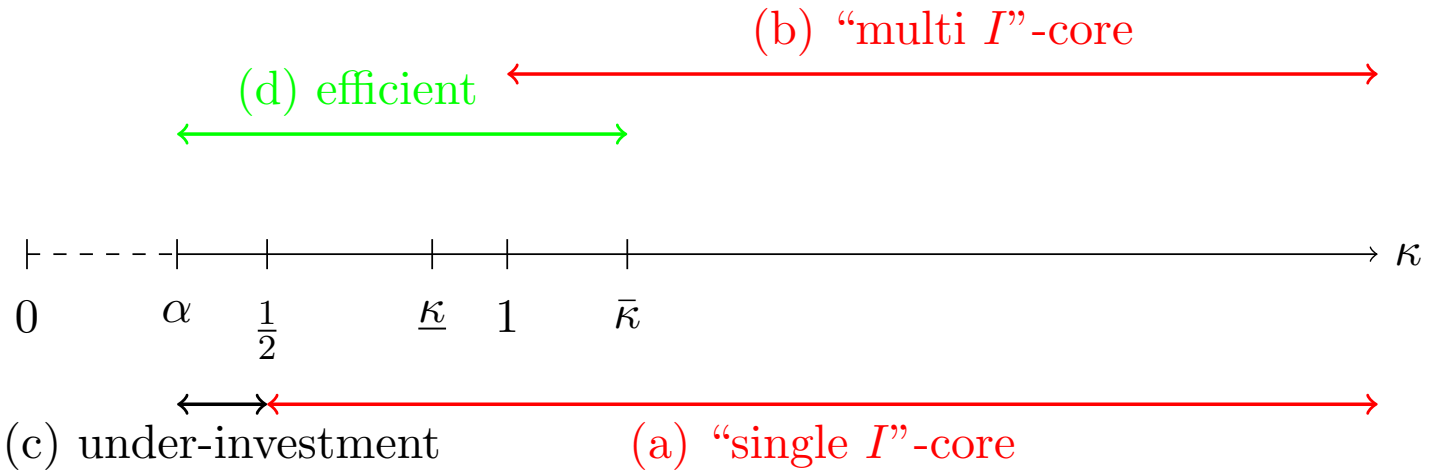
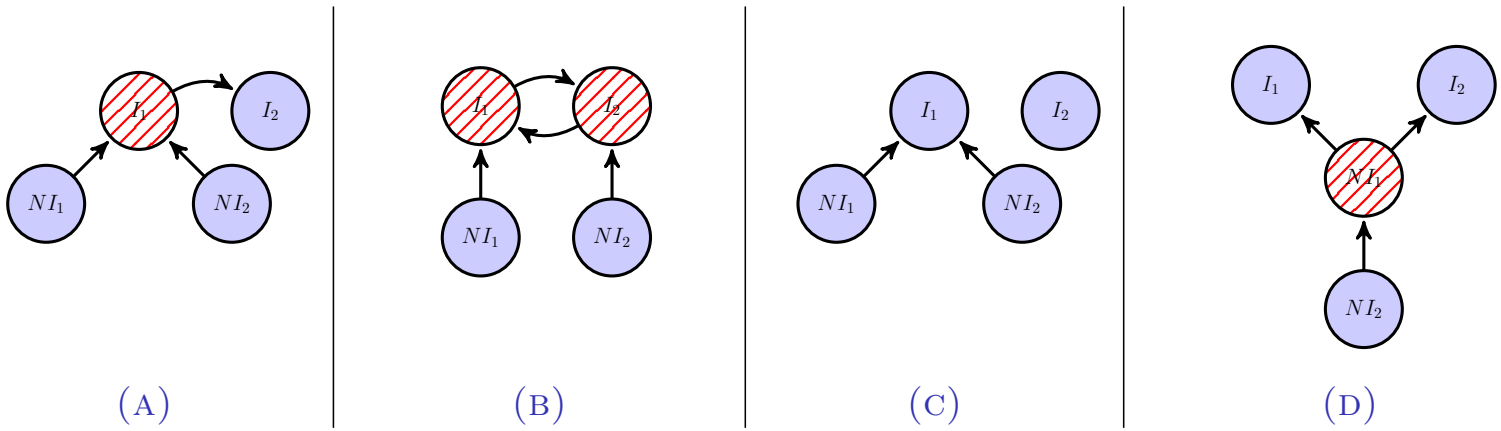
Economy with Four Banks Revisited

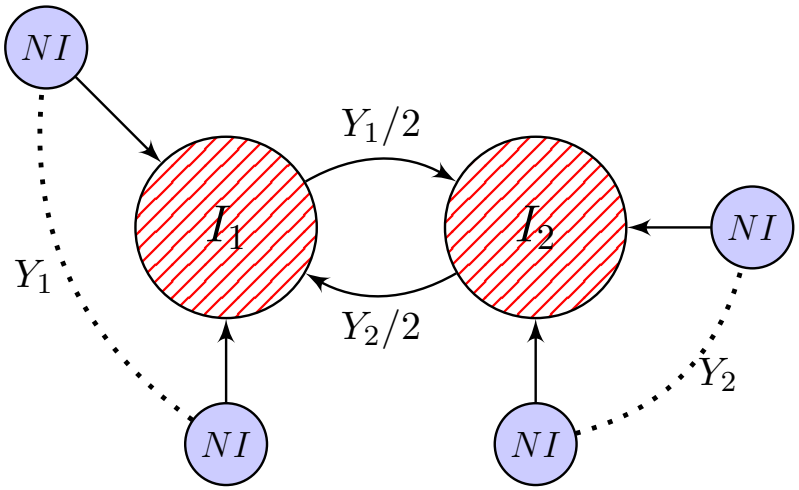


- $\kappa = \dfrac{\text{intermediation rent}}{\text{expected cost of default}} = \dfrac{(1-\alpha)\alpha X}{(1-p)V_I}$



back Deviation Policy

Diversification



Assets	Liabilities
$\frac{Y_1+Y_2}{2}\tilde{R}$	$Y_1 D_{11}$
$\frac{Y_1-Y_2}{2}D_{21}$	

(A) Net Lender (I_1)

Assets	Liabilities
$\frac{Y_1+Y_2}{2}\tilde{R}$	$Y_2 D_{22}$
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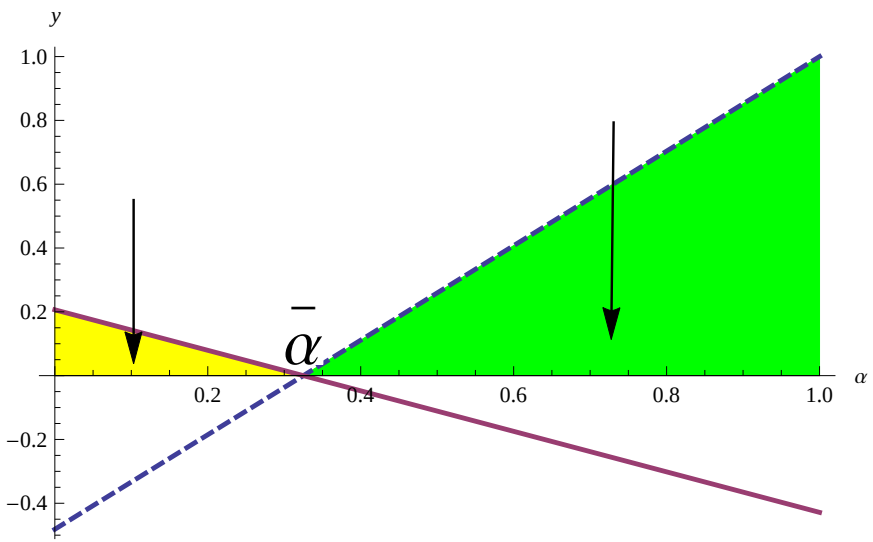
(B) Net Borrower (I_2)

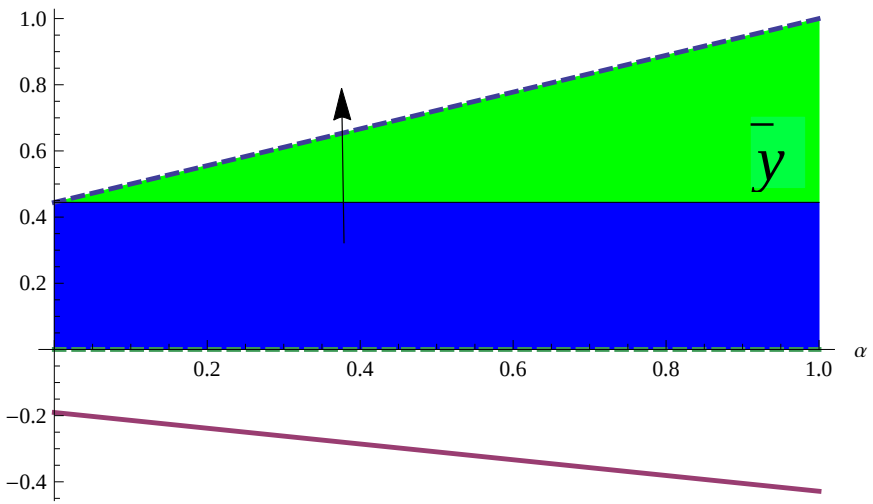
- $Y_1 > Y_2$
- $y = \frac{Y_2}{Y_1}$, $0 < y \leq 1$

Diversification

- Net lender



(A) $R > \frac{2}{p(2-p)}$



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back

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

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  - Wachovia (Evergreens Investment)
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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

Back

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: $< 1\%$

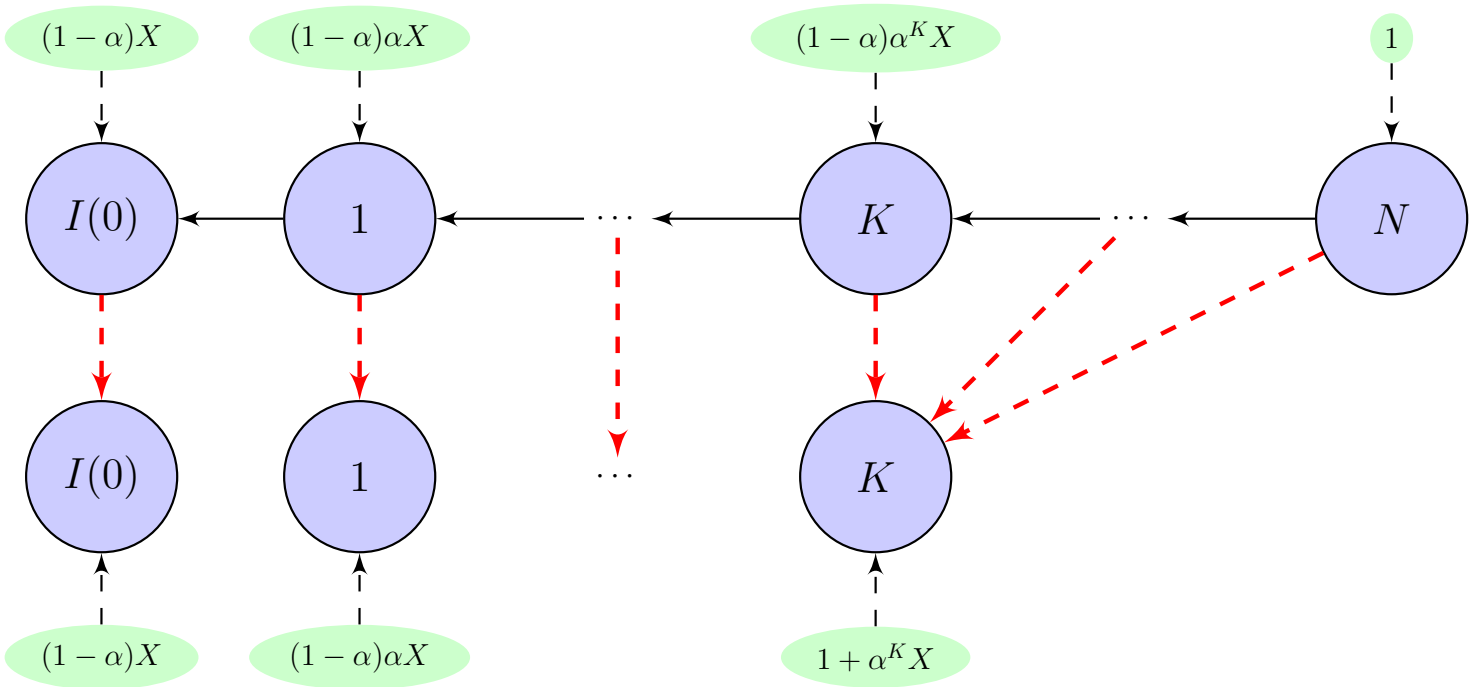
Back

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 (α-rule)
  - Each bank only cares about distance to final borrower

▸ Eq ▸ α-rule

General α-Rule

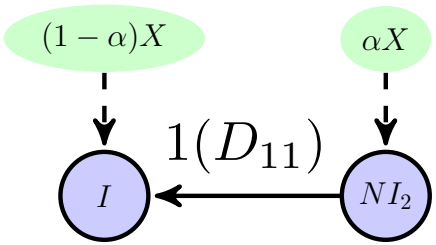


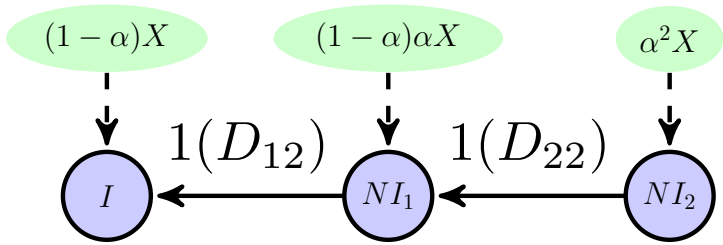
- $j < K$ gets $(1-\alpha)\alpha^j X$
- K gets $1+\alpha^K X$
- Shares only depend on distance from final borrower
- Face value of debt set to reflect shares
  - $D_j - D_k =$ intermediation spread between k and j

▸ Eq ▸ α-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 $= p(D_1 - D_2) = \alpha(1-\alpha)X$

Back

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

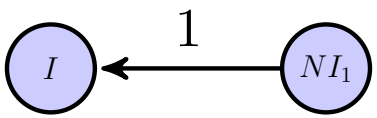
Back

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

▸ Flow of Funds ▸ Debt Payoff

Efficient Direct Lending



- Efficiency

$$pR - 1 > (1 - p)(V_I + V_{NI})$$

- Borrower and lender participation constraint

$$(1 - \alpha)(pR - 1) > (1 - p)V_I$$
$$\alpha(pR - 1) > (1 - p)V_{NI}$$

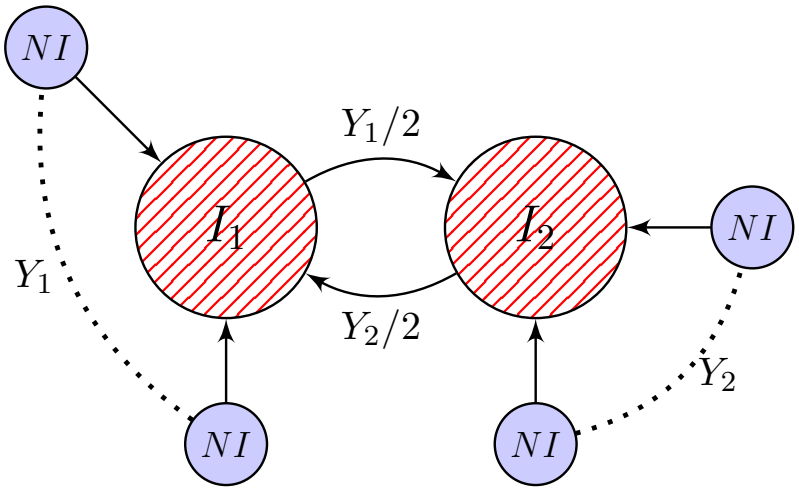
▸ Bank Maximization

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

▸ General Result

Diversification



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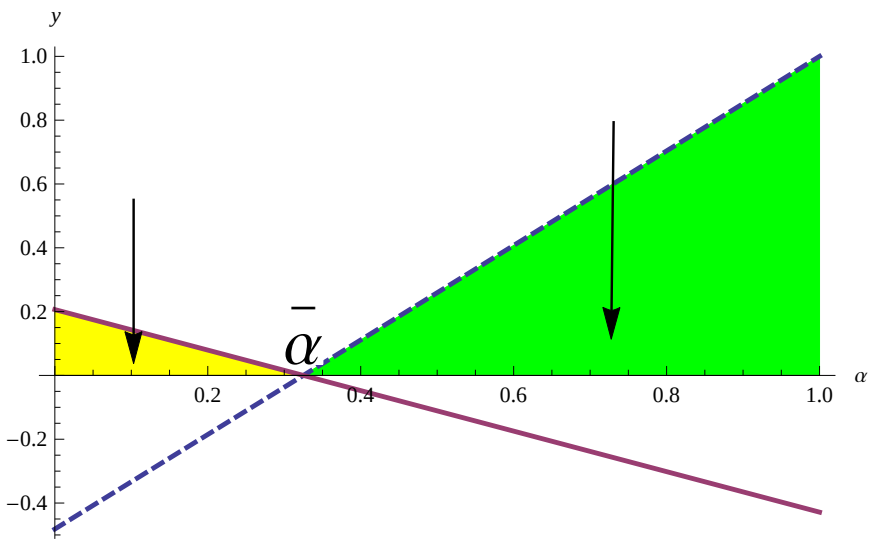
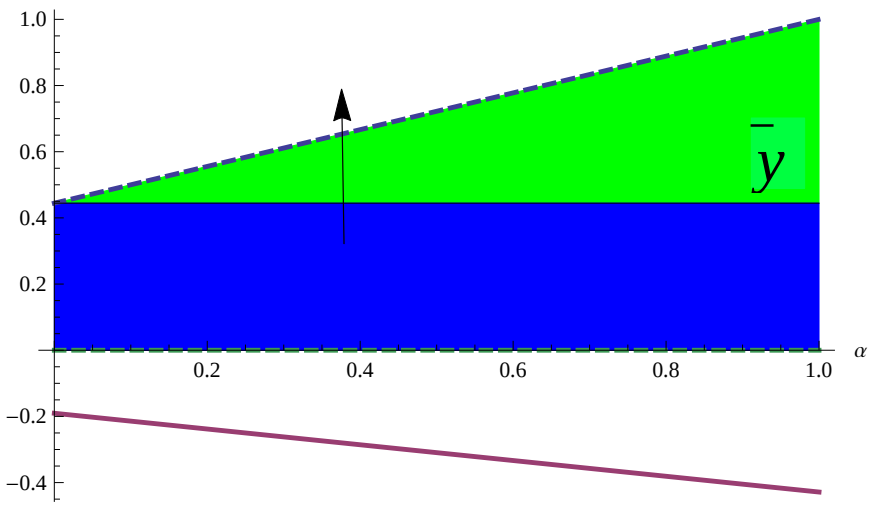
Diversification

- Net lender



(A) $R > \frac{2}{p(2-p)}$



(B) $R < \frac{2}{p(2-p)}$