Bank Networks and Systemic Risk: Evidence from the National Banking Acts

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How does financial architecture affect systemic risk?

- The financial system is highly interconnected.
  - systemic risk, SIFIs, LCR, Dodd-Frank, CCPs
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How does financial architecture affect systemic risk?

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_sprite: This paper looks at bank networks in 1862 and 1867
  - networks simply formed by interbank deposits
  - National Banking Acts (1863-1864) reshaped network structure
  - 5 major banking crises afterwards
Empirically documents how National Banking Acts (NBAs) affected bank linkages

finding: Post-NBAs network had a more concentrated tiered structure.

Quantitatively examines the impact on systemic risk

finding: a more concentrated network is robust-yet-fragile.
Outline

1. Historical Background
2. Data and Empirical Results
3. Model and Quantitative Analysis
Historical Background
State Banking Era: 1837 - 1862

- Banks were state-regulated; no uniform currency, no Fed, no OCC.
- State banks issued own banknotes. Large dispersion in discounts.

- Banks had correspondent networks
  - shaped by interbank deposits, note-deeming, trade patterns
  - core-periphery structure with local hubs (Weber 2003)
National Banking Acts (NBAs): 1863 - 1864

- Lincoln tried to finance the Civil War for the North. Banks didn’t lend.
- Secretary of Treasury Chase launched National Banking Act in 1863.
  - national banking system: national charters, OCC, uniform currency
  - national chartered banks: buy US bonds, reserves requirements
- National charters were not popular; NBA revision (1864) raised taxes on state banknotes 2%→10% ⇒ most converted
Interbank Network after the National Banking Acts

- NBAs set reserve requirements that reshaped bank networks
  - classified banks into 3 tiers with different reserve ratios
  - mandated reserve deposits with approved agents

<table>
<thead>
<tr>
<th>Banks</th>
<th>Reserve ratio</th>
<th>Max deposit in upper tiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central reserve city banks</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td>Reserve city banks (PHL, PIT)</td>
<td>25%</td>
<td>1/2</td>
</tr>
<tr>
<td>Country banks</td>
<td>15%</td>
<td>3/5</td>
</tr>
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</table>

- Profitable to deposit reserves at approved agents due to interest

- Interbank networks became 3-tiered and more concentrated.
Data and Empirical Results
Data: detailed balance sheets and links in 1862, 1867

- Unique achieve data on Pennsylvania and NYC banks in 1862, 1867
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State banks: balance sheets, detailed interbank deposits (1862, 1867)

Due to the Allentown Bank, from the following named solvent banks respectively, on the third day of November, 1862:

Manufacturers' and Mechanics' Bank, Philadelphia...................... $29,710 52
Union Bank, New York............................................................ 88,413 33
Easton Bank................................................................. 9,209 69
Farmers' and Mechanics' Bank, Philadelphia.............................. 6,453 44
Northern Liberties Bank..................................................... 3,328 20
Penn Township Bank......................................................... 2,765 62
Corn Exchange Bank, Philadelphia.................................. 4,225 01
Mauch Chunk Bank........................................................... 2,412 79
Union Bank, Philadelphia.................................................. 649 90
Union Bank of Reading..................................................... 1,183 91
Farmers' and Mechanics' Bank of Easton................................. 606,17
Farmers' Bank of Reading.................................................. 8 33
Bank of Catasauqua............................................................ 885 13
Philipsburg Bank, New Jersey............................................ 713 21
Pottstown Bank............................................................... 72 00
E. W. Clark & Co., Philadelphia........................................... 5,780 58

156,367 83
Data: detailed balance sheets and links in 1862, 1867

- Unique achieve data on Pennsylvania and NYC banks in 1862, 1867

- National banks: balance sheets, deposits at approved agents (1867)
Empirics: NBAs led to a concentration of bank linkages

- Post-NBAs network had a more concentrated tiered structure.

(a) 1862  
(b) 1867

- NYC
- PHL
- PIT
- country banks

Log Size of Due-To Deposits
Empirics: NBAs led to a concentration of bank linkages

- Distribution of interbank deposits was more concentrated in 1867.

- Similar results from degree distribution and other network statistics.
Model and Quantitative Analysis
Model: key features

- Demand deposits, long-term investment $\rightarrow$ liquidity risk
- Interbank liability relationships form the network
- Banks can withdrawal from and default on others $\rightarrow$ contagion
- Clearing equilibrium (Eisenberg, Noe 2001; Acemoglu et al 2015)
- Contagious withdraws and liquidation
Model: environment

- N risk-neutral banks, 2 periods \((t_0, t_1, t_2)\), no discounting

- Balance sheet given at \(t_0\)

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- \(L\) is interbank deposit network; \(L_{ij} > 0\): bank \(i\) deposits at \(j\).
  - bank \(i\) is the respondent: it has \(L_{ij}\) due-from \(j\)
  - bank \(j\) is the correspondent: it has \(L_{ij}\) due-to \(i\)
  - \(L\) is a weighted directed graph
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- Loan investment matures at \(t_2\) with random return
  \[\log \hat{R}_i = \log \bar{R}_i + \varepsilon_i;\] expected return \(\bar{R}\) is known at \(t_1\)
Model: liquidity withdrawal payment equilibrium

Liquidity withdrawal payment equilibrium at $t_1$: withdrawals by banks $W^L$, by local depositors $W^D$, payments $X^L$, $X^D$, liquidation $I^l$, default $I^{d1}$:

- Costly liquidation $I^l_i = 1$: $C_i + \sum_j W^L_{ij} X^L_{ij} < \text{withdrawals}$

- Default $I^{d1}_i = 1$: $C_i + \sum_j W^L_{ij} X^L_{ij} + I^l_i \xi_l I_i < \text{withdrawals}$

- If default: *pro rata* payments to banks $X^L$, to local depositors $X^D$

- Withdrawals occur if
  
  - respondent itself has liquidity shortage (cash < withdrawals)
  - correspondent is likely to liquidate (dominating strategy)
  - correspondent is likely to default (Diamond, Dybvig 1983)
Model: final date payment equilibrium

Final date payment equilibrium at $t_2$: payments $Y^L$, $Y^D$, default $\mathbb{I}^{d2}$:

- If not liquidated, investment matures $I\tilde{R}$.
- Default $\mathbb{I}^{d2}$: cash + deposit redemptions + investment $<$ deposits due-to
- If default: *pro rata* payments to banks $Y^L$, to local depositors $Y^D$

The final date equilibrium always exists and is generically unique.
Quantitative Analysis

- Construct banking systems
  - balance sheet items \( \{C, I, K, D, L\} \) come from real data in 1862, 1867
- Simulate two types of banking crises
- Compare systemic risk measures before and after NBAs
- Extensions: New York City banks’ reactions to crises
Quantitative Analysis: top-to-bottom crises

- Investment loss in NYC banks $\rightarrow$ spread out (1873, 1884, 1890, 1907)
  $\rightarrow$ reduce $\bar{R}$ of NYC banks
  $\rightarrow$ depositors withdrawal
  $\rightarrow$ NYC banks liquidate $\rightarrow$ default
  $\rightarrow$ PHL, PIT banks get withdrawals $\rightarrow$ liquidate, etc.
Quantitative Analysis: top-to-bottom crises

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Finding: a more concentrated network is *robust-yet-fragile*: more robust to small shocks, more vulnerable to large shocks

\[ a. \text{Prob(Pct. liquidation > } \theta_l)\% \]

\[ b. \text{Prob(Pct. default > } \theta_d)\% \]
Mechanism: downward withdrawal contagion

- **Small shocks**: diversification limits contagion
- **Large shocks**: concentrated links exacerbate contagion

![Graph showing the effect of shocks to NYC banks on withdrawal contagion](image-url)
Quantitative Analysis: bottom-to-top crises

- Panic withdrawals originated at country banks → spread out (1893)

  - local depositors’ withdrawal trigger runs.
  - country banks have shortage → withdraw
  - correspondents liquidate, withdraw, etc.
Quantitative Analysis: bottom-to-top crises

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  → correspondents liquidate, withdraw, etc.

Finding: Post-NBAs network is more robust.

Mechanism: NYC banks endogenously held more cash → LCR of SIFIs

\[
\begin{align*}
\text{a. Prob}(\text{Pct. liquidation} > \theta_1)\% \\
\text{b. Prob}(\text{Pct. default} > \theta_2)\%
\end{align*}
\]
Extensions: NYC banks’ reactions to crises

- NYC banks collectively issued clearinghouse loan certificates in 1873, 1893.
  - Risk-sharing significantly alleviates top-to-bottom crises.

- NYC banks suspended cash payments in panics of 1873, 1893, 1907.
  - Systemic risk reduces; “robust-yet-fragile” result remains.
We study bank networks and systemic risk.

We take a unique historical and quantitative approach:

- examine bank networks in 1862 and 1867
- quantify effect of bank network changes on systemic risk

Findings and insights:

- The NBAs reshaped the bank networks to be more concentrated.
- A more concentrated network is robust-yet-fragile to liquidity crises.
- Systemic risk depends on networks and the size, type, location of shocks.