Reallocating Liquidity to Resolve a Crisis: Evidence from the Panic of 1873

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Introduction

- Crisis management without monetary injections?
  - Run-mitigating policies could strengthen "no bailout" stance against next gen shadow banks
  - Less reliance on monetary injections reduces inflation concerns
- Explore policies of New York Clearinghouse in the Panic of 1873:
  - Loan certificates
  - Information suppression
  - Partial suspension
- Questions to answer along the way:
  - Were loan certificates just completing the interbank market?
  - Would an interbank market with info suppression do better?
  - Was partial suspension necessary given the other policies?
- Overall, quantitative counterfactuals suggest loan certificates (which didn't increase total cash) were pretty effective.

1873

Historical Background

- New York Clearinghouse (NYCH)
  - Association of all of the major banks in New York City
  - Emerged to facilitate check-clearing by netting across members
  - Took the lead in managing financial crises when they arose
- Clearinghouse Loan Certificates (CHLC)
  - Collateralized notes that members could use instead of cash to settle check-clearing obligations
  - Functioned as forced loans (i.e., could not be refused as payment by other members)
  - Interest rate set by NYCH and payable only on loan certificates used
- Panic of 1873
  - First major banking panic of the National Banking Era
  - Failure of Jay Cooke & Co. due to investments in railroad bubble
  - Stocks tumbled on September 18th and bank runs ensued
  - NYCH authorized $10M in CHLC on September 20th
  - Another $10M in CHLC (and other policies) on September 22nd

Data Sources

- Minutes of NYCH Committee
  - Daily clearing and settlement of all members
  - Daily issuance and cancellation of CHLC
  - Interest payments on CHLC by banks
  - Snapshot of deposits on 10/21/1873
- Balance sheet information
  - Weekly balance sheets from Commercial & Financial Chronicle
  - Call reports from Comptroller of the Currency and Superintendent of the Banking Department of the State of New York
  - National bank examination reports

Summary Statistics, NYCH Members

	Non-Recipient Banks	Recipient Banks	All Banks
Cash / Total Assets	11.18	8.52	9.70
	(4.88)	(3.29)	(4.25)
Call Loans / Total Loans	26.07	23.69	24.74
	(23.19)	(18.90)	(20.74)
Investment / Total Assets	66.68	62.13	64.13
	(5.50)	(11.40)	(9.48)
Equity / Total Liabilities	34.53	25.10	29.26
	(7.07)	(8.58)	(9.19)
Due From Banks / Total Assets	4.46	5.27	4.91
	(2.54)	(3.52)	(3.13)
Due To Banks / Total Liabilities	5.67	19.23	13.25
	(6.12)	(19.77)	(16.67)
Loan Certificate Volume / Total Deposits	0	13.09	7.32
	(0)	(7.67)	(8.68)
Total Assets	$6,164,669	$8,870,033	$7,677,838
	(5,824,123)	(8,345,285)	(7,408,112)
Obs.	26	33	59

Notes: Recipient refers to whether or not the bank received loan certificates during the panic. Data are averages over the indicated NYCH members just before the panic. All ratios are expressed as percentages. Standard deviations are in parentheses.

Check Clearing and Loan Certificates

Banks that owed more checks received more loan certificates:

	Due to NYCH	Due from NYCH
Issuance	0.799***	-0.138
	(0.00)	(0.235)
Obs.	76	76

Notes: Pearson correlations with p-values in parentheses. Issuance is the volume of loan certificates received from the NYCH. Due to NYCH is the volume of checks owed. Among 61 banks in the clearinghouse, 33 banks received loan certificates. Loan certificates were issued 76 times because some banks received loan certificates multiple times in this window.

Deposit Growth During the Panic

Recipient banks had much higher deposit outflows than non-recipients:

	9/20 to 10/21	10/21 to 12/6
Non-Recipient Banks	-13.92	22.34
	(16.12)	(34.48)
Recipient Banks	-32.76	13.24
	(29.07)	(25.69)

Notes: Difference between the groups is only statistically significant in the first column (at 1%). Standard deviations are in parentheses. Deposits on 10/21 were not made public. The currency premium (Gorton and Tallman, 2018) was positive for 9/20 to 10/21 and zero for 10/21 to 12/6.

Ratio of Cash to Deposits Before and After the Panic

But liquidity seems to have been successfully redistributed (i.e., each group emerged from the crisis with its pre-crisis cash-to-deposit ratio):

	9/20	12/6
Non-Recipient Banks	0.332	0.339
	(0.137)	(0.192)
Recipient Banks	0.263	0.278
	(0.083)	(0.107)

Notes: Cash refers to specie and legal tender. Data are averages over the indicated NYCH members at the indicated dates. Standard deviations are in parentheses. No statistically significant difference between the two columns for either group.

MODEL

Baseline Model

Environment

- Three dates, $t = 0, 1, 2$
- Continuum $i \in [0, 1]$ of banks, each serving a unique set of depositors of measure one
- Bank i endowed with cash c_i and loans $\widetilde{z}$ at $t = 0$, where $c_i + \widetilde{z} \geq 1$
  - Each loan pays $x \in (0, 1)$ if liquidated at $t = 1$; else $1 + r_z$ at $t = 2$
  - At $t = 1$, liquidate $l_i \in [0, \widetilde{z}]$ or make additional loans $z_i \geq 0$ at an adjustment cost $\frac{\zeta z_i^2}{2}$ due at the end of $t = 2$
- Each depositor in bank i has 1 unit of deposits at $t = 0$
  - Entitled to 1 if withdraws at $t = 1$; else $1 + r$ at $t = 2$
  - Fraction $\rho \in (0, 1)$ hit by shock at $t = 1$ and must withdraw; rest choose whether to withdraw at $t = 1$ or $t = 2$

Baseline Model

Timing

- Date $t = 1$:
  - Depositors learn their liquidity shocks
  - Patient depositors decide whether to withdraw at $t = 1$ or $t = 2$
  - Each bank i chooses liquidations l_i, additional loans z_i, and net interbank borrowing Δ_i, with r_b determined by market clearing
    - Walrasian interbank market with net borrowing $\Delta_i \in \mathbb{R}$ by bank i
    - For simplicity, can only take out loans that can be repaid
    - Interbank rate r_b determined by market clearing: $\int_0^1 \Delta_i di = 0$
  - Banks with insufficient cash to pay depositors fail
- Date $t = 2$:
  - Solvent banks obtain returns from unliquidated loans, settle interbank obligations, and repay remaining depositors

Baseline Model

Conservative Equilibrium

- Could be multiple equilibria based on depositor beliefs about what other depositors will do
- Conservative equilibrium: each patient depositor decides whether or not to withdraw at $t = 1$ based on the worst case scenario that all other depositors in their bank withdraw at $t = 1$
- Bank i is run-proof at $t = 1$ if and only if $V_i(1) \geq 0$, where

$$V_i(\omega_i) \equiv \max_{\ell_i, z_i, \Delta_i} \left\{ \begin{array}{l} c_i + x\ell_i - z_i + \Delta_i - \omega_i + (1 + r_z)(\widetilde{z} - \ell_i + z_i) \\ -(1 + r_b)\Delta_i - (1 + r)(1 - \omega_i) - \frac{\zeta z_i^2}{2} \end{array} \right\}$$

$$s.t.$$

$$c_i + x\ell_i - z_i + \Delta_i \geq \omega_i$$

is the optimization problem of bank i at $t = 1$ given fraction ω_i of depositors withdrawing from it at $t = 1$

Baseline Model

Proposition 1

1. If $\int_0^1 c_i di \geq \rho$, then there exists a conservative equilibrium with no bank runs (i.e., $\omega_i^* = \rho$ for all i).

2. If $\int_0^1 c_i di < \rho$, then a conservative equilibrium will involve runs on a positive measure of banks, namely any bank i with cash endowment

$$c_i < \overline{c}\left(r_b^*\right) \equiv 1 - \frac{\left(1 + r_z\right)\widetilde{z}}{1 + r_b^*}$$

where the interbank rate r_b^* solves

$$\int_{\left\{i | c_i \geq \overline{c}\left(r_b^*\right)\right\}} \left(\rho - c_i\right) di = 0$$

and existence of the equilibrium requires $r_b^* \in \left(r_z, \frac{1+r_z}{x} - 1\right)$.

Baseline Model

Pecuniary Externality

- Social welfare when $\int_0^1 c_i di < \rho$:

$$\mathcal{W} = \int_0^1 c_i di + x\widetilde{z} + \left[f\left(\widetilde{z}\right) - x\widetilde{z}\right] \int_{\left\{i | c_i \geq \overline{c}\left(r_b^*\right)\right\}} di$$

  where $f\left(\widetilde{z}\right)$ is output by recipients of (unliquidated) loans $\widetilde{z}$

- Welfare is decreasing in r_b^* (because minimum cash endowment for a bank to be run-proof is increasing in r_b^*)

- Mechanism that lowers equilibrium interbank rate could improve welfare

- A "reserve pooling" benchmark:

$$\mathcal{W}_{\max} = \int_0^1 c_i di + x\widetilde{z} + \left[f\left(\widetilde{z}\right) - x\widetilde{z}\right] \frac{\int_0^1 c_i di}{\rho}$$

Loan Certificates

Overview

- Introduce as alternative to interbank market
- To connect to check-clearing (as in 1873), decompose bank i's cash endowment into

$$c_i \equiv \widetilde{c}_i - \nu_i + \overline{\nu}$$

  where
  - $\widetilde{c}_i$ is cash reserves (specie and legal tender)
  - ν_i is cash outflows associated with checks owed to other banks
  - $\overline{\nu}$ is cash inflows associated with checks owing from other banks
- At $t = 0$, planner sets an allocation of loan certificates $\left\{\widehat{k}_i\right\}_{i\in[0,1]}$ and an interest rate r_k
  - Bank i uses $k_i \in \left[0, \min\left\{\nu_i, \widehat{k}_i + \overline{k}\right\}\right]$ to meet check-clearing obligations with other banks (before withdrawals) at $t = 1$
  - Utilized certificates incur r_k and are repaid (if solvent) at $t = 2$

Loan Certificates

Proposition 2

- Consider $\widetilde{c}_i = \widetilde{c}$ and $\overline{\nu} > \rho - \widetilde{c}$, meaning:
  - Check-clearing obligations drive variation in initial cash positions
  - Aggregate check-clearing activity is sufficiently high
- Then, when $\int_0^1 c_i di < \rho$, an allocation of loan certificates

$$\widehat{k}_i^* = \begin{cases} 0 & if \quad c_i < \overline{c}\left(r_k^*\right) \\ \nu_i & if \quad c_i \geq \overline{c}\left(r_k^*\right) \end{cases}$$

with interest rate r_k^* solving

$$\int_{\left\{i | c_i \geq \overline{c}\left(r_k^*\right)\right\}} \left(\rho - c_i\right) di = \int_{\left\{i | c_i < \overline{c}\left(r_k^*\right)\right\}} \min\left\{\overline{k}, c_i\right\} di > 0$$

can achieve higher welfare than the decentralized equilibrium.

- The welfare-improving allocation implements $\Delta_i = 0$ and restricts banks with $\widehat{k}_i = 0$ to use cash before any recirculated $\overline{k}$.

Loan Certificates

Intuition

- Banks above $\overline{c}\left(r_k^*\right)$ get enough loan certificates to cover checks owed to other banks
- Banks below $\overline{c}\left(r_k^*\right)$ get no loan certificates
  - Must use cash reserves to pay checks owed while receiving no cash reserves as payment for checks owing
- Implements forced reallocation of cash reserves away from failing banks (and their depositors) to the rest of the system
- Permits $r_k^* < r_b^*$ and thus fewer runs than decentralized equilibrium
- Volume of check-clearing activity affects how close can get to $\mathcal{W}_{\max}$
  - If $\overline{\nu} \geq \rho - \widetilde{c} + \overline{c}\left(r_k^*\right)$, then all the cash of failing banks is reallocated to run-proof banks, achieving the same welfare as reserve pooling

Information Suppression

Proposition 3

- Primitives:
  - Return to decentralized interbank market with $\int_0^1 c_i di < \rho$
  - But now suppose depositors know only the distribution of c_i
- For a fixed interbank rate, there are (weakly) fewer bank failures if information is suppressed than if it is not.
- If there exists an equilibrium without runs under info suppression, then the measure of banks that ultimately fails is the same as in the equilibrium without info suppression, but welfare may be higher.

Information Suppression

Intuition

- Information suppression can introduce cross-subsidization of weak banks by strong ones
- With enough strong (i.e., run-proof) banks:
  - No depositors run so some bank failures are deferred until $t = 2$
  - Welfare gains come from fewer loans liquidated at $t = 1$
- But interbank rate will adjust to deliver the same measure of bank failures with or without information suppression:
  - If information suppression decreases the cash threshold below which banks fail, more low-cash banks will be in the interbank market, pushing up the interbank rate and increasing the threshold
  - Information suppression offers no mechanism by which to extract cash reserves from failing banks for use by the rest of the system

QUANTITATIVE

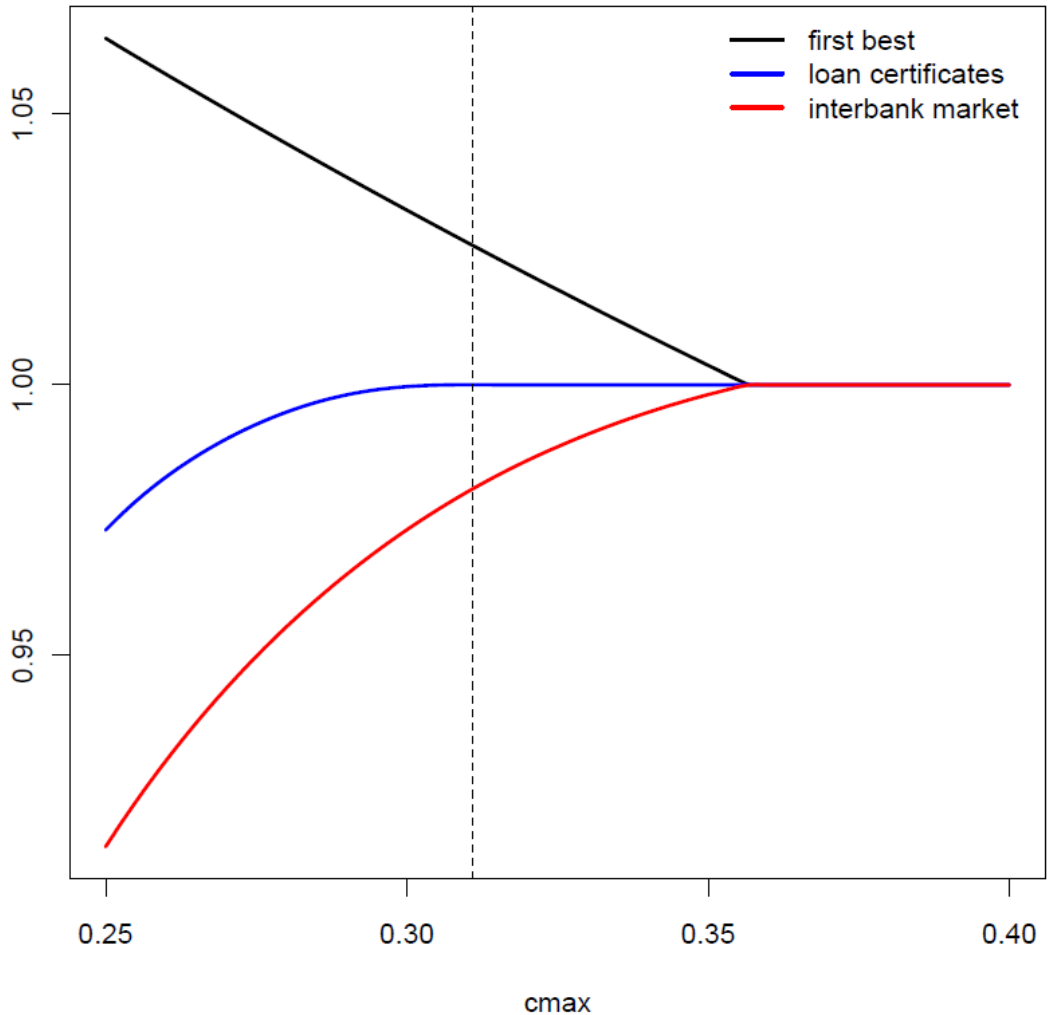
Quantitative Analysis

Parameterization

- Cash distribution: $c_i \sim \mathcal{U}[0.068, 0.311]$
- Deposit rate: $r = 0.02$
- Average loan rate: $r_z = 0.04$
- Output function: $f(z) = (1 + r_z) z$
- Liquidation value: $x = 0.75$
- Adjustment cost: $\zeta \to \infty$ (few profitable opportunities in crisis)
- Loans outstanding: $\widetilde{z} = 0.932$ (so $c_{\min} + \widetilde{z} = 1$)
- Aggregate check clearing: $\overline{\nu} = 0.122$ (so $c_{\max}$ owes no checks)
- Early withdrawals: $\rho = 0.212$ (calibrated to get $r_k^* = 0.07$)

Quantitative Analysis

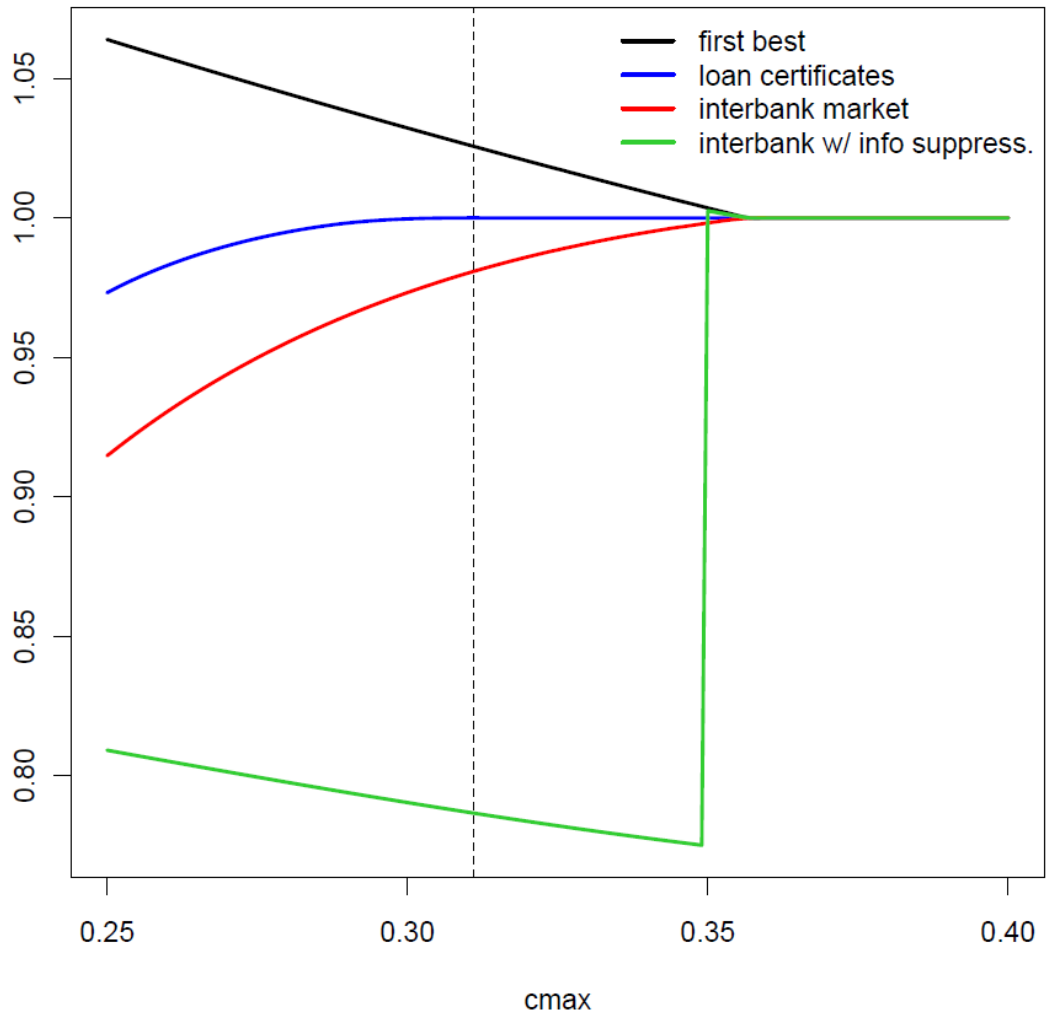
Welfare Relative to Reserve Pooling



Notes: Higher c_{max} captures a system with more total cash. Dashed vertical line indicates the 1873 level of c_{max}. First best is $\tilde{c} + f(\tilde{z})$.

Quantitative Analysis

Welfare Relative to Reserve Pooling



Notes: Higher c_{max} captures a system with more total cash. Dashed vertical line indicates the 1873 level of c_{max}. First best is $\tilde{c} + f(\tilde{z})$.

Quantitative Analysis

Partial Suspension

- At 1873 parameters:
  - Total cash ($\widetilde{c} = 0.189$) is less than early withdrawals ($\rho = 0.212$) so loan certificates alone cannot eliminate all bank failures
  - Info suppression without suspension would have been disastrous
  - Lack of bank failures among NYCH members attributable to suspension of convertibility on retail deposits

Conclusion

- Were loan certificates just completing the interbank market?
  - No. Decentralized interbank market would have a pecuniary externality that loan certificates help correct.
  - Forced reallocation of cash reserves away from failing banks lowers interbank rate and increases bank survival.
- Would an interbank market with info suppression do better?
  - Need sufficient aggregate liquidity, else welfare falls.
  - Even if cross-subsidization eliminates runs, final number of bank failures is the same as without info suppression.
- Was partial suspension necessary given the other policies?
  - Depends on whether goal is to stop all bank failures.
  - Low aggregate liquidity in NYC at onset of panic; loan certificates can minimize bank failures in this case but not eliminate them.