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# *Did the Founding of the Federal Reserve Affect the Vulnerability of the Interbank System to Systemic Risk?*

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Views expressed are not necessarily official positions of the Bank for International Settlements, the Federal Reserve Bank of St. Louis or the Federal Reserve System.

## *The Interbank System and Crises*

- Unit banking encouraged development of, and placed heavy demands on the interbank system.
- Highly *seasonal* demands for cash, loans, and interregional payments resulted in large flows through the interbank system via the money centers, esp. NYC (Kemmerer 1910).
- The interbank system allocated liquidity, but did not create liquidity. “Inelastic currency” resulted in seasonal “stringency.”
- Panics occurred when shocks coincided with peak seasonal demands (Kemmerer, Sprague, many others).

## *The Interbank System of the NB Era*

- A “core-periphery” system with three tiers (reflecting structure of reserve requirements):
  - Central reserve city banks (NYC, Chicago, St. Louis)
  - Reserve city banks
  - Country banks (and non-national banks)
- More concentrated (esp. in NYC) with shorter reserve-deposit chains than before NB era (Paddrik, Park, and Wang, 2016)
- A “robust-yet-fragile” system
  - Diffused local seasonal withdrawals and minor shocks across the system; resilient to small shocks to banks at the center
  - More vulnerable to large shocks because the system, esp. reserve requirements, encouraged interconnections and economizing on liquidity

## *The Fed was intended to replace the interbank system*

- The Fed was founded to address/prevent banking panics and make the payments system more efficient.
- The founders saw these problems as stemming from “inelastic” currency and a fragile/inefficient interbank system.
- New structure of reserve requirements
- New currency (Federal Reserve note) and reserves supplied via rediscounting of illiquid bank loans
- Fed provided payments services

## *The Fed did not Replace the System Entirely*

- Most state banks did not become members and continued to use national bank correspondents.
- Fed members (mostly national banks) also continued to hold balances with other banks (interest earning, access to money market investments, some check clearing (Watkins 1929)).

## *This Paper*

How did the Fed's founding affect the vulnerability of the interbank system to systemic risks?

- Seasonal accommodation largely eliminated one source of pressure on the interbank system.
- Reduced interconnectedness lessened vulnerability to solvency shocks at the core.
- Reduced liquidity *potentially* increased system's vulnerability to liquidity shocks (presence of a LLR may have caused banks to act in ways that made use of LLR more likely).

## *What we do*

- Present new evidence that seasonal pressures on the interbank system were lessened post-Fed.
- Examine how contagion risk from central reserve city banks and the vulnerability of country and reserve city banks to such shocks evolved over time.
- Present a counterfactual analysis (“stress test”) to see how reserve city and central reserve city banks would have fared in the 1920s against a liquidity shock similar to 1893. Wicker (2000) emphasizes the importance of withdrawals by country banks on reserve city and central reserve city banks in 1893.

## *A Caveat*

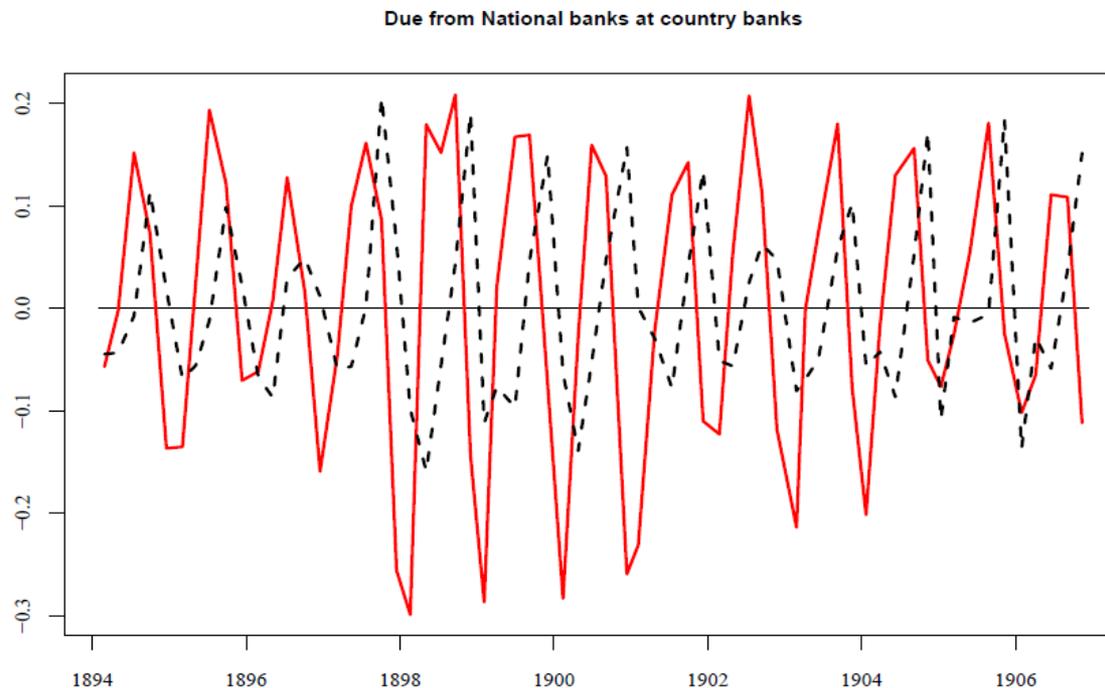
- We find large changes in the structure and characteristics of the interbank market before and after the founding of the Fed.
- We conjecture that changes in interbank markets and contagion risk were caused by the presence of the Fed, but don't control for other possibilities (e.g., WWI, gold standard, etc.).

## *Seasonal Pressure and Banking Panics*

- Seasonal demands for money and credit dominated interregional flows (Kemmerer 1910).
- The centralized structure of the interbank system likely made the system more resilient/responsive to normal seasonal pressure (Paddrik, Park and Wang 2016; various models). Banks at the core were able to offset outflows to some regions with inflows from others to some extent.
- Seasonal pressure on interbank system was reflected in changes in correspondent deposits.

## *Seasonal Pressure in Interbank Market*

Two principal components of change in “due from banks/assets” for country banks (state-level data)

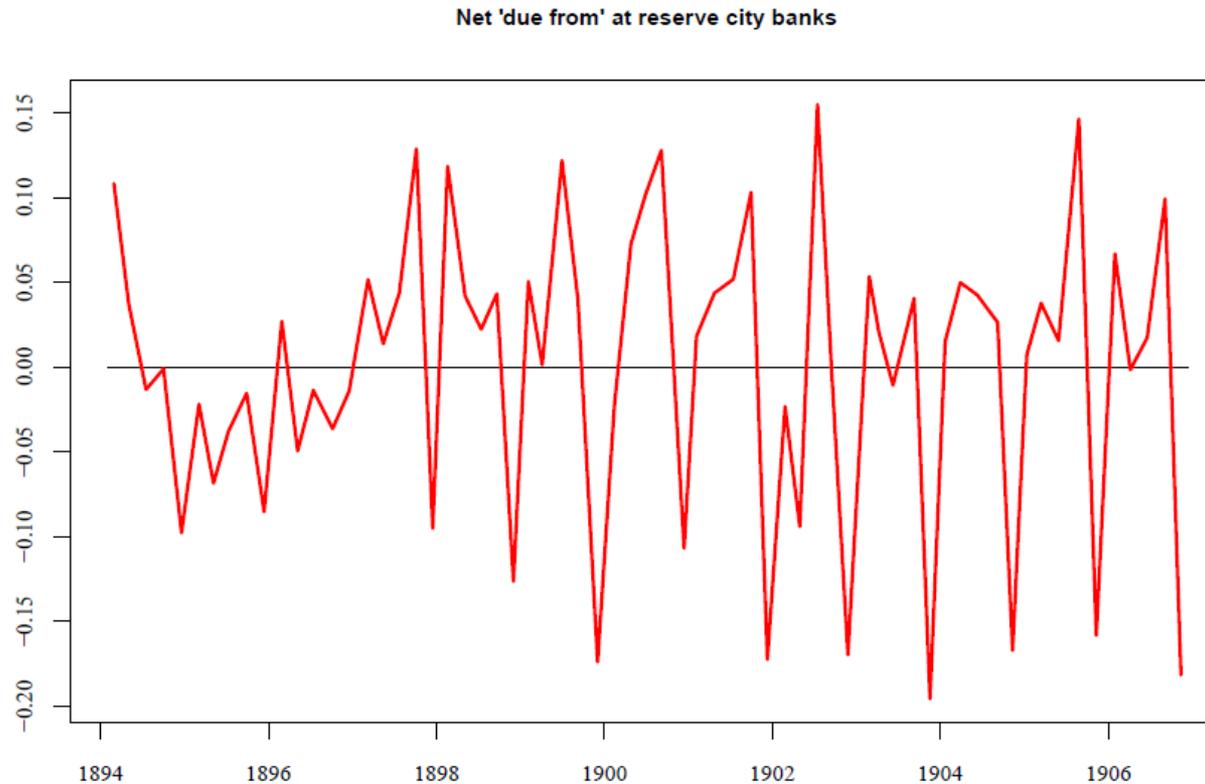


## *Offsetting Flows*

- First two PC's are highly seasonal and explain about 50 percent of the variation in changes in due from/assets.
- Outflows to about half the states were offset to some extent by inflows from others, e.g., 23 states load positively on first PC; 25 load negatively.
- Southern cotton states have heaviest positive loading on first PC. Western states and New England have negative loadings.
- PC 1 and 2 offset in time by one call report; also indicative of somewhat offsetting flows.
- Despite partial offset, net interbank balances at core cities were highly seasonal.

## *Reserve City Banks were in the Middle*

Changes in *net* due from/assets for 18 cities (first principal comp.)



## *Panics: From “Robust” to “Fragile”*

- Panics added to seasonal pressures on city banks in 1893 and 1907 (total withdrawals were larger than normal).
- Country banks from all regions pulled deposits from city banks, rather than some regions adding while others were withdrawing.
- Differences in size of deposit flows between normal and panic periods provides an indication of the size of shocks needed to shift the system from “robust” to “fragile.”

		Average change May to Sept. 1894-1906	Change from May to Oct. 1893	Average change Sept. to Dec. 1894-1906	Change from Aug. to Dec. 1907
<b>Country banks, change in due from national banks scaled by own total assets</b>					
1	All country banks	0.5	-1.3	0.2	-1.1
2	New England & Mid-Atlantic	1.3	0.5	-0.6	-0.2
3	Upper Midwest	1.2	-1.7	-0.8	-2.9
4	Southern	-4.1	-4.6	3.5	0.9
5	Plains	2.5	-2.0	-0.1	-1.3
6	Western	3.1	-5.0	0.1	-3.8
<b>Country banks, change in due from national banks scaled by total assets of banks in reserve cities and central reserve cities</b>					
7	All county banks	0.4	-1.7	-0.0	-1.7
<b>Reserve city banks, change in due from national banks scaled by total assets of banks in central reserve cities</b>					
8	Reserve city banks	0.5	-1.0	-0.1	-1.6
<b>Reserve city and central reserve city banks, change in due to national banks scaled by own total assets</b>					
9	Reserve city banks	1.0	-2.5	-0.2	-2.7
10	Central Reserve city banks	-0.2	-3.3	-0.4	-2.6

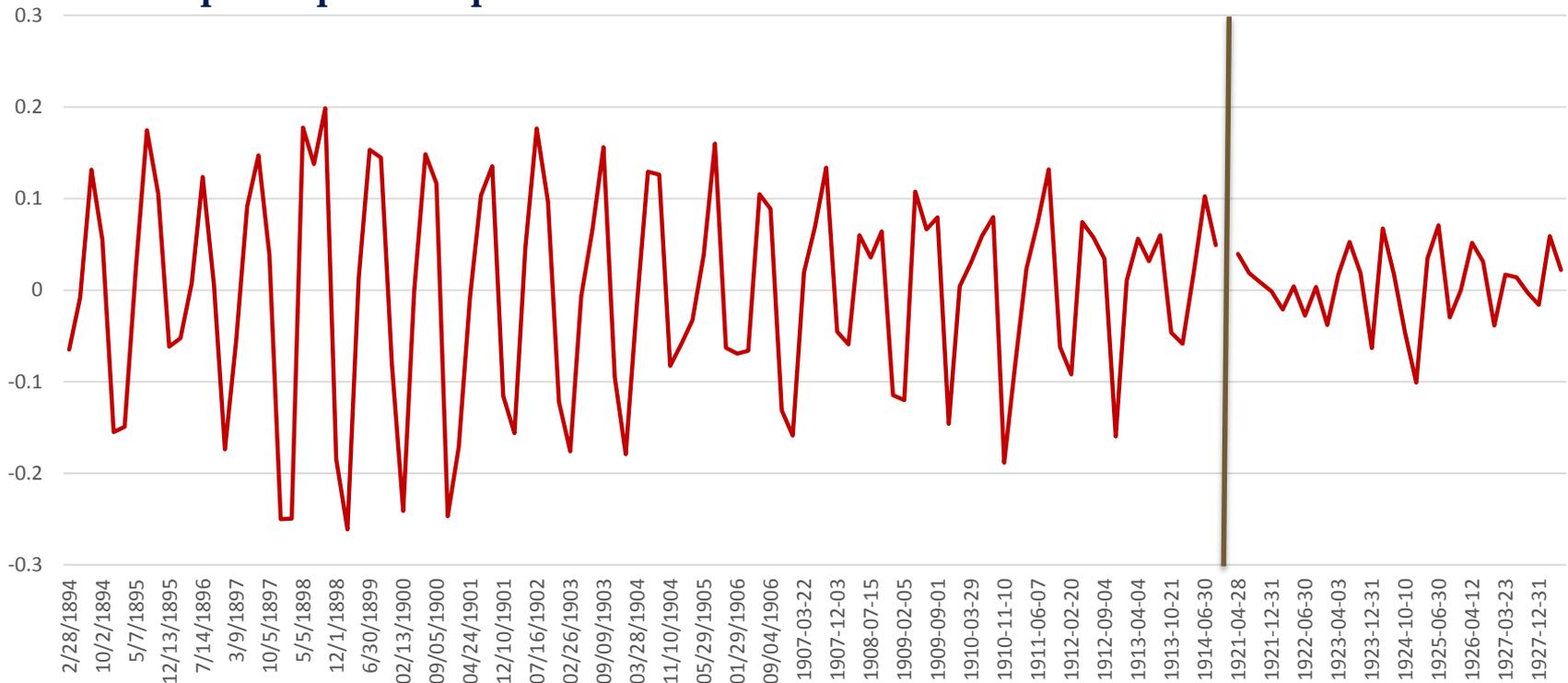
## *Interbank Market Post-Fed*

- Measured by volume of interbank deposits as a percent of bank assets/liabilities, the interbank market was substantially smaller in the 1920s than before 1914.
- Central reserve cities held a smaller share of interbank claims, despite having a larger share of total assets, in the 1920s.
- Interbank flows were decidedly less seasonal in the 1920s. Fed accommodation removed the seasonal stress on the interbank system.

	<b>Pre-Federal Reserve (1894-1914)</b>	<b>1920s (April 1921- June 1928)</b>
<b>Due from national banks as a share of assets, country banks</b>	13.8 (1.9)	6.8 (0.8)
<b>Due to national banks as a share of liabilities at banks in 18 reserve cities</b>	17.9 (1.5)	9.1 (1.1)
<b>Due to national banks as a share of liabilities of banks in Chicago, New York, and St. Louis</b>	28.6 (2.0)	10.7 (1.8)
<b>Portion of due to national banks in these 18 reserve city and Chicago, New York City, and St. Louis banks held at the central reserve cities</b>	65.3 (2.2)	58.1 (1.7)
<b>Portion of assets at banks in the 18 reserve cities and banks in the central reserve cities held by banks in Chicago, New York, and St. Louis</b>	54.9 (1.9)	57.3 (1.7)

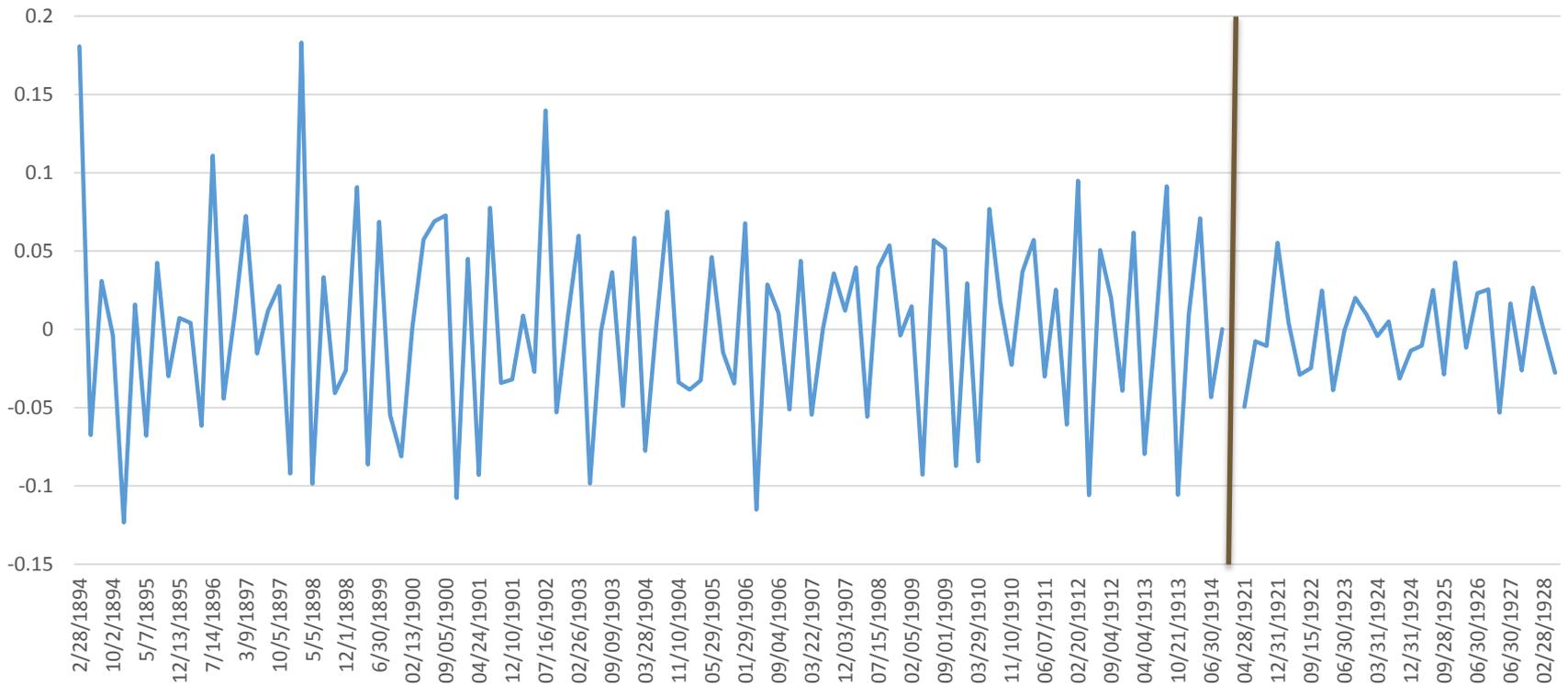
# *Change in Due From, Country Banks*

First principal component

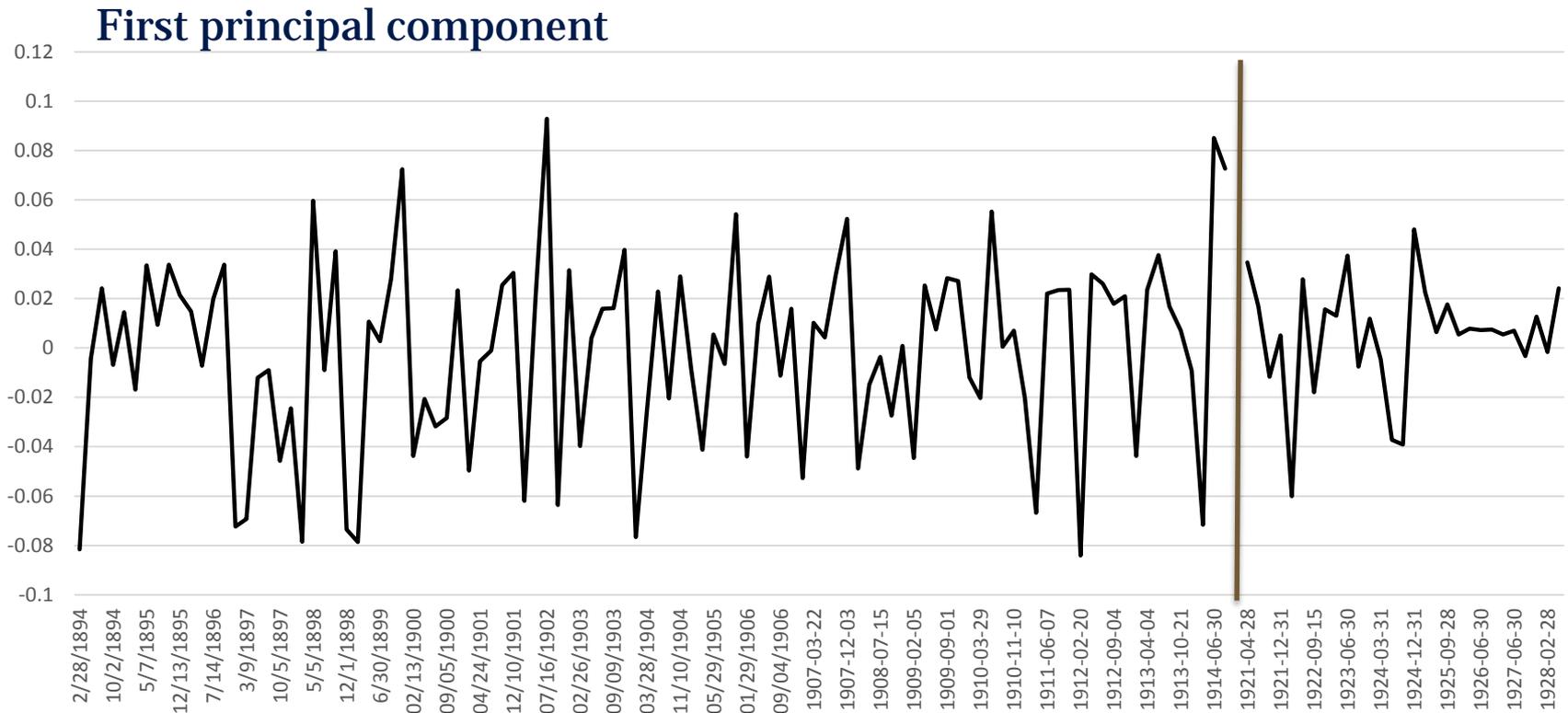


# *Change in net Due From, Reserve City Banks*

## First principal component



# *Change in Due to, Central Res. City Banks*



# *Federal Reserve Credit*

discount window loans + acceptance purchases



Sample: Jan. 1922 - Aug. 1931  
Additional controls include:  
- IP series difference relative to January 1915

## *Summary*

- Interbank flows were highly seasonal in NB era.
- Interbank system was generally robust to seasonal flows (diffused across regions).
- 1893 and 1907 shocks disrupted normal interregional flow patterns (robust to fragile).
- Fed lending was highly seasonal, likely contributed to less pressure on interbank system to manage seasonal liquidity in 1920s.
- We next consider the extent to which the system was robust to different types of shocks.

## *Contagion Risk: Top-Down Solvency Shocks*

- Did the Fed make country and reserve city banks less vulnerable to shocks from central reserve city banks?
- Contagion risk index (Glasserman and Young 2015) from central city banks is higher, the larger is CRC
  - size (total net worth)
  - leverage (*outside* assets/net worth)
  - connectedness (percent of total liabilities owed to other banks)

$$\text{Contagion Index}_j = \text{size}_j \times \text{connectedness}_j \times (\text{leverage}_j - 1)$$

## *Vulnerability*

- Other banks are more resilient to contagion from CRC banks, the larger their total net worth and less their exposure to other banks (due from banks/net worth).

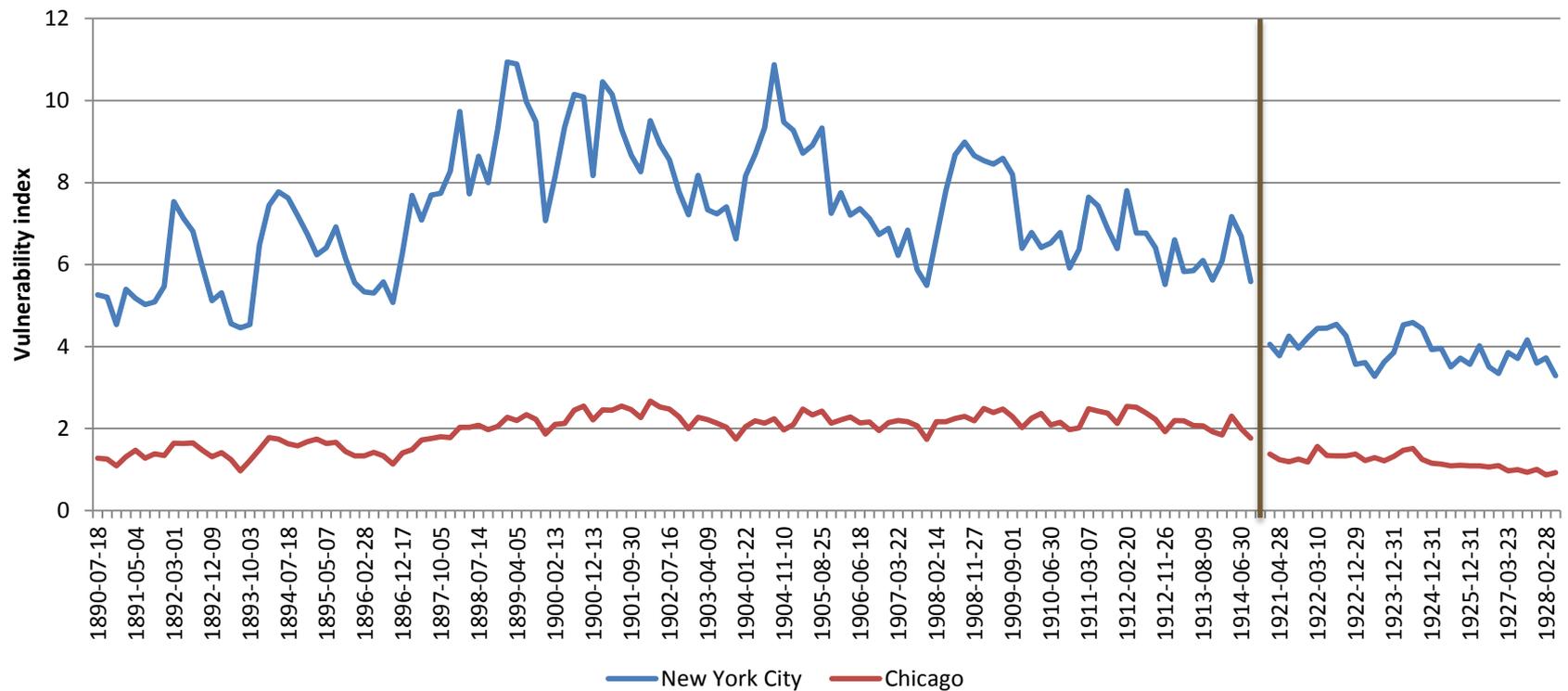
*Average Resilience<sub>i</sub> = harmonic mean of leverage<sub>i</sub>  
x arithmetic mean of size<sub>i</sub>*

- *Vulnerability = Contagion Index<sub>j</sub>/Resilience<sub>i</sub>*

Contagion is “weak” if Vulnerability < 1

## Contagion Risk Index/Resilience, Country Banks

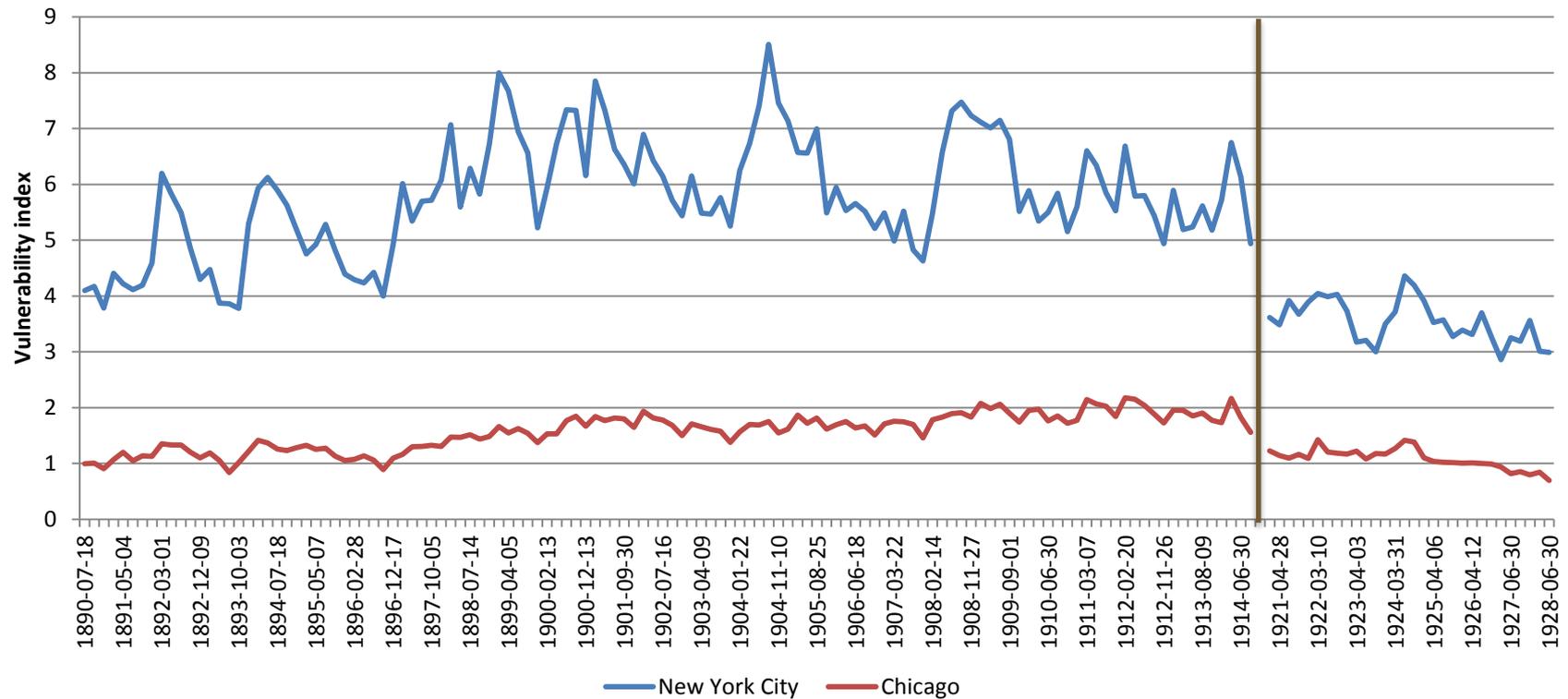
Country banks were less vulnerable to shocks from CRC banks in the 1920s



Ratio is about 1/3 lower in the 1920s → Less risk of contagious solvency shock from central reserve cities

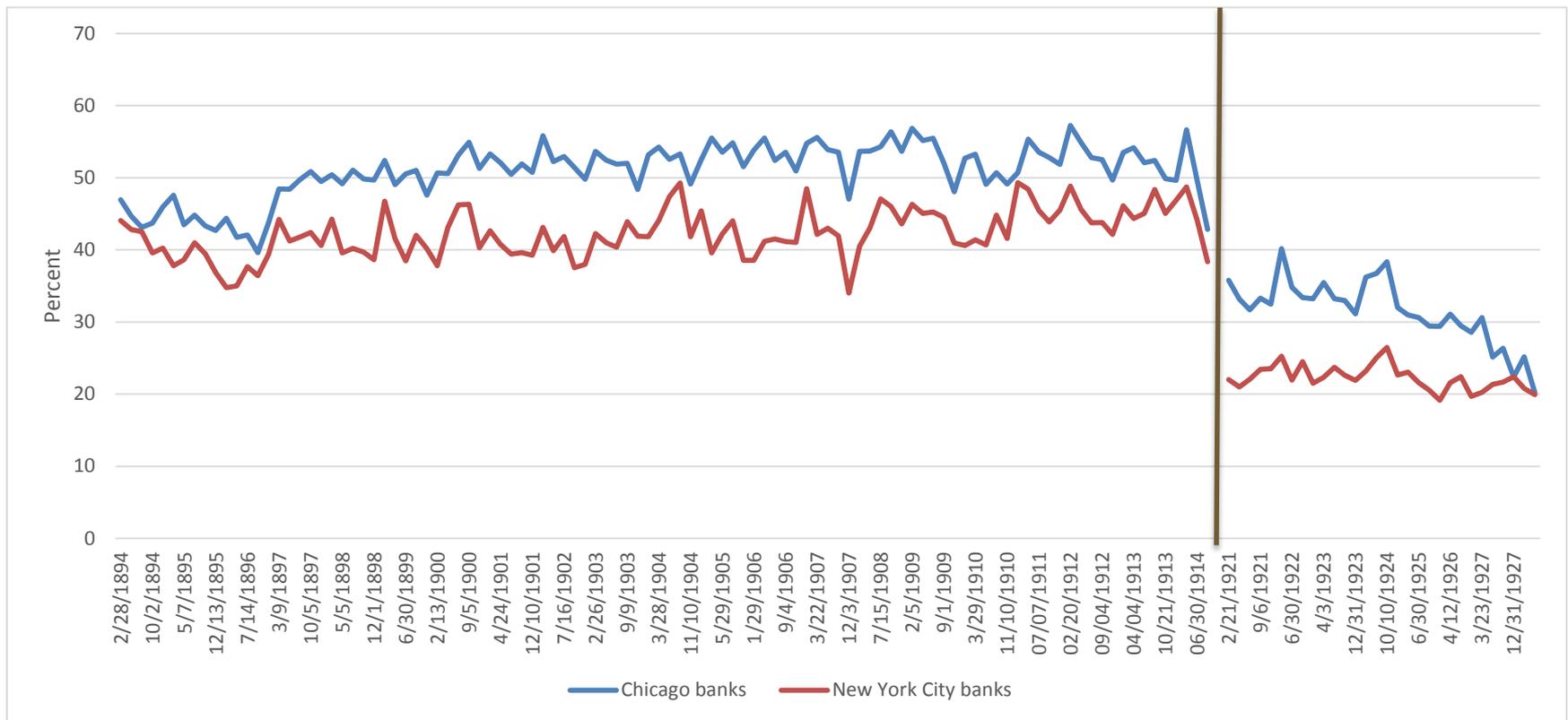
# Contagion Risk Index/Resilience, Res City Banks

Res. city banks were less vulnerable to shocks from CRC banks in the 1920s



# *Less Risk was driven by less Connectedness*

Deposits due to banks/total liabilities, central reserve city banks



## *Comments/Caveats*

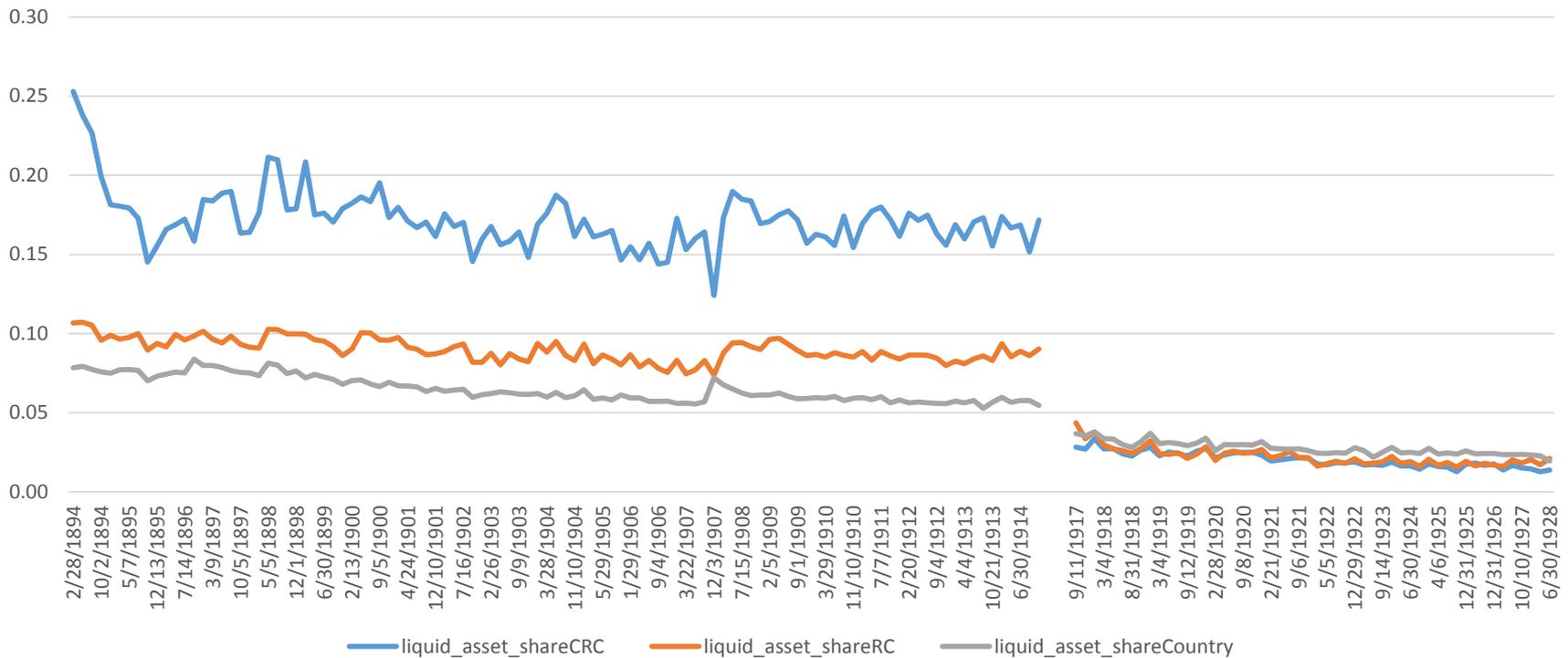
- Contagion risk only among *national* banks. Fragility of connections between national and state banks not considered.
- Banks generally became larger and more leveraged (and more exposed to “shadow banks,” non-members) – potentially more risky (captured by outside assets/net worth).
- Banks generally also became less liquid—potentially more vulnerable to panics.

## *Liquidity Pre- and Post-Fed*

- National banks generally had higher ratios of liquid assets to total assets in NB era (less clear for country banks).
- Banks tended to hold more of both cash and deposits with agents in NB era.
- Hypothesis: Banks opted for less liquidity in the 1920s because of the availability of the Fed's discount window.

# Vault Cash + Cash Items

Share of Liquid Assets



# Cash + Cash Items + Deposit with Fed

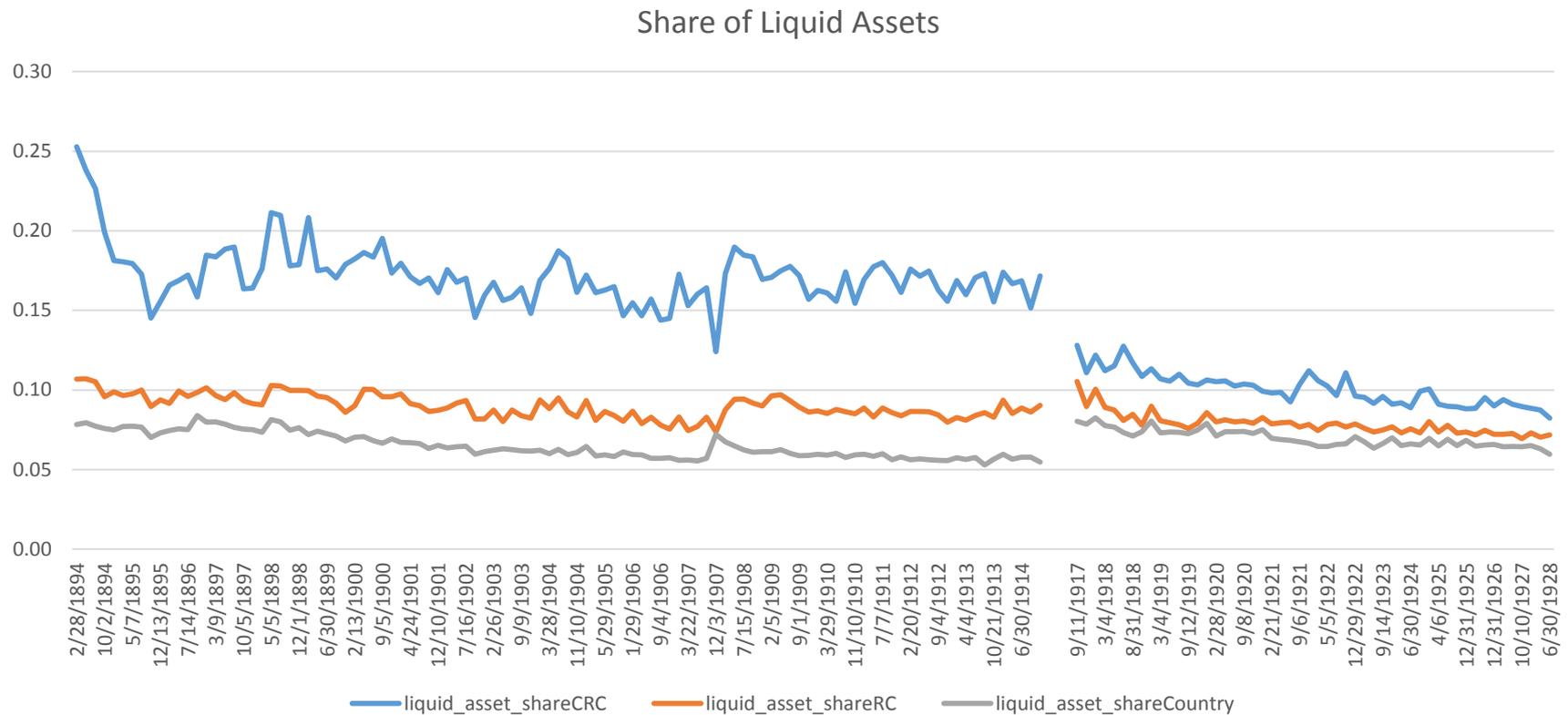
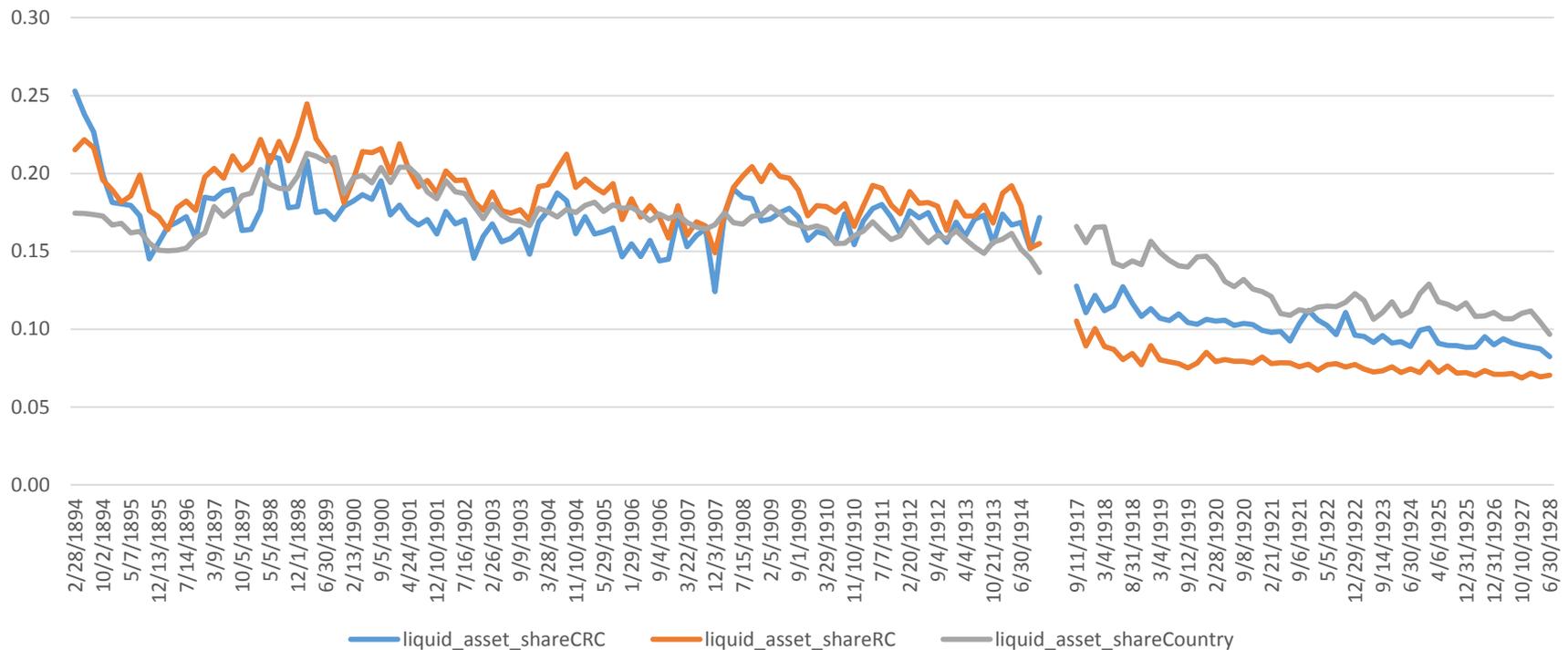


Figure 8 in paper; excludes due from agents pre-Fed

# Cash + Cash Items + Net Due From<sup>1</sup>

Share of Liquid Assets



(1) Includes net due from agents and other natl. banks and the Fed.

## *Contagion Risk: Liquidity Shocks*

- Liquidity shocks reflected runs by individual depositors and state-chartered banks on the national banking system.
- We consider the impact of a shock to country banks and trace the impact up the pyramid.
- We calibrate the shock to the Panic of 1893, and estimate the impact on reserve city and CRC banks at each call report date during 1897-1910 and 1922-28.

## *Impact on Country Banks*

- Estimate the impact of an 1893-size shock using state-level aggregated data for each call report date. Size of shock = withdrawals by non-bank depositors May-Oct. 1893 (20% of individual deposits and 36% of state bank deposits)
- We assume that banks meet withdrawals by first using their cash, then deposits with reserve agents (i.e., the Fed in the 1920s), then any net positive deposits with other national banks.

## *Impact on Reserve City Banks*

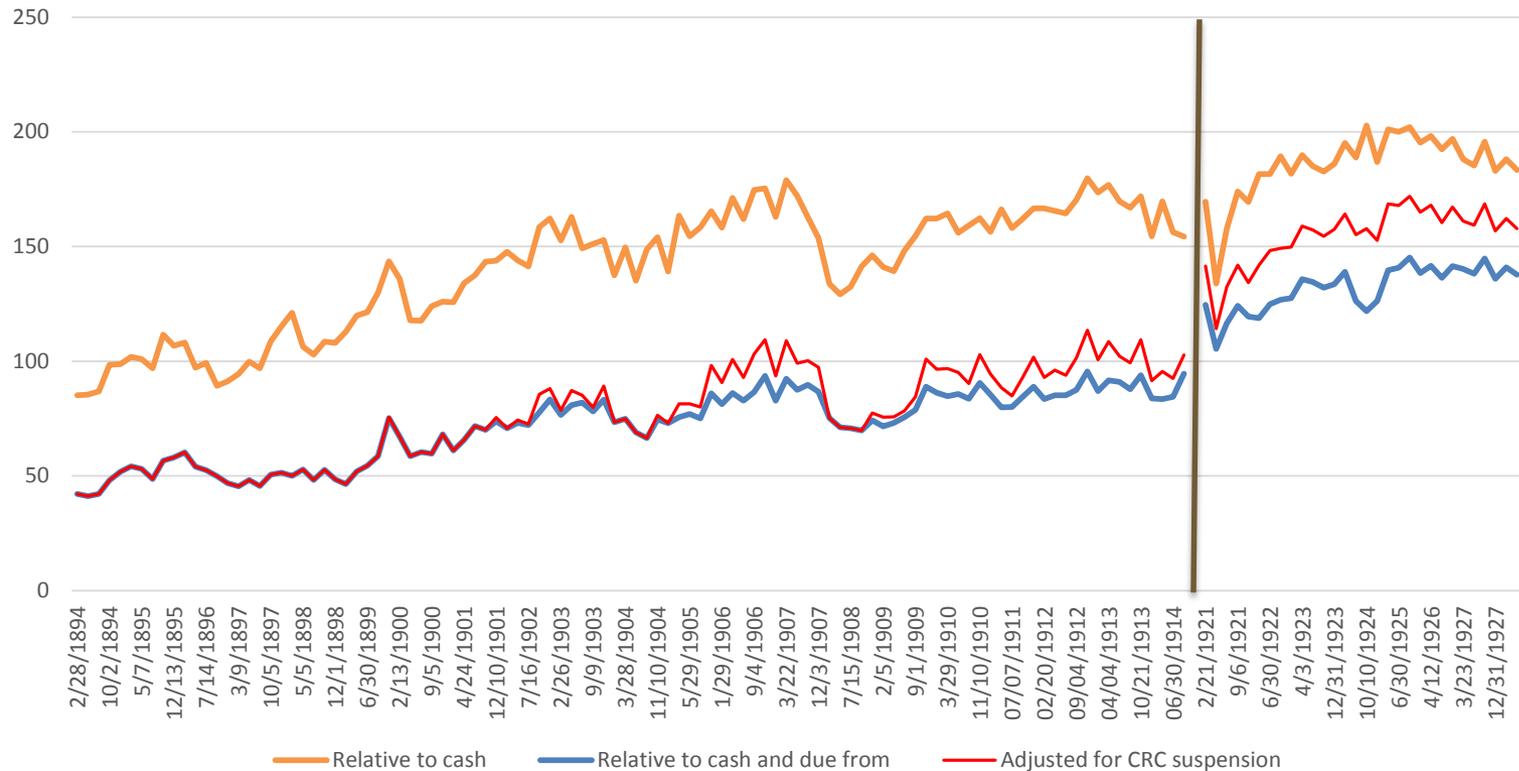
- Estimate impact on res. city banks in 18 long-time reserve cities and a composite “other” reserve city.
- Use 1893 withdrawals of individuals and state-chartered banks plus *estimated* withdrawals of country national banks (we assume that country bank withdrawals are proportionate to a given reserve city’s share of deposits due to nat. banks).
- Assume banks first use cash, then deposits due from reserve agents (CRC banks and the Fed).
- We limit withdrawals from reserve agents to cash held by central reserve city banks if the shock to CRC banks exceeds their combined cash holdings.

## *Impact on Central Reserve City Banks*

- We assume that CRC banks can only use cash (and deposits with the Fed in the 1920s) to meet withdrawals (which are the sum of withdrawals by individuals, state banks, and other national banks).
- For reserve cities and central reserve cities, we calculate the percentage of liquid assets needed to meet the 1893 shock in each period.
- We also calculate the number of reserve cities and central reserve cities that must suspend in each period.
- We assume no issuance of clearinghouse loan certificates. However, these did not circulate widely outside the cities of issuance, and they are consistent with the pooling of resources across clearinghouse members as implicitly assumed here.

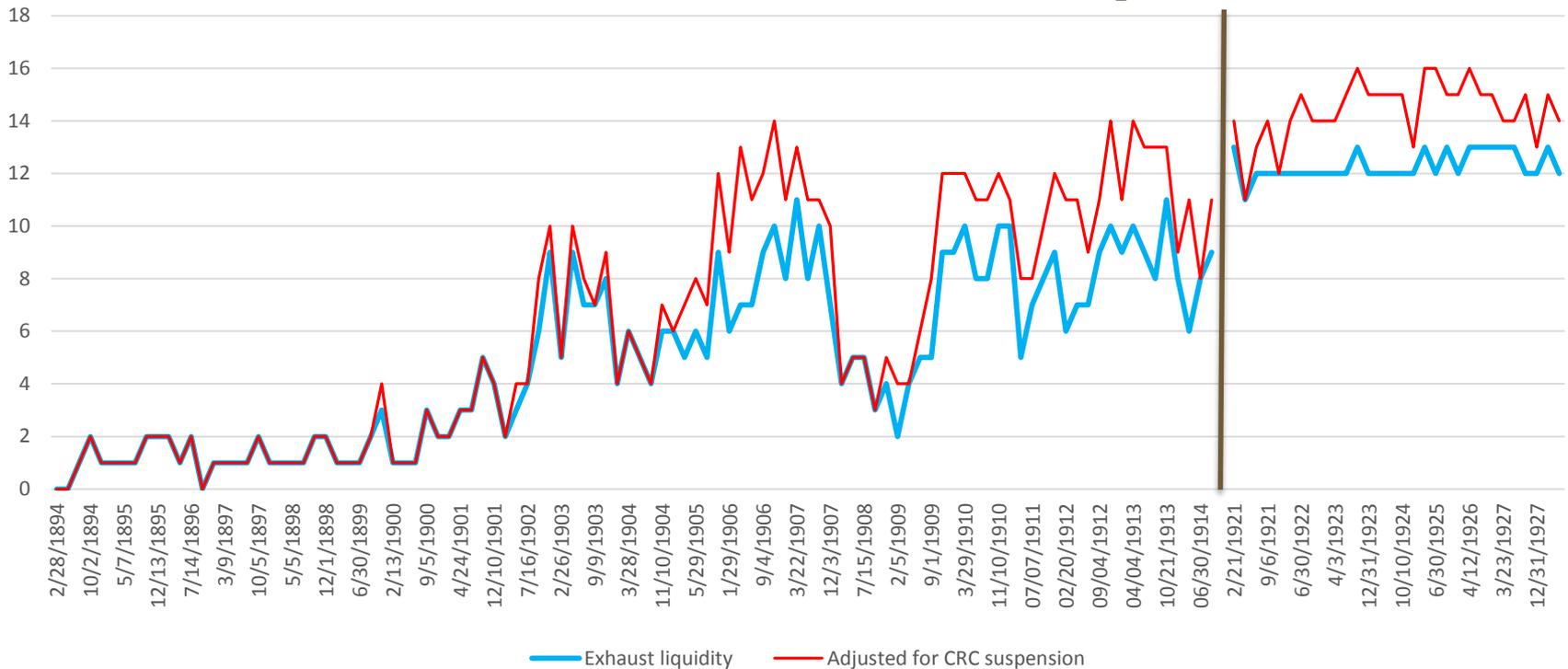
# Reserve City Results

## Percentage of liquid assets required to meet an 1893 shock



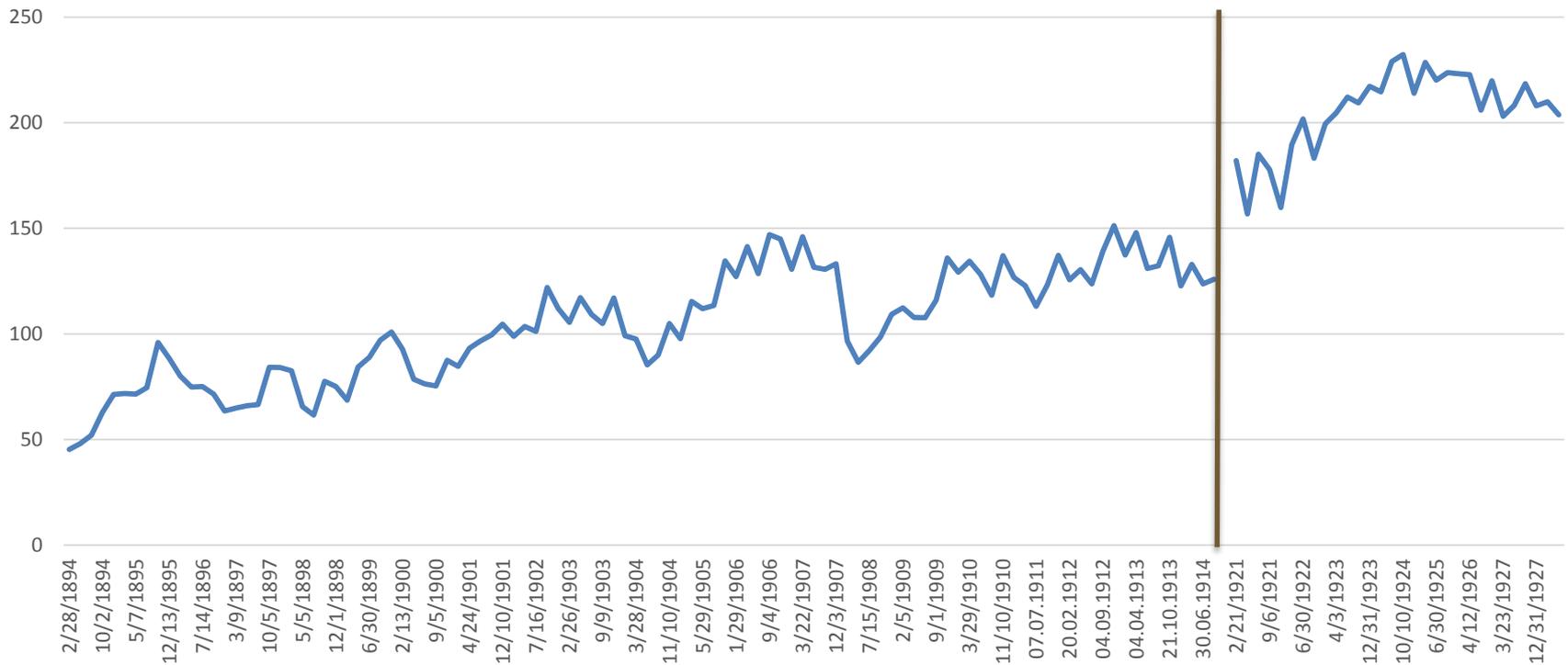
# Reserve City Suspensions

Number of reserve cities with insufficient liquid assets



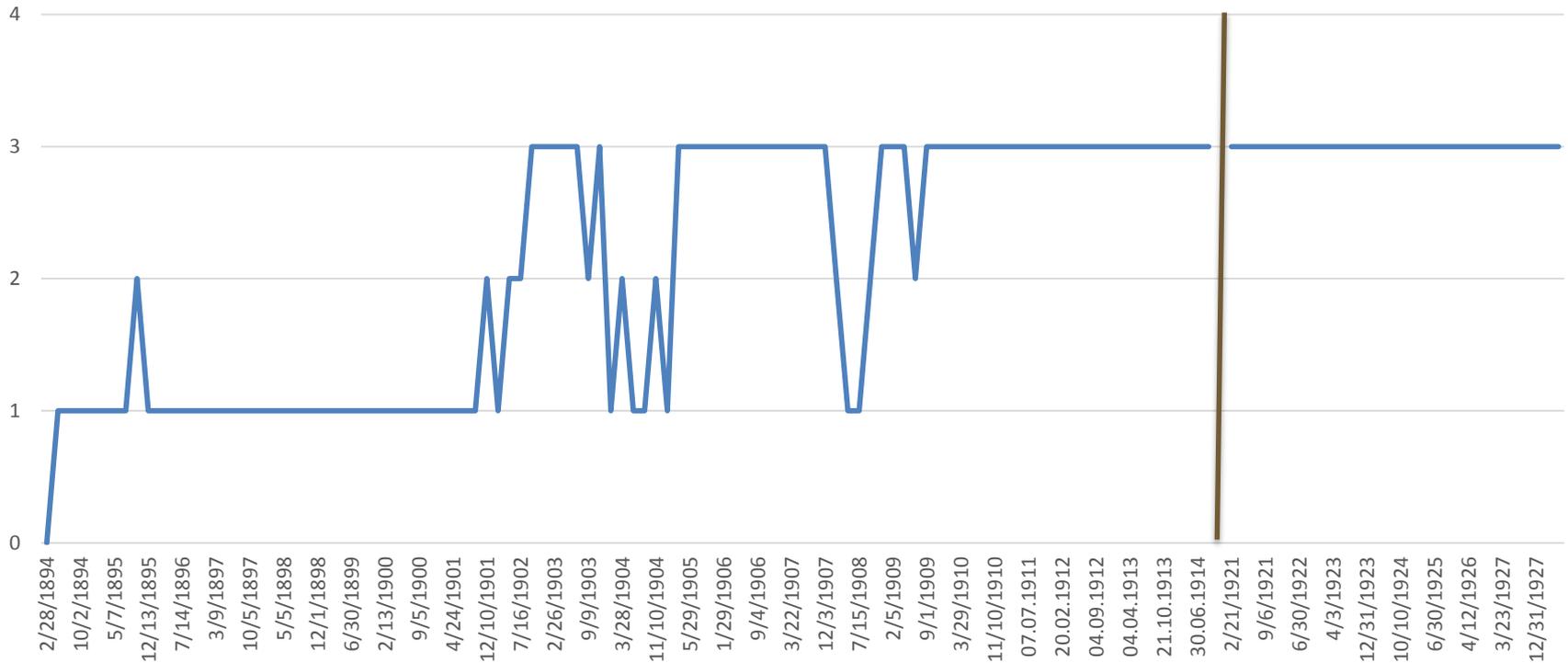
# Central Reserve City Results

Percentage of liquid assets required to meet an 1893 shock



# Central Reserve City Suspension

Number of central reserve cities with insufficient liquid assets



## *Summary of “Stress Test” Results*

- After 1897, reserve city banks could never meet a panic with cash alone. Borderline even with access to CRC banks around 1907-08 and 1913-14, and never in the 1920s (12-16 cities could not meet panic).
- After 1900, CRC's lacked cash to meet a panic in most years; well short in 1920s (all 3 cities likely to suspend).
- Banks may have expected the Fed to provide liquidity, and therefore chose to be less liquid themselves.
- The presence of a LLR may have made it more likely that the LLR would be needed.

## *Summary*

- The Fed was intended to replace the interbank system, which it *partly* did.
- The Fed largely removed one source of instability (seasonal illiquidity).
- Reduced interconnectedness lessened vulnerability of interbank system to contagious solvency shocks.
- Reduced liquidity increased the *potential* for contagious liquidity crises.
- Presence of the Fed may have encouraged banks to behave in ways that made the need for LLR support more likely.