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Interbank Networks and the Interregional Transmission of Financial Crises: Evidence from the Panic of 1907

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This paper provides quantitative evidence on interbank transmission of financial distress in the Panic of 1907 and ensuing recession. Originating in New York City, the panic led to payment suspensions and emergency currency issuance in many cities. Data on the universe of interbank connections show that i) suspension was more likely in cities whose banks had closer ties to banks at the center of the panic, ii) banks with such links were more likely to close in the panic and recession, and iii) banks responded to the panic by rearranging their correspondent relationships, with implications for network structure.

Keywords: banking panics, interbank network, contagion, bank closures, Panic of 1907
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1. Introduction

The financial crisis of 2007-09 focused the attention of policy analysts and regulators on how shocks are transmitted across financial firms. A default at one firm can lead to losses at other firms with correlated positions, even if they are not contractually connected. For example, when the collapse of Lehman Brothers in October 2008 caused Reserve Primary Fund, a money market fund with a large exposure to Lehman, to partially default, it triggered runs on money market funds broadly, including many that had no Lehman debt or connection to Reserve Primary Fund. Research suggests that counterparty risk associated with direct interbank connections also played a role in 2007-09 by aggravating declines in risky asset prices and bank lending (Iyer, et al. 2014; Heider, et al. 2015). However, clear evidence that contagion through direct interbank connections was a significant factor in the 2007-09 global financial crisis or precipitated any financial institution's failure is limited (see e.g., Scott 2012), at least in part because the contractual relationships between banks are often complex and opaque.

Increasingly, researchers have studied the transmission of financial distress through interbank networks in historical settings, particularly in the United States between the Civil War and Great Depression of the 1930s, when network connections were less complex or obscure. Calomiris and Carlson (2017), for example, find that network connections were a significant source of liquidity risk that contributed to bank failures in the Panic of 1893, especially for banks that held significant shares of their liquid assets in correspondent banks while relying heavily on deposits of other banks (their respondents) for funding. Studying the Great Depression, Mitchener and Richardson (2019) show that the network amplified financial distress and Calomiris, et al. (2022) find that financial distress broadcast through the network contributed to bank closures.

Theoretical research concludes that the structure of interbank network can affect the transmission of shocks and either enhance banking system stability or be destabilizing. These studies find that greater interconnectedness can make interbank networks "robust-yet-fragile" in the sense that they make a network more resilient to relatively minor shocks but can spread financial distress in the face of shocks that wipe out the excess liquidity of the banking system (e.g., Allen and Gale 2000, 2007; Gai, et al. 2011; Acemoglu, et al. 2015). Highly connected, pyramid-shaped networks are especially vulnerable to shocks affecting the network's core locations. Studies show that the U.S. interbank network in the late 19th and early 20th centuries

had such a structure (Jaremski and Wheelock 2020; Das, et al. 2022). The network consisted of central nodes in the major financial centers, especially New York City, secondary nodes in regional banking centers, and local banking markets in smaller towns and cities throughout the country. Banks throughout the United States maintained deposits with correspondents in regional centers and major cities to facilitate interregional payments, invest surplus funds, and satisfy reserve requirements. This highly-connected, pyramid structure was the outcome of laws and practices that limited branch banking, as well as the structure of reserve requirements imposed on national banks (e.g., Calomiris and Carlson 2017; Anderson, et al. 2019; Ladley and Rousseau 2023). Evidence of significant contagion through network connections in financial crises has thus supported insights from theoretical studies about the importance of network structures.

This paper provides new evidence on network transmission of financial distress during the Panic of 1907 and ensuing recession, as well as of changes to the network's structure coming out of the panic. The Panic of 1907 was the quintessential and perhaps most consequential panic of the National Banking era. In broad terms, the panic originated in New York City when the failure of a stock corner triggered runs, first on the city's trust companies, and then on its commercial banks. Almost immediately, the New York panic was broadcast through the correspondent banking system to markets throughout the nation. In his National Monetary Commission study of the crisis, Sprague (1910, p. 259) summarized how the panic spread through the web of interbank connections: "Everywhere the banks suddenly found themselves confronted with demands for money by frightened depositors; everywhere, also, banks manifested a lack of confidence in each other. Country banks drew money from city banks and all the banks throughout the country demanded the return of funds deposited or on loan in New York." Further, "Had New York been a city with only local responsibilities it is probable that the disturbance would have gone no further; but, as in 1873 and in 1893, the disasters in New York had caused alarm to spread throughout the country" (p. 258).

The interbank network's role in spreading the Panic of 1907 across the nation has been largely accepted in the mostly descriptive literature on the panic. Early studies, such as Kemmerer (1910), and more recent ones, such Carlson and Wheelock (2018), show that the panic disrupted the seasonal pattern of flows of interbank deposits and payments into and out of New York City's major correspondent banks, while Tallman and Moen (2018), matching

Sprague (1908; 1910), argue that the panic spread to the rest of the country when the major New York banks restricted convertibility of deposits into currency and prevented normal interregional payment flows from occurring. Despite these accounts, previous studies have not investigated whether specific network connections played a role in the panic's spread across the banking system or in transmitting distress between connected banks during the panic and ensuing recession. In part, this stemmed from a lack of complete information about the mass of network connections in place on the eve of the panic. Consequently, it is unclear whether the nationwide panic reflected transmission of distress through direct network connections to New York City banks and trust companies or simply a heightened concern about banking conditions in general after the New York City shock.

This paper uses newly digitized data on the universe of interbank network connections in early 1907 to study the interregional transmission of the panic and associated bank distress throughout the ensuing recession. We show that bank clearinghouses were more likely to suspend deposit withdrawals or issue cash substitutes (e.g., clearinghouse certificates) in cities whose banks had direct correspondent links to the New York institutions at the center of the panic. Further, we provide quantitative evidence of the transmission of financial distress through direct interbank connections during the panic and ensuing recession. Banks with connections to other banks that closed were themselves at greater risk of going out of business, and those with connections to the New York City institutions at the center of the panic were at even greater risk of closing.

Finally, we investigate whether banks with connections to banks and trust companies at the center of the panic changed their correspondent connections after the panic. Although New York City remained the network's primary node, we find that the percentage of network connections to New York City institutions declined compared with the overall growth of the U.S. banking system. Moreover, the links to New York City became more concentrated among the City's largest six national banks. Banks directly connected to New York trust companies and banks at the center of panic events were especially prone to shift their connections away from New York City and to concentrate their remaining New York connections among the City's largest national banks.

This paper contributes to the literature on the Panic of 1907 as well as the broad literature on the banking panics of the National Banking era. Studies about the Panic of 1907 such as

James, et al. (2013) and Tallman and Moen (2018) discuss how shocks to the New York City banking market reverberated across the United States. Others examine how specific network connections affected customers of New York City trust companies and banks at the center of the panic. Frydman et al. (2015), for example, show that large non-banking firms with close connections to the most involved New York City trust companies faced higher borrowing costs than other listed firms, and consequently had lower stock returns, dividend and profit rates, and made fewer investments. They find no such impact from connections to New York City banks, however, even those central to panic events, suggesting that support from the New York Clearinghouse insulated those banks and their borrowers from significant distress.[1] Building on this literature, we investigate whether correspondent connections to the banks that were central to the panic influenced general suspensions of deposits in other cities, risk of individual banks closing during the panic and worsening recession, or changes in how banks chose to connect to the network. Few banks outside of New York City had correspondent relationships with the trust companies that were most involved in the panic's events, but many were connected to the most involved commercial banks. Our research finds that connections to those banks were consequential, suggesting that clearinghouse support did not entirely prevent direct connections to banks at the center of the panic from affecting banks outside of New York City.

Much of the literature on 19th and early 20th century U.S. financial crises, such as Calomiris and Gorton (1991), Wicker (2000), and Gorton and Tallman (2018), stress the importance of structural flaws in the banking system, such as unit banking and the absence of a lender of last resort, for the frequency and severity of banking panics. As previously noted, branching restrictions encouraged a dense, highly-interconnected interbank network to arise to facilitate interregional payments and mobilize capital. Clearinghouses served to some extent as local lenders of last resort, but the banking system was susceptible to frequent, severe disruptions that were amplified by direct interbank connections. The evidence presented herein supports the long-held view that the interbank network was an important source of contagion in the 19th and early 20th centuries and suggests that the Panic of 1907 would have had less impact on banks outside of New York City if the structure of the network had been flatter and less focused on

[1] Few banks outside of the New York City area maintained correspondent relationships with the trust companies identified by Frydman et al. (2015) as central to the panic. Fohlin and Lu (2021) show that investors discriminated among New York City trust companies, however, and that those with connections to the city's leading national banks maintained higher stock market valuations during the panic than other trusts.

New York City. The data thus support the mostly descriptive accounts about how the network transmitted a New York City stock market shock throughout the United States during the Panic of 1907 and subsequent recession, as well as theoretical research relating interbank contagion to network structure.

The following section briefly describes the interbank network and reviews the history of the Panic of 1907, focusing especially on the network's structure and the pressures that banking panics put on the network. In Section 3, we investigate the interregional transmission of the panic in two ways: First, we test whether connections to New York City trust companies and banks most directly tied to the panic explain differences in how local bank clearinghouses responded to the crisis; Second, we examine whether such connections contributed to bank closure risks in an empirical model that also tests for risks associated with ties to distressed banks in general. In Section 4, we investigate whether banks with connections to institutions at the center of the panic systematically altered their network connections after 1907 compared with banks without such connections. Section 5 concludes.

2. The Interbank Network and Panic of 1907

In the 19th and early 20th centuries, the U.S. banking system was comprised of thousands of mostly single-office ("unit") banks. Because state and federal laws limited branch banking, and prohibited interstate branching altogether, banks often contracted with banks or trust companies located in other cities to conduct business outside their home markets. Most banks had at least two or three such correspondents and maintained those relationships by keeping deposits with their correspondent banks. These correspondent links formed the interbank network. Interbank deposits comprised significant shares of the banking system's assets and liabilities. Correspondent deposits constituted 12.4 percent of all commercial bank assets in 1907 (Board of Governors 1959, Table A-1a), but the percentage was higher for banks outside of the large national banks in the central reserve cities (i.e., New York City, Chicago, and St Louis) which typically held few interbank assets. Disaggregated data from the Comptroller of the Currency indicate that, on average, national banks (i.e., banks with federal charters) outside the central reserve cities held deposits equal to approximately 15 percent of their total assets in bank correspondents in August 1907 (Office of Comptroller of the Currency 1907). The network thus constituted a high proportion of total bank assets and an even larger proportion of liquid bank assets.

The network had a core-periphery structure, with New York City as the network's central node and a few other large cities as secondary or regional nodes.[2] New York City had long been the financial capital of the United States. Banks relied on their New York City correspondents to make and receive payments in New York or elsewhere, to invest in securities and stock exchange loans, and for short-term loans (Watkins 1929). The structure of reserve requirements for national banks also contributed importantly toward making New York City the network's central hub as national banks were permitted to use deposits in New York City national banks (one of the nation's three designated central reserve cities) to satisfy a portion of their legal reserve requirements.[3] Many of the smaller regional interbank hubs were those designated as reserve cities. Further, state-chartered banks, which were subject to reserve requirements specified by their states, were often permitted to use deposits placed in correspondents located in the state to satisfy a portion of requirements (White 1983). Consequently, most banks had multiple correspondents located in different cities depending on their reserve requirements, investments, and customer needs.

Although national banks held by far the largest volume of interbank deposits, New York City trust companies emerged toward the end of the 19th century as aggressive competitors for interbank deposits which they used to invest in securities markets (Neal 1971; Moen and Tallman 2019). As of January 1907, 70 percent of U.S. commercial banks, mutual savings banks and trust companies had at least one New York City correspondent, and the largest correspondent banks in the city had hundreds of respondents, i.e., banks for which the city bank served as a correspondent. Chicago was the second most important network node; its banks linked to 30 percent of the nation's banks. Of the five banks in 1907 with more than 1,200 respondents, four were New York City banks and one (with the fewest links among the five) was a Chicago bank. With 2,836 respondents, Hanover National Bank in New York had the most respondents and was a correspondent of 15.5 percent of all banks in the United States. The largest Chicago bank (First National Bank) had 1,344 respondents (7.4 percent of all banks).

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[2] Most connections to other large cities were among banks in the same geographic region. Jaremski and Wheelock (2020) provide information about the structure and evolution of the interbank network over the early 20th century.

[3] The National Banking Acts required that national banks located in designated central reserve cities maintain their required reserves in the form of gold. National banks in designated reserve cities and country national banks, however, could satisfy a portion of their requirement with deposits held in central reserve city and reserve city national banks.

In modern parlance, the historical U.S. interbank market was "robust-yet-fragile." Payment flows through the interbank network were highly seasonal, reflecting fluctuations in agriculture and other commercial activity (Kemmerer 1910; Barsky and Miron 1989; Davis, et al. 2009; Carlson and Wheelock 2016). Although the aggregate demand for money and credit varied seasonally, demand varied somewhat by region so that banks in some parts of the country were depositing funds into their correspondent banks when banks in other parts were withdrawing funds. The regionally asynchronous nature of flows of funds into and out of correspondent banks in the major cities during non-panic periods allowed the system to economize on cash and is an illustration of the robust nature of the network in dissipating local fluctuations in the demand for money and credit. However, a characteristic of major banking panics, such as the Panic of 1907, was that banks in all regions sought to withdraw funds from their correspondents simultaneously. The demand for cash then far exceeded the capacity of the network to deliver and its fragility became evident.

The Panic of 1907 began in mid-October 1907.[4] The panic's proximate cause was the October 16 collapse of an attempt by New York City financiers Augustus Heinze and Charles W. Morse to corner the stock of United Copper Company.[5] The collapse caused the failure of two brokerage houses connected to the scheme and precipitated runs on three banks that were connected to Heinze and his partners: Mercantile National Bank, New Amsterdam National Bank, and the National Bank of North America. Morse controlled the latter two banks and was a director and major stockholder of Mercantile National. Runs then spread to other banks and trust companies with connections to Heinze, Morse and their associates, including Knickerbocker Trust Company, headed by Charles T. Barney, and then more broadly to other New York financial institutions.[6] By October 25, ten banks and trust companies had suspended operations (Wicker 2000, p. 95). Banks across the city suspended payments on October 26 and the New York Clearinghouse issued clearinghouse loan certificates to augment the reserves of its

[4] We only briefly review key events here and refer readers to detailed accounts by Brunner and Carr (2007), Moen and Tallman (1992), Sprague (1910), Tallman and Moen (2018), and Wicker (2000), among others.
[5] The panic occurred when credit conditions were already unusually tight. Alarmed by gold outflows, in part resulting from insurance payouts after the San Francisco earthquake of 1906 (Odell and Weidenmier 2004), the Bank of England raised its Bank Rate and acted to limit the issuance of American finance bills in London in order to stem the loss of gold (Tallman and Moen 2012).
[6] Other banks closely tied to the panic were Consolidated National Bank, Hamilton Bank and Hudson Trust Company. Edward and Orlando Thomas, who owned Consolidated National and were officers of the other two institutions, were close associates of Heinze and also had interest in Amsterdam National Bank.

members, which at the time did not include any trust companies. The panic spread rapidly across the United States and within days banks suspended payments and local clearinghouses issued loan certificates in many cities (Andrew 1910). Although the worst of the panic had ended by January, clearinghouse certificates remained in circulation in many cities, including New York City, into the Spring of 1908 (Andrew 1910, Table 1).

The Panic of 1907 coincided with a serious economic recession. The NBER identifies a cycle peak as having occurred in May 1907. However, measures of economic activity indicate that the economic downturn worsened significantly during the panic and was especially acute while payments were limited or suspended (James, et al. 2013).[7] Contemporary studies, such as Cleveland (1908, p. 125), reported that "the whole business constituency which depended on bank credit for 'cash' was thrown into a condition of distress" by payments suspensions and the panic generally (see also Sprague 1910).

Although many studies have identified the interbank network as a source of contagion in the Panic of 1907 and other National Banking era panics, none has mapped the universe of network connections in 1907 or tested whether direct network connections transmitted distress across banks in the panic or ensuing recession. The rest of this paper makes use of a dataset consisting of the network connections of every U.S. bank both before and after the panic and recession to first test whether direct network connections help explain differences in local responses to the panic. We then investigate whether such connections contributed to higher bank closure rates throughout the United States, and finally whether banks shifted their correspondent links in an effort to reduce risks associated with network ties. *Rand McNally Bankers Directories* provide "a full and complete list of banks, bankers and savings banks in the United States" and their "principal" correspondents.[8] We use the January 1907 edition to identify the U.S. banks operating before the panic and their correspondent relationships. In addition, we use data on

[7] For instance, Babson's Seasonally Adjusted Index of the Physical Volume of Business Activity peaked in May 1907 at 58.2 but fell only to 54 in October before plummeting to 44.4 in December and a trough of 42 in May 1908 (Moore 1961). Similar patterns occurred in pig iron production and industrial production, as noted by James, et al. (2013), suggesting that panic had broad impact on manufacturing and business activity.

[8] While giving no definition of "principal" correspondents, the evidence suggests that the *Directory* attempted to capture the largest and most important correspondents. The few surviving archival records that contain full correspondent information for individual banks suggest that the *Directory* covered the vast majority of interbank funds. The *Directory* listed bank branches, private banks (i.e., unincorporated banks without a government-issued charter), securities dealers, and other financial firms. We omit these firms and branch offices, as well as the few banks with no listed correspondents as we are unsure whether those banks had no correspondents or that the information is missing.

network links from the July 1910 edition collected by Jaremski and Wheelock (2020) to investigate how banks changed their correspondent connections after the panic.[9]

3. Interbank Transmission of the Panic and Financial Distress

The panic originated in New York City in October, and though largely over by the end of January, its effects on banking and economic conditions lingered for several more months. The lack of high frequency data, especially for banks outside of New York City, makes it difficult to gauge the extent of bank runs and deposit withdrawals at the height of the panic.[10] However, two measures of financial distress can be observed: i) clearinghouse actions to suspend payments and issue emergency currency and ii) permanent bank closures. The former reflects an immediate response to the panic at the city level, whereas the latter is a measure of financial distress during the panic and ensuing recession. This section examines both outcomes for evidence that the network contributed to transmitting financial distress across the nation.[11]

3.1 Intensity of New York Correspondent Connections and Payments Suspensions

The New York City clearinghouse suspended cash payments and began to issue clearinghouse certificates on October 26. The clearinghouses of Chicago and St. Louis—the nation's two other central reserve cities—suspended and issued clearinghouse certificates on October 28, as did clearinghouses in several other cities (Andrew 1910, Table 1). Clearinghouses in at least 95 cities had done so by the second week of November, and clearinghouse notes continued to circulate through January 1908 in most of those cities.

The suspension of payments as well as the amount and duration of clearinghouse certificate issuance provide clear measures of the immediate dissemination of the panic. Andrew (1910) collected information on cash payments suspensions and clearinghouse certificate issuance during the panic for the National Monetary Commission. According to Andrew (p. 439), cash payments were restricted "to a greater or less degree" in two-thirds of U.S. cities with at least 25,000 inhabitants. He lists separately those where cash payments were restricted or

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[9] The *Directories* identify specific correspondent relationships but do not include the dollar amount of deposits associated with each such link. We are unaware of any comprehensive source for such information. However, in our data, the number of respondent relationships that a bank had was highly correlated with the amount of deposits it held for respondents (correlation coefficient of 0.90), indicating that a mapping of the network based on the information in the directories is likely reflective of the size and structure of the network in terms of deposits.

[10] Moen and Tallman (2018) use weekly data for New York City banks from the *Commercial and Financial Chronicle* as well as daily financial market pricing data. To our knowledge, high frequency data are not available for banks in other locations.

[11] In the appendix, we augment these findings with a preliminary analysis of the transmission of financial distress through the network to real economic activity.

clearinghouse certificates issued (Table 1) and all other large cities (p. 445).[12] For most cities where emergency liquidity was introduced, he provides the dates of issue, the total amount issued and the peak amount outstanding. In addition, Andrew (Table 2) provides an incomplete list of cities with fewer than 25,000 inhabitants where cash payments were restricted or currency substitutes were issued.

We use information from Andrew's tables to study the immediate spread of the panic from New York City. Specifically, we test whether cash payment suspensions and clearinghouse certificate issuance were more likely in cities where the correspondent connections of local banks were more concentrated among New York City financial institutions in general, New York City trust companies, or New York City banks associated with Heinz and his associates. The names of the financial institutions and individuals involved in precipitating the panic in New York were widely reported in the press. Depositors of a bank whose correspondents included trust companies or commercial banks that were most involved in the crisis might have been more likely to run and thus impair the bank's liquidity. Moreover, banks with extensive connections to New York banks and trust companies might have been more pessimistic about quickly receiving funds they had on deposit with those institutions. An extensive literature finds that uninsured depositors are sensitive to risk and will run on banks that are thought to be in danger of defaulting (e.g., Gorton and Pennacchi 1990; Martinez Peria and Schmukler 2001; Calomiris and Wilson 2004; Calomiris and Jaremski 2019). Thus, conceivably, payment suspensions and cash substitute issues were more likely in cities whose banks had extensive correspondent relationships with New York banks and trust companies, especially those directly involved in the start of the crisis.

We use four different outcome measures to test for a relationship between New York connections and local responses: i) An indicator for whether a city's banks or local clearinghouse substantially restricted cash transactions or issued clearinghouse certificates; ii) The total value of clearinghouse certificates issued per bank; iii) The date at which clearinghouse certificates were first issued; and iv) The number of days that clearinghouse certificates circulated before

[12] Washington DC, Albany NY, Rochester NY, Toledo OH, and Dubuque IA, all of which were reserve cities, were among those where neither cash payments were restricted nor clearinghouse certificates issued. Andrew (1910, p. 444) also lists a few cities where clearinghouses had requested their members to ask "their larger customers to mark checks payable only through the clearinghouse." We treat those cities as ones where suspensions were not imposed as they did not represent required payments restrictions. However, our results are similar if those cities are omitted. We also omit the few cities where Andrew does not provide any information about the timing of suspension or the issuance of cash substitutes.

their retirement. To reflect the intensity of connections to New York City, we use i) the fraction of the total number of correspondents of banks within a given city that were comprised of New York City banks and trust companies; ii) the fraction of banks in the city that were connected to any New York City trust company, and iii) the fraction of banks in the city that were connected to any New York City bank implicated in precipitating the panic, which we identify as banks of which Charles Morse, Augustus Heinze, Charles Barney, Edward Thomas or Orlando Thomas was an owner, officer, or director (hereafter we refer to these as the "HMBT Banks").[13] We also control for the logarithms of the number of correspondents and respondent connections of the banks within the city to capture the city's importance to the overall network, and the logarithm changes in population 1900-1910 and number of banks 1900-1907 to control for any differential pre-trends across cities.

Figure 1 shows that banks with a correspondent relationship with HMBT banks (top panel) or any New York City trust company (bottom panel) were located throughout the United States. Although more predominant in the East, the distribution closely matches the geographic distribution of banks generally, which reflected the relative concentration of U.S. population and economic activity in the East at that time.

We estimate the following specification with logit regressions for binary outcomes and ordinary least squares for continuous outcomes:

$$Suspension_c = a + \beta_1 Ln\,(Resp)_c + \beta_2 Ln(Corr)_c + \beta_3 \%NYCCorr_c + \beta_4 \%NYCTrust_c + \beta_5 \%HMBTBank_c + \beta_6 Ln(Banks)_c + \beta_7 C_c + \beta_8 Region_c + e_c \quad (1)$$

where $Suspension_c$ is a vector of the four suspension variables described above, $Ln(Resp)_c$ and $Ln(Corr)_c$ are the logarithms of the number of respondents and number of correspondents of city *c* in 1907, respectively; $\%NYCCorr_c$ is the fraction of city *c*'s correspondents that were located in New York City in 1907; $\%NYCTrust_c$ and $\%HMBTBank_c$ are, respectively, the fraction of city *c*'s commercial banks that were connected to either a New York City trust

[13] The central role that these men played in the panic was well publicized in the financial press at the time. The *Commercial and Financial Chronicle*, for example, reported regularly on banking conditions in New York City and elsewhere, including reports on individual banks and bankers. For example, it reported that the New York City Clearinghouse required the resignations of Morse, Barney and others as a condition of assistance to their banks (October 26, 1907, p. 1059). We identify the banks at the center of the panic from reports in the *Chronicle* and secondary sources, including Wicker (2000) and Bruner and Carr (2007). The banks that we identify as "HMBT Banks" are: New Amsterdam National Bank, Mechanics and Traders Bank, National Bank of North America, Mercantile National Bank, Merchants Exchange National Bank, New York Produce Exchange Bank, Fourteenth Street Bank, Garfield National Bank, Northern Bank, Coal and Iron National Bank, Bank of Discount, Riverside Bank, and Consolidated National Bank.

company or to a state or national bank of which Heinz, Morse, Barney or Thomas were principals; $Ln(Banks)_c$ is the logarithm of the number of commercial banks in city c in 1907; C_c is a vector of location characteristics from Haines (2008) which includes indicator variables for whether the city was a central reserve or reserve city, the logarithm of the city's population in 1910, the logarithm change in city population 1900 to 1910, the logarithm change in the number of banks in the city from 1900 to 1907, the fraction of the county that was non-white, and the number of farms per capita; C_c also includes the linear distance to New York City from city c to capture any pure geographic spillover effects, $Region_c$ is a vector of indicators for the region in which the city was located and e_c is the White-robust standard error.

We estimate Equation (1) for two samples. The first includes the 165 cities listed in Andrew (1910), whereas the second excludes the 33 cities with fewer than 25,000 inhabitants. Neither sample is large, especially for the outcomes that are conditional upon issuing any clearinghouse certificates. The larger sample has the advantage of allowing for more controls without raising concerns about degrees of freedom, whereas estimation based on the smaller sample provides an indication of any bias introduced by including the smaller cities.

Table 1 reports estimation results for Equation (1). The results indicate no effect on any of the dependent variables of additional connections to either New York City banks and trust companies generally or of additional connections to New York City trust companies specifically. However, cities where higher fractions of banks were connected to HMBT banks were more likely to suspend payments and issue clearinghouse certificates.[14] Specifically, a one standard deviation increase in the fraction of banks connected to HMBT banks (i.e., 0.153) is associated with an additional 8.6 percent probability of suspending. Cities whose banks had more respondents, and thus were more central to the network, tended to suspend earlier and for less time. The evidence indicates that specific network connections affected the decision to declare a suspension and issue currency substitutes, while the volume and timing of emergency currency issuance in a city was a function of the number of respondents that the city's banks had. Hence, direct network connections were important for transmitting the shock from New York City to the rest of the nation.

[14] The effect of connections to HMBT banks is robust to a variety of alternative specifications. These include using an indicator variable for any connection to an HMBT bank, using the share of a city's assets that were in banks connected to HMBT banks, dropping cities with populations over 250,000 (or alternatively over 75,000), controlling for the trust companies identified by Frydman, et al. (2015), or controlling for the change in bank assets from 1905 to 1906 for cities with available data.

3.2 Interbank Connections and Bank Closure Risk

The Panic of 1907 was a major financial crisis that had significant economic repercussions. Although it produced relatively few outright bank failures compared with the Panic of 1893 or the Great Depression of the 1930s, many banks closed permanently during the panic and subsequent recession.[15] Comparing the listings of banks in the January 1907 and January 1909 editions of *Rand McNally Bankers Directory,* we identified 654 national and state-chartered banks that were present in 1907 but not at the end of 1908 (excluding banks that merely changed their name, location, or charter type). These represent a mix of failures (involuntary liquidations with receivers appointed), voluntary liquidations, and mergers, of which most were likely due to financial distress given the period involved.[16]

Studies of bank failures in modern times typically treat a failure as occurring on the date on which Federal Deposit Insurance Corporation (FDIC) seizes the bank and extinguishes its charter. Such precise dating is impossible for most failures, particularly of state-chartered banks, in the pre-FDIC (i.e., pre-1934) era. Moreover, the demise of a bank rarely happens suddenly, and banks can continue to operate in a weakened, even insolvent, condition for some time before closing, though ultimately a run by depositors might force a bank to close. Thus, even if the precise date when a bank ceases to operate is known, in most instances the bank likely was in a period of demise some months before it closed.[17]

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[15] Board of Governors (1943) and other sources of historical (i.e., pre-1934) information on bank distress report data on bank *suspensions*, defined as "all banks closed to the public, either temporarily or permanently, by supervisory authorities or by the banks' boards of directors on account of financial difficulties… unless the closing was under a special banking holiday declared by civil authorities" (pp. 281-82). For national banks, suspensions data include only banks that failed with receivers appointed, but data for state-chartered banks are a mix of receiverships and other suspensions. Using this narrow definition, 102 banks "suspended" during the 12-month period ending June 30, 1908. By comparison, 297 banks suspended in 1893 (over a 14-month period ending August 31, 1894), and more than 4,900 banks suspended between June 30, 1929, and June 30, 1932 (Board of Governors 1943, p. 283)

[16] Network studies such as Das, et al. (2022) and Calomiris, et al. (2022) on the Great Depression use a similar definition to study bank distress. Most bank reports distinguish acquisitions from mergers. When we can identify acquisitions as distinct from mergers, we do not treat the acquiring bank as having closed; otherwise we treat both banks as closures. Results reported in Wheelock and Wilson (2000) for the late 20th century suggest that the determinants of bank closure due to merger and failure are similar.

[17] Balla, et al. (2019) describe the mechanics of bank failure in modern times, and report that the FDIC loss rate averaged 26 percent on banks the failed during 2007-13, indicating that banks are often insolvent well before being closed. Moreover, bank regulators sometime intervene in an attempt to prevent a bank from failing or to buy time to find a merger partner for an insolvent bank and thus some insolvent banks are never treated as failures. Because of this, some studies define failures to include banks that are critically undercapitalized but not closed (see, e.g., Wheelock and Wilson 2000). Unfortunately, the absence of timely, detailed balance sheet data for most banks prevents us from using such a definition here.

Here, we study bank closures that occurred over a window that includes not only the few weeks when the panic was at its height but also the full year of 1908 when most of the bank failures and other closures occurred.[18] We do this in part because data sources do not identify precisely when most banks closed, and so we do not have a comprehensive list of banks that closed during the panic *per se*. Moreover, if we could identify all the banks that closed permanently during just the panic weeks, restricting the sample period to just those weeks would miss banks that were either weakened by the panic and later closed and those that closed as a result of the ensuing recession. Moreover, quantitative estimates of the impact of interbank connections on bank closures over the longer period likely understate their impact at the height of the panic. Thus, if we find that interbank connections were important for closures over the longer window, it seems likely that they were even more important for transmitting distress at the height of the panic.

To estimate the impact of network transmission of financial distress, we build upon the network-augmented model of Calomiris, et al. (2022). In their study of the Great Depression, the authors begin with a model in which the closure outcome is regressed on bank characteristics such as its size, age, and various balance sheet measures that other studies have found to be important for explaining a bank's likelihood of closing.[19] They then add variables intended to capture the influence of interbank connections. These variables include the numbers of correspondents and respondents (if any) a bank had, and the fractions of its correspondents and respondents that closed. The authors find that having more respondents or larger fractions of correspondents and respondents that closed increased a bank's closure risk. Having more respondents might reduce a bank's risk in normal times (when inflows and outflows of respondent deposits were less correlated) but increase risk in panics when the bank's respondents were all attempting to withdraw their deposits simultaneously. Having deposits in a larger number of correspondents would likely reduce a bank's risk, however, especially in a crisis period, through diversification. The likely explanation for the impact of correspondent closures is

[18] In the appendix, we show that states with more interbank connections to New York City experienced a larger rate of commercial failures through the end of 1908 compared with other states. This supports the study of bank closures through that period as well.

[19] The specification is like those estimated in other settings, such as the National Banking era (Jaremski 2018), Great Depression (White 1984; Calomiris and Mason 2003), 1980s-90s (Wheelock and Wilson 1995, 2000), and Great Recession (Cole and White 2012).

that they would cause a bank to lose access to liquid assets, while the impact of respondent closures on a bank's own closure risk is that they stripped the bank of a key funding source.

Calomiris, et al. (2022) find that contagion spreading through interbank connections was an important source of bank closure risk during the Great Depression, but they do not test whether connections to specific locations mattered. Here we expand the network-augmented closure model to test whether network connections to New York City institutions *per se* affected a bank's closure risk in the Panic of 1907 and ensuing recession using New York City-focused measures like those in Equation (1).

Banks with correspondent connections to New York City banks and trust companies, especially those at the center of the panic, could have been affected in various ways. Six of those City banks and trusts closed, which would have directly impaired the assets of their respondents. Respondents of New York City banks and trusts that were most directly associated with the panic might have also experienced a loss of reputation and thus increased funding costs due to their connections. Thus, even if they survived during the immediate panic period, those respondents might have faced higher costs or less access to loans from correspondents that left them more vulnerable during the recession. Although the New York clearinghouse supported the city's banks (but not its trust companies), HMBT banks continued to experience substantial deposit outflows in 1908 even as the city's other banks recovered. Surviving HMBT national banks experienced a 22.8 percent decrease in total deposits and 18.1 decline in interbank deposits between August 1907 and September 1908, while other surviving New York City national banks saw a 26.7 percent increase in total deposits and 26.2 percent increase in interbank deposits. Although other explanations for the differences in deposit growth are possible, the data suggest that depositors discriminated among banks and that those most directly involved in the panic may have suffered tarnished reputations with respondent banks and other depositors. And, because *Rand McNally* and other directories published the names of every bank's correspondents, it is conceivable that banks whose correspondents included notorious New York City banks and trusts also suffered some loss of reputation that hastened their own demise. Moreover, previous studies (i.e., Sprague 1910; Laughlin 1912; and Moen and Tallman 2019) highlight that the national banks stepped in during the panic to add liquidity to the call loan market.

We estimate the determinants of bank closure between January 1907 and December 1908 using the following logit model:

$$Closure_i = a + \beta_1 Ln\,(Resp)_i + \beta_2 Ln(Corr)_i + \beta_3 RespClosures_i + \beta_4 CorrClosures_i + \beta_5 \%NYCCorr_i + \beta_6 NYCTrust_i + \beta_7 HMBTBank_i + \beta_8 B_i + \beta_9 X_i + \beta_{10} Region_i + e_i \quad (2)$$

where $Closure_i$ is an indicator for whether bank *i* had closed permanently by the end of December 1908, $Ln(Resp)_i$ and $Ln(Corr)_i$ are the logarithms of the number of respondents and number of correspondents of bank *i* in 1907, respectively; $RespClosures_i$ and $CorrClosures_i$ are the fractions of bank *i*'s respondents or correspondents that closed by December 1908, respectively; $\%NYCCorr_i$ is the fraction of bank *i*'s correspondents in 1907 that were located in New York City; $NYCTrust_i$ and $HMBTBank_i$ are indicators for whether bank *i* had among its correspondents a New York City trust company or a commercial bank with connections to Heinz, Morse, Barney or Thomas, respectively; $B_{i,}$ is a vector of bank balance sheet items (log of total assets, loans/assets, surplus and undivided profits/assets, cash and balances due from banks/deposits), the bank's charter type, and the logarithm of bank age;[20] X_i is a vector of characteristics in 1910 from Haines (2008) that includes indicator variables for whether the bank's county had a central reserve or reserve city, the logarithm of county population, the fraction that was urban, the fraction that was non-white, and the number of farms per capita; X_i also includes the linear distance to New York City from bank *i* to capture any pure geographic spillover effects, $Region_i$ is a vector of region indicator variables, and e_i is the standard error that is clustered by state.

We obtain available balance sheet information for individual national banks as of September 4, 1906, from *Annual Report of the Comptroller of the Currency* for 1906*,* and for state-chartered banks from state banking reports for 1906. Because some states did not publish reports with balance sheet information for their state-chartered banks (e.g., Mitchener and Jaremski 2015), we estimate Equation (2) with i) a full sample consisting of all U.S. commercial banks but where the regressions omit balance sheet variables, and ii) a restricted sample consisting of commercial banks in the 31 states that reported balance sheet information (which

[20] Studies typically find that bank failure or closure risk is positively related to loans as a share of total assets, and negatively related to bank size, age, measures of net worth such as capital to total assets, and measures of liquidity such as cash and balances due from banks relative to total deposits. See, e.g., Calomiris, et al. (2022).

represents 71 percent of all U.S. banks). In this way, we show that the network effects are not the result of sample selection choices or omitted balance sheet variables.[21]

Table 2 reports means and standard deviations for the variables included in the model. The top panel provides statistics for the variables included in Equation (2) for both the limited and full datasets which consists of all non-New York City state and national banks in existence in January 1907. A comparison of the statistics for the full and limited samples suggests no systematic differences.

Table 3 reports the marginal effects of the independent variables in Equation (2).[22] We report three specifications for each sample (results for the full sample are reported in columns 1, 3 and 5; those for the smaller sample are reported in columns 2, 4, and 6). The first specification (reported in the first two columns) includes the network variables that Calomiris, et al. (2022) found important for helping to explain bank closures during the Great Depression. As in that study, we find that a bank's risk of closing in 1907-08 was greater when a higher percentage of its correspondents or respondents closed. Closures among a bank's correspondents would limit access to a portion of the bank's assets, at least temporarily, while closures among a bank's respondents would eliminate funding sources. In addition, and again as in the Great Depression, we find that having more respondents increased a bank's risk of closing. Although having more respondents might ordinarily provide diversification among its funding sources, relying on respondents for funding could be risky in a panic or recession when many of a bank's respondents were attempting to withdraw their funds simultaneously. Because we do not observe high-frequency flows of deposits or the precise date of each closure, it is not possible to definitively identify the direction of causality. Even if we could date precisely when every bank closed, the simple fact that one bank closed before its correspondent (or respondent) does not necessarily mean that the direction of causality went from the first bank to close to the second. A correspondent bank might close as a result of withdrawals by its respondents as the latter were

[21] We omit banks located within 30 miles of Manhattan to avoid confounding local contagion within New York City and direct links to banks and trusts in the city. Our results are not sensitive to the distance choice.

[22] We find that the results are similar when including state-fixed effects instead of regional fixed effects. Further, separate estimates by charter type indicate that state bank closure risk was more susceptible to New York City trust company links while national bank closure risk was more susceptible to the HMBT banks (likely because national banks had very few correspondent relationships with trust companies). The results are also robust to a number of different specifications including testing separately for an effect of connections to the trust companies at the center of the panic (as identified by Frydman, et al. 2015) and omitting any respondents or correspondents located in the same city as the given bank.

attempting to forestall their own demise. However, the results indicate clearly that contractual contagion within the interbank network was an important source of bank closure risk during the 1907 panic and subsequent recession.

The second and third specifications, reported in columns 3 and 4, and 5 and 6, respectively, include variables meant to test whether having connections to New York City banks and trust companies contributed to a bank's closure risk. We find no evidence that a bank's closure risk was associated with the share of its total correspondents comprised of New York institutions in general. However, the results indicate that banks were at greater risk of closing if they had a correspondent relationship with a New York City trust company or with one of the commercial banks connected to Morse, Heinze, Barney or Thomas. Moreover, the size and statistical significance of connections to trust companies and HMBT banks are qualitatively unaffected by including the fractions of a bank's respondents or correspondents that closed, suggesting that the New York connections do not simply reflect the effects of network connections to closed banks in general. And, because the results are qualitatively similar across the two samples, it is unlikely that they reflect the omission of balance sheet characteristics in the larger sample. Further, in finding that closure risks of banks that were older, larger, or had higher ratios of surplus and undivided profits to assets were lower, the results are consistent with those of other studies of bank closure and suggest that our model is well specified.

In sum, our regression evidence indicates that network connections were an important conduit for bank distress during 1907 and subsequent recession. And, while we cannot explicitly observe bank-specific runs, the evidence closely matches the literature on the Panic of 1907. The traditional story has been that the financial panic originated in the New York stock market and engulfed the U.S. banking system by way of the interbank network. The fact that specific distant connections to a handful of New York City banks and trust companies were correlated with immediate payment suspensions and subsequent bank closures provides the first empirical evidence for papers on the subject. The results thus support other recent studies showing that direct interbank connections have historically been an important conduit for transmitting financial shocks while also providing new information about the determinants of bank distress in the Panic of 1907 and subsequent recession. More preliminary results presented in the appendix show a correlation between network transmission of the panic and measures of real economic activity.

4. Did the Panic Reorient the Network?

The interbank network played a key role in transmitting the New York City based financial shock to the rest of the nation. The literature, however, has not examined whether the network changed in response to the shock. From previous studies we know that networks can adjust in response to changes in regulation (e.g., Anderson, et al. 2019, Jaremski and Wheelock 2020) and financial shocks (e.g., Das, et al. 2022). Here we investigate whether banks adjusted their network connections after Panic of 1907 in an effort to lessen their future exposure to the New York correspondents linked to the panic.

We start by showing broad changes in the volumes of interbank deposits in Table 4 and number of interbank connections by various groups of banks in Table 5. Clearly banks did not suddenly abandon New York City correspondents. The total interbank liabilities of all New York City banks, grew from 32 percent of total U.S. interbank liabilities in 1907 to 40 percent in 1908 before falling back to 35 percent in 1910. Shown in Table 5, the number of interbank connections to New York City also rose by 10 percent from 1907 to 1910.

While the number of interbank connections to New York City banks rose between 1907 and 1910, the increase was less than the 21 percent increase in the total number of U.S. banks and trust companies over that period. Moreover, while the percentage of total network connections to New York City banks rose by 0.4 percentage points between 1907 and 1910, the number of U.S. banks that had at least one New York City correspondent fell by 5 percentage points. By comparison, Chicago banks became more central to the network, outpacing the overall growth in the total number of banks. Between 1907 and 1910, the number of connections to Chicago banks increased by 1.6 percentage points and the fraction of banks that had least one connection to a Chicago bank grew by 0.6 percentage points. Nonetheless, the number of connections to Chicago remained only about half the number of New York City connections. New York City's continued dominance is not surprising given the role of New York City banks in the securities markets and international trade.

Although the panic did not cause a substantial reorientation of the interbank network away from New York City, it seems to have led banks to change their correspondent relationships within New York City. Conceivably, the apparent riskiness of trust companies and the HMBT banks led some banks to move their correspondent links away from those institutions to other, perhaps more stable banks. Shown in Table 4, six large national banks (i.e., the "Big

Six" that included National Bank of Commerce, First National Bank, National Park Bank, National City Bank, Chase National Bank and Hanover National Bank) combined had an especially large increase of 52 percent in interbank liabilities from 1907 to 1908, and saw their share of total U.S. interbank liabilities rise from 17 percent to 23 percent.[23] The flood of deposits into the Big Six banks likely reflected a flight to safety. Their market share declined somewhat as the panic and recession faded, however, though by 1910 it still exceeded the pre-panic level. The major New York City national banks also tended to have the largest gains in respondent connections, as shown in Table 5. Although 91 of the 143 New York City banks and trust companies operating in 1907 had at least one respondent, the Big Six national banks alone had 68.7 percent of the city's total respondents in 1907. By 1910, these banks had 71.1 percent of the total number of interbank connections to New York City institutions despite two of them (National Bank of Commerce and First National) having fewer links in 1910 than in 1907. The other four had gains of at least 15 percent, led by National City Bank which had 33 percent more links in 1910 than in 1907.[24]

National banks outside New York City experienced essentially no change in interbank liabilities in 1907-08 while state-chartered banks and trust companies experienced modest declines. The shares of interbank liabilities held in banks and trust companies outside New York City recovered somewhat in 1909 and 1910. The interbank liabilities of HMBT banks dropped sharply and did not recover, however. By 1910, the liabilities of HMBT banks were less than half as large as they had been in 1906, and these banks had lost 36.3 percent of their respondents.[25] Over the same period, New York City trust companies had a small gain in interbank liabilities but a 3.4 percent decline in number of respondents. Most of the banks and trust companies at the center of the panic that survived experienced large declines in numbers of respondents. For example, Mercantile National Bank had 166 respondents in 1907 but only 69 in

[23] Sprague (1910) focuses on these six banks in his study of correspondent deposit flows during the Panic of 1910, and Tallman and Moen (2012) refer to them as the "Big Six" banks.

[24] National Bank of Commerce had a prominent role in the panic as the clearing bank for Knickerbocker Trust. Charles Barney was one of its directors, along with J. P. Morgan. Knickerbocker's situation worsened when National Bank of Commerce announced on October 21, 1907, that it would no longer clear for Knickerbocker. Barney subsequently resigned from the bank's board of directors. Although National Bank of Commerce was visible in the panic and Charles Morse had been a director of the bank, because of its long association with Morgan and reputation for stability, we do not consider it one of the banks whose survival was in question and therefore do not include it among the HMBT banks.

[25] A sizable portion of the respondent losses of HMBT banks reflected bank closures. Surviving HMBT banks lost about 8.5 percent of their respondents over the period.

1910, Knickerbocker Trust Company had 27 respondents in 1907 but only 5 in 1910, and Trust Company of America had 65 respondents in 1907 but just 32 in 1910 despite having merged with Colonial Trust Company (which had 21 respondents before the panic). By contrast, the number of respondents among all other New York City banks rose by 12.8 percent.

On the whole, the data on interbank liabilities and numbers of interbank connections indicate that New York City remained the center of the nation's interbank network. However, there was a substantial reorientation interbank liabilities and connections within New York City towards the largest national banks. Ironically, while this reorientation likely reflected an attempt by individual banks to reduce solvency or liquidity risks associated with depositing funds in trust companies or marginal banks, the increased concentration of interbank deposits in a small number of correspondent banks may have had competitive or systemic risk implications.[26]

The increased concentration of correspondent links and deposits among the largest national banks suggests that respondent banks sought to lessen their liquidity risks, especially banks that had been customers of trust companies or the HMBT banks. To investigate this possibility, we estimate regressions to test whether having connections to New York City trust companies or the HMBT banks affected how correspondent relationships changed after the panic. Specifically, we test whether banks i) reduced their total correspondent or respondent connections; ii) redirected their correspondent relationships away from New York City banks and trust companies; or iii) shifted toward the Big Six banks that dominated the market.

We estimate the following ordinary least squares regression at the bank-level for banks that survived from January 1907 through June 1910:

$$\Delta Network_i = a + \beta_1 NYCTrust_i + \beta_2 HMBTBank_i + \beta_3 B_i + \beta_4 X_i + \beta_5 Region_i + e_i \quad (3)$$

where $\Delta Network_i$ is a vector of network variables for bank *i*, i.e., the changes between 1907 and 1910 in i) total correspondents; ii) total respondents; iii) fraction of correspondents located in New York City; iv) fraction of total correspondents comprised of the Big Six banks; v) fraction of total New York City correspondents comprised of the Big Six banks; and vi) fraction of total correspondents comprised of banks located in other reserve or central reserve cities.[27] The other

[26] Das, et al. (2022) associate a bank's contribution to systemic risk during the Great Depression to its size and concentration of network connections. For a theoretical association between network concentration and system risk, see Glasserman and Young (2015).

[27] We also estimated specifications where we used as dependent variables indicators for increases or decreases in i) total number of correspondents, ii) total number of respondents, iii) number of New York City correspondents, iv) number of Big Six correspondents, and v) number of non-New York City correspondents. The results for the effects

variables retain the definitions described previously. We also include a control for whether a bank had multiple New York City correspondents in 1907 in all regressions and the log change in a bank's total number of correspondents in certain regressions as noted below. As before, we estimate the regressions both on the full sample of banks without balance sheet measures and on the smaller sample of banks with available balance sheet measures.[28] The lower panel of Table 2 reports means and standard deviations for the variables included in the model.

Table 6 reports coefficient estimates for Equation (3). First, we examine patterns in the raw changes in total correspondents and total respondents. We find no evidence that banks with connections to the HBMT banks before the panic had declines in total correspondents or respondents.

Next, we investigate changes in correspondent links to New York City banks and trusts. Controlling for the change in a bank's total number of correspondents, we find that banks were more likely to reduce the fraction of their correspondent links going to New York City if they had a New York City trust company or HMBT bank correspondent before the panic.

We also find that connections to New York City trusts and HMBT banks influenced a bank's choice of New York City correspondents. Again controlling for the change in a bank's total number of correspondents, we find that banks having a New York City trust or HMBT bank correspondent before the panic were more likely to have increased their ties to one or more of the Big Six banks, either as a fraction of their total correspondent relationships or as a fraction of their correspondent relationships with New York City banks and trusts, by 1910. This suggests that banks that had been connected to riskier institutions before the panic were more likely to shift toward the very largest, and perhaps safest, banks by 1910.

Finally, we test whether banks with connections to New York City trusts or HMBT banks before the panic were more likely to increase their connections to banks in other reserve cities (including the central reserve cities of Chicago and St. Louis). Indeed, we find that to be the case

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of network ties to New York City trust companies and HMBT banks are consistent with those reported in the paper for our original specifications. The results are also robust to a number of different specifications including ones that test specifically for the effects of connections to the trust companies affiliated with Morse and associates and that use data for only those banks that had at least one link to a New York City correspondent in 1907.

[28] To maintain a similar sample, we continue to exclude trust companies from the regressions. However, we find relatively similar results when splitting the sample based on charter type or including trust companies.

in that banks with such connections had larger increases in the non-New York City shares of their correspondent connections by 1910.[29]

Further evidence that banks moved their correspondent relationships away from New York City trusts and HMBT banks is shown in Table 7. The table shows information for the 9,645 commercial banks present in both 1907 and 1910 that had one and only one New York City correspondent in 1907. Specifically, the table examines whether each bank: (1) kept its same New York City correspondent, (2) changed to another New York City correspondent, or (3) dropped all New York City correspondents. The results are clear that banks with an HMBT or New York City trust correspondent in 1907 were much more likely to either switch their relationship to another institution in the city or pull out of the city altogether. Specifically, only 32.5 percent of HMBT connected banks and 58.4 percent of trust company connected banks retained their New York City correspondent compared with 83.7 percent of all others. Hence, we are confident that the changes observed in Table 6 are not driven by banks with many New York City connections or those with none.

The detailed network data indicate several facets of how the network shifted in response to the Panic of 1907. While New York City remained the center of the nation's interbank network, the data indicate a slowing in the growth of connections to New York City after the panic. Perhaps more importantly, there was also a sizable shift in the financial institutions that banks outside of New York City chose as their correspondents within the city. Connections grew more concentrated among the Big Six national banks while the shares of connections to other banks and, especially, trust companies and banks associated with Heinz, Morse, Barney, and Thomas, declined. Finally, we find that banks that had a New York City trust company or an HMBT bank correspondent before the panic were more likely to reduce their connections to New York City and to shift their remaining city connections toward the Big Six banks. Thus, taken as a whole, the evidence indicates that banks responded to the panic by reorienting their correspondent ties and hence that the panic induced some restructuring of the interbank network.

5. Conclusion

The interbank network has long been recognized as an important conduit by which the Panic of 1907 was transmitted from New York City to the rest of the United States. However, the

[29] We tested for differences in the tendency of banks to move their correspondent relationships to Chicago specifically as opposed to St. Louis and the reserve cities. We found that banks that had connections to the HMBT banks were equally likely to increase their ties to Chicago or other reserve cities.

evidence to date has been largely anecdotal or circumstantial. Similarly, quantitative evidence of the transmission of financial distress through direct contractual relationships in the banking system in any era is limited. Using newly digitized data on all U.S. bank correspondent relationships on the eve of the panic, this paper provides quantitative support for the importance of network connections in broadcasting the panic throughout the nation. We show that payments suspensions and issuance of cash substitutes were more likely in cities whose banks had more connections to New York City trust companies generally and to commercial banks at the center of the panic. Cities with higher numbers of respondent links were also more likely to issue large amounts of emergency currency to meet the increased demand for liquidity. Further, we show that throughout 1907 and 1908 banks with either correspondent or respondent connections to other banks that closed were themselves more likely to go out of business. And we find that banks with connections to New York City trust companies or commercial banks at the center of panic events were at increased risk of closing. These findings show that direct network connections were an important conduit for disseminating banking distress during the panic and recession.

Finally, we show that following the panic, the network reoriented away from the institutions that had been most associated with panic events. A full analysis of how the panic affected the network's structure is a topic for future research. However, the evidence presented here that banks connected to the panic's central players were more likely to reorient their connections away from New York City or to move their connections to stronger banks within the city indicates that the panic was likely driving changes in the network. Hence, the paper's results add new evidence that the structures of interbank networks can and do change in response to financial shocks. Moreover, evidence of a shift in correspondent links to the largest banks following the panic suggests that flight to quality in interbank markets has the potential to increase network concentration and, hence, systemic risk.

The Panic of 1907 was the last major banking crisis of the National Banking era. In its wake, Congress established a National Monetary Commission to investigate defects in the U.S. banking system and ultimately enacted the Federal Reserve Act of 1913 to establish a lender of last resort and lessen the banking system's dependence on the interbank network. In providing direct loans to its member banks facing liquidity problems, the Federal Reserve lessened somewhat the vulnerability of its members to payments suspensions by their correspondents.

Further, the Act eliminated provisions of the National Banking Acts that permitted national banks to hold a portion of their required reserves in the form of deposits with correspondent banks. These changes somewhat reduced the concentration of interbank deposits in New York City and other reserve cities (Jaremski and Wheelock 2020). However, the Federal Reserve Act did not alter state and federal prohibitions on branch banking or require state-chartered banks to join the System. Few state banks concluded that the benefits of membership outweighed the additional regulations that they entailed (Calomiris and Jaremski 2022). Further, unlike most correspondent deposits, banks earned no interest on their deposits at the Federal Reserve, and the Federal Reserve did not offer investment and other services that banks received from correspondents. Consequently, the interbank network remained in place and nearly as large in deposit volume as it was before 1913. The return of banking panics and transmission of contagion through the network in the early 1930s proved that the reforms and network responses stemming from the Panic of 1907 had not ended the problem of U.S. banking instability.

References

Acemoglu, Daron; Ozdaglar, Asuman and Alireza Tahbaz-Salehi. "Systematic Risk and Stability in Financial Networks." *American Economic Review* 105 (2), 2015, pp. 564-608.

Allen, Franklin, and Douglas Gale. "Financial Contagion," *Journal of Political Economy* 108 (1), 2000, pp. 1-33.

Allen, Franklin, and Douglas Gale. "Systemic Risk and Regulation," in Mark Carey, and René M. Stulz, eds., *The Risks of Financial Institutions*, pp. 341–76. Chicago: University of Chicago Press, 2007.

Anderson, Haelim; Paddrik, Mark and Jessie Jiaxu Wang. "Bank Networks and Systemic Risk: Evidence from the National Banking Acts." *American Economic Review* 109 (9) September 2019, pp. 3125–61.

Andrew, A. Piatt. "Substitutes for Cash in the Panic of 1907," in O. M. W. Sprague, *History of Crises under the National Banking System*. Washington: Government Printing Office 1910, pp. 434-59.

Balla, Eliana; Mazur, Laurel C.; Prescott, Edward Simpson; and John R. Walter. "A Comparison of Community Bank Failures and FDIC Losses in the 1986-92 and 2007-13 Banking Crises," *Journal of Banking and Finance* 106, 2019, pp. 1-15.

Barsky, Robert B., and Jeffrey A. Miron. "The Seasonal Cycle and the Business Cycle," *Journal of Political Economy* 97 (3), June 1989, pp. 503-534.

Bernanke, Ben S. "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Review* 73, June 1983, pp. 257-76.

Board of Governors of the Federal Reserve System. *Banking and Monetary Statistics 1896-1941*. Washington, DC: Board of Governors of the Federal Reserve System, 1943.

Board of Governors of the Federal Reserve System. *All Bank Statistics*. Washington, DC: Board of Governors of the Federal Reserve System, 1959.

Bordo, Michael D. and Joseph G. Haubrich. "Credit Crises, Money and Contractions: An Historical View," *Journal of Monetary Economics* 57, January 2010, pp. 1-18.

Bruner, Robert F. and Sean D. Carr. *The Panic of 1907: Lessons Learned from the Market's Perfect Storm*. Hoboken, NJ: John Wiley & Sons, 2007.

Calomiris, Charles W. and Mark Carlson. "Interbank Networks in the National Banking Era: Their Purpose and Their Role in the Panic of 1893." *Journal of Financial Economics* 125 (3), September 2017, pp. 434–53.

Calomiris, Charles W., and Gary Gorton. “The Origins of Banking Panics: Models, Facts, and Bank Regulation,” in R. Glenn Hubbard, ed., *Financial Markets and Financial Crises*, pp. 109-174. Chicago: University of Chicago Press, 1991.

Calomiris, Charles W., and Matthew Jaremski. "Stealing deposits: Deposit insurance, risk-taking, and the removal of market discipline in early 20th-century banks." *Journal of Finance* 74, 2019, pp.711-754.

Calomiris, Charles W., and Matthew Jaremski. "Why Join the Fed?" *Journal of Economic History* 82, 2022, pp. 765-800.

Calomiris, Charles W.; Jaremski, Matthew, and David C. Wheelock. “Interbank Connections, Contagion and Bank Distress in the Great Depression.” *Journal of Financial Intermediation* 51, July 2022, article no. 100899.

Calomiris, Charles W., and Joseph R. Mason. “Fundamentals, Panics, and Bank Distress During the Depression.” *American Economic Review* 93, December 2003, pp. 1615-47.

Calomiris, Charles W., and Berry Wilson. “Bank Capital and Portfolio Management: The 1930s ‘Capital Crunch’ and Scramble to Shed Risk,” *Journal of Business* 77, 2004, pp. 421-55.

Carlson, Mark, and David C. Wheelock. “Interbank Markets and Banking Crises: New Evidence on the Establishment and Impact of the Federal Reserve*.” American Economic Review Papers and Proceedings*, May 2016, 106(5), pp. 533–37.

Carlson, Mark, and David C. Wheelock. “Did the Founding of the Federal Reserve Affect the Vulnerability of the Interbank System to Contagion Risk?” *Journal of Money, Credit and Banking* 50 (8), July 2018, pp. 1711–1050.

Cleveland, Frederick A. “Neglected Aspects of Currency and Banking,” in Emory R. Johnson, editor, *Lessons of the Financial Crisis. The Annals of the American Academy of Political and Social Science* 31 (2), March 1908, pp. 120-47.

Cole, Rebel A., and Lawrence J. White. “Déjà Vu All Over Again: The Causes of U.S. Commercial Bank Failures *This* Time Around.” *Journal of Financial Services Research* 42, 2012, pp. 5-29.

Das, Sanjiv R. Mitchener, Kris, and Angela Vossmeyer. “Bank Regulation, Network Topology, and Systemic Risk: Evidence from the Great Depression.” *Journal of Money, Credit and Banking* 54 (5), August 2022, pp. 1261-1312.

Davis, Joseph H.; Hanes, Christopher, and Paul W. Rhode. “Harvests and Business Cycles in Nineteenth-Century America.” *Quarterly Journal of Economics* 124 (4), November 2009, pp. 1675-1727.

Fohlin, Caroline and Zhikun Lu. “How Contagious Was the Panic of 1907? New Evidence from Trust Company Stocks.” *AEA Papers and Proceedings*, 111, May 2021, pp. 514-19.

Friedman, Milton and Anna J. Schwartz. *A Monetary History of the United States, 1867-1960*. Princeton: Princeton University Press, 1963.

Frydman, Carola, Eric Hilt, and Lily Y. Zhou. "Economic Effects of Runs on Early 'Shadow Banks': Trust Companies and the Impact of the Panic of 1907." *Journal of Political Economy*, 123 (4), July 2015, pp. 902-40.

Gai, Prasanna, Andrew Haldane, and Sujit Kapadia. "Complexity, Concentration and Contagion." *Journal of Monetary Economics*, 58 (5), July 2011, pp. 453–70.

Glasserman, Paul and Peyton Young. "How Likely is Contagion in Financial Networks?" *Journal of Banking & Finance* 50, January 2015, pp. 383-399.

Gorton, Gary, and George Pennacchi. "Financial intermediaries and liquidity creation." *Journal of Finance* 45, 1990, pp. 49-71.

Gorton, Gary B., and Ellis W. Tallman. *Fighting Financial Crises: Learning from the Past*. Chicago: University of Chicago Press, 2018.

Haines, Michael R. *Historical, Demographic, Economic, and Social Data: The United States Inter-university Consortium for Political and Social Research*, pp. 1790-2000. Ann Arbor, MI, 2008. ICPSR Study 2896.

Heider, Florian; Hoerova, Marie; and Cornelia Holthausen. "Liquidity Hoarding and Interbank Market Rates: The Role of Counterparty Risk," *Journal of Financial Economies* 118, 2015, pp. 336-54.

Iyer, Rajkamal; Paydro, Jose-Luis; da-Rocha, Samuel; and Antoinette Schoar. "Interbank Liquidity Crunch and the Firm Credit Crunch: Evidence from the 2007-2009 Crisis," *Review of Financial Studies* 27, 2014, pp. 347-72.

James, John A.; McAndrews, James and David F. Weiman. "Wall Street and Main Street: The Macroeconomic Consequences of New York Bank Suspensions, 1866-1914." *Cliometrica* 7, 2013, pp. 99-130.

Jaremski, Matthew. "The (Dis)Advantages of Clearinghouses Before the Fed" *Journal of Financial Economics* 127, 2018, pp. 435-58.

Jaremski, Matthew and David C. Wheelock. "The Founding of the Federal Reserve, the Great Depression, and the Evolution of the U.S. Interbank Network." *Journal of Economic History* 80 (1), March 2020, pp. 69-99.

Kemmerer, E. W. *Seasonal Variations in the Relative Demand for Money and Capital in the United States: A Statistical Study*. United States: U.S. Government Printing Office, 1910.

Ladley, Daniel, and Peter L. Rousseau. "Panic and propagation in 1873: A network analytic approach." *Journal of Banking & Finance,* 2023, article no. 106844.

Laughlin, James L. *Banking Reform.* Chicago: The National Citizens' League, 1912.

Martinez Peria, Maria Soledad, and Sergio L. Schmukler. "Do depositors punish banks for bad behavior? Market discipline, deposit insurance, and banking crises." *Journal of Finance* 56, 2001, pp. 1029-1051.

Mitchener, Kris J., and Matthew Jaremski. "The Evolution of Bank Supervisory Institutions: Evidence from American States." *Journal of Economic History* 75, 2015, pp. 819-859.

Mitchener, Kris J., and Gary Richardson. "Network Contagion and Interbank Amplification during the Great Depression." *Journal of Political Economy* 127 (2), 2019, pp. 465–507.

Moen, Jon R., and Ellis W. Tallman. "The Bank Panic of 1907: The Role of Trust Companies." *Journal of Economic History* 52 (3), September 1992, pp. 611-30.

Moen, J., & Tallman, E. "Outside lending in the New York City call loan market: Evidence from the Panic of 1907". *Financial History Review 26*(1), 2019, pp. 43-62.

Moore, Geoffrey Hoyt. *Business cycle indicators. Vol. 2*. Princeton, New Jersey: Princeton University Press, 1961.

Neal, Larry. "Trust Companies and Financial Innovation, 1897-1914." *The Business History Review* 45 (1), Spring 1971, pp. 35-51.

Odell, Kerry A., and Marc D. Weidenmier. "Real shock, monetary aftershock: The 1906 San Francisco earthquake and the panic of 1907." *The Journal of Economic History* 64 (4), December 2004, pp. 1002-1027.

Office of the Comptroller of the Currency. *Annual Report of the Comptroller of the Currency*. Washington: Government Printing Office, various years.

Scott, Hal S. *Interconnectedness and Contagion*, Committee on Capital Markets Regulation, November 20, 2012.

Sprague, O. M. "The American crisis of 1907". *Economic Journal*, 18 (71), 1908, pp. 353-72.

Sprague, O. M. *History of Crises under the National Banking System*. Washington, DC: National Monetary Commission, Senate Document 538, 61st Congress, 2d Session, 1910.

Tallman, Ellis W., and Jon R. Moen. "Liquidity creation without a central bank: Clearing house loan certificates in the banking panic of 1907." *Journal of Financial Stability*, 8 (4), December 2012, pp. 277-291.

Tallman, Ellis W., and Jon R. Moen. "The transmission of the financial crisis in 1907: an empirical investigation." *Cliometrica* 12 (2), March 2018, pp. 277-312.

Watkins, Leonard L. *Bankers' Balances: A Study of the Effects of the Federal Reserve System on Banking Relationships*. Chicago: A.W. Shaw, 1929.

Wheelock, David C., and Paul W. Wilson. "Explaining Bank Failures: Deposit Insurance, Regulation, and Efficiency," *Review of Economics and Statistics* 77 (4), November 1995, pp. 689-700.

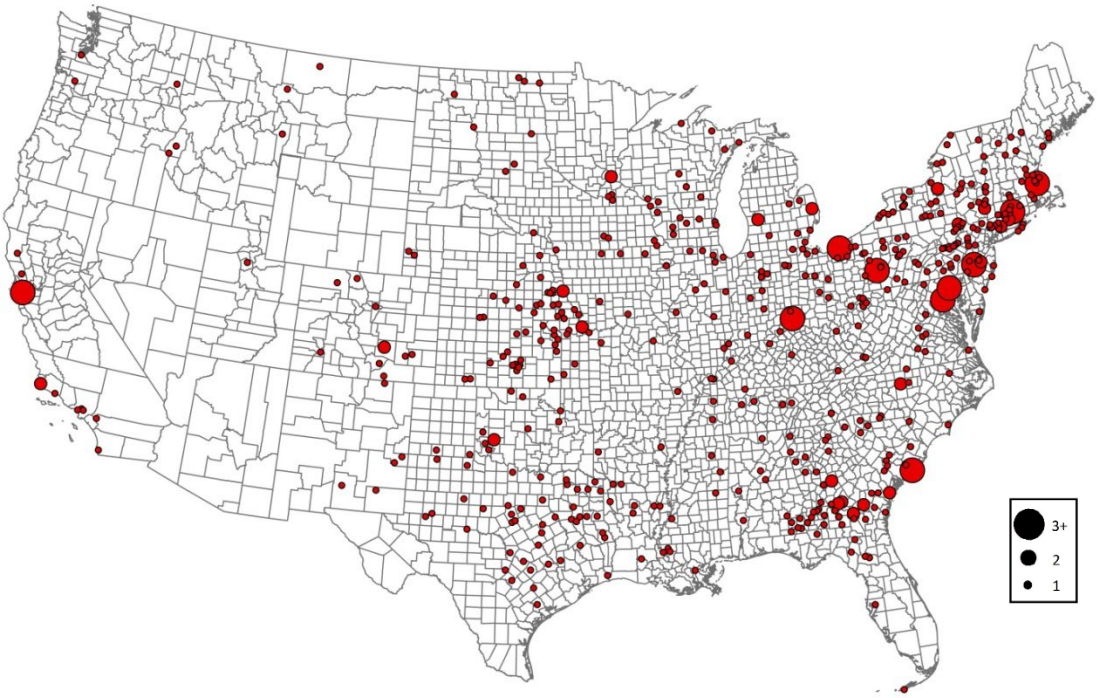
Wheelock, David C., and Paul W. Wilson. "Why do banks disappear? The determinants of US bank failures and acquisitions." *Review of Economics and Statistics* 82 (1), February 2000, pp. 127-138.

White, Eugene N. *The Regulation and Reform of the American Banking System 1900-1929*. Princeton: Princeton University Press, 1983.

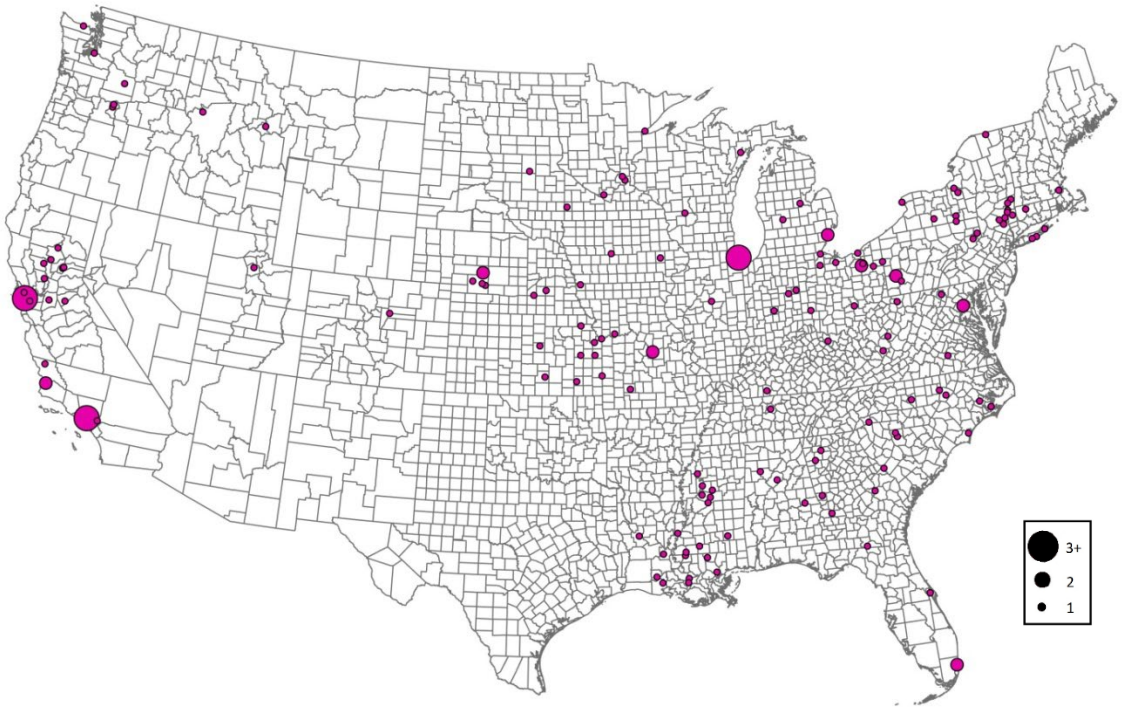
White, Eugene N., "A Reinterpretation of the Banking Crisis of 1930," *Journal of Economic History* 44 (1), March 1984, 44(1), pp. 119–38.

Wicker, Elmus. *Banking Panics of the Gilded Age*. Cambridge, UK: Cambridge University Press, 2000.

Figure 1: Locations of Banks Connected to HMBT Banks and New York City Trust Companies
Panel A: Banks Connected to HMBT Banks



Panel B: Banks Connected to any New York City Trust Company



Notes: The figures display the location of banks with a correspondent connection to either an HMBT bank or a New York City trust company in 1907. The size of the dot reflects the number of banks with a connection.

Table 1: Determinants of Cash Restrictions and Currency Substitutes by City

	All Listed Cities				Only Listed Cities With 25,000 or More Inhabitants			
	Instituted Cash Restrictions and Currency Substitutes Indicator	**Ln(CH. Certificates Issued/# of Banks)**	**Date Instituted Cash Restrictions and Currency Substitutes**	**Days With Cash Restrictions and Currency Substitutes**	**Instituted Cash Restrictions and Currency Substitutes Indicator**	**Ln(CH. Certificates Issued/# of Banks)**	**Date Instituted Cash Restrictions and Currency Substitutes**	**Days With Cash Restrictions and Currency Substitutes**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction of Corr in NYC	-0.067	-0.183	-0.538	32.377	-0.164	0.405	9.257	52.538
	[0.410]	[1.512]	[11.091]	[54.767]	[0.578]	[1.876]	[12.121]	[45.218]
Fraction of Banks Connected to Any NYC Trust	-0.600	0.812	-5.618	-50.553	-0.517	-1.449	-8.351	-36.334
	[0.457]	[2.728]	[14.612]	[73.776]	[0.716]	[2.288]	[10.726]	[46.129]
Fraction of Banks Connected to Any HMBT Bank	0.565*	-0.661	3.360	18.974	0.724**	-0.829	15.612*	18.771
	[0.305]	[0.517]	[5.074]	[18.716]	[0.350]	[1.714]	[9.132]	[32.141]
Ln(Respondents+1)	0.024	0.288**	-1.270*	-4.223	0.019	0.248*	-1.479**	-7.585*
	[0.028]	[0.133]	[0.736]	[3.433]	[0.031]	[0.136]	[0.584]	[3.787]
Ln(Correspondents+1)	0.137	-0.797	-4.937	6.347	0.096	-1.837*	3.641	50.535
	[0.205]	[0.929]	[7.068]	[25.199]	[0.222]	[1.054]	[7.030]	[31.372]
Ln(# of Banks)	-0.046	0.076	3.697	19.792	-0.036	1.045	-4.049	-13.229
	[0.215]	[0.983]	[8.010]	[26.293]	[0.245]	[0.980]	[7.485]	[27.680]
Location Controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Controls?	Region	Region	Region	Region	Region	Region	Region	Region
Observations	154	95	89	87	122	62	57	56
R-squared	0.509	0.553	0.216	0.319	0.531	0.710	0.536	0.544

Notes: The table presents the marginal effects of a logit model in columns (1) and (5) and ordinary least squares coefficients in the remaining columns. Each observation is a city. The column headings identify the dependent variables and sample used. Cities that did not issue currency substitutes are not included in columns (2)-(4) or (6)-(8). "Location Controls" includes the logarithm of city population, the change in city population 1900 to 1910, and the change in the number of banks in the city 1900 to 1907, the change in bank assets in the city 1905 to 1906, the fraction of the county population that was non-white, the number of farms per capita, and indicators for whether the city was a central reserve or reserve city as well as the distance from the city to New York City. Standard errors are presented in parentheses below the coefficients. * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 2: Summary Statistics

	Panel A: Closure Regressions Statistics			
	All Banks (N=16,179)		Banks With BS (N=12,124)	
	Mean	Std Dev.	Mean	Std Dev.
Closed By 1909	0.040	0.197	0.032	0.177
Ln(Respondents+1) in 1907	0.174	0.620	0.183	0.643
Ln(Correspondents+1) in 1907	1.216	0.275	1.234	0.270
Fraction of Resp that Closed by 1909	0.006	0.060	0.005	0.052
Fraction of Corr that Closed by 1909	0.067	0.173	0.066	0.167
Fraction of Corr in NYC in 1907	0.300	0.237	0.305	0.233
Connected to Any NYC Trust in 1907	0.010	0.098	0.010	0.099
Connected to Any HMBT Bank in 1907	0.034	0.182	0.038	0.191
Ln(Bank Age) in 1906	1.963	0.955	2.092	0.943
Ln(Assets) in 1906	-	-	12.301	1.223
Loans/Assets in 1906	-	-	0.629	0.149
Surplus+Profits/Assets in 1906	-	-	0.057	0.050
Cash+Due From Banks/Deposits in 1906	-	-	0.340	0.215
	Panel B: Network Regressions Statistics			
	All Banks (N=14,466)		Banks With BS (N=11,147)	
	Mean	Std Dev.	Mean	Std Dev.
Connected to Any NYC Trust in 1907	0.009	0.096	0.009	0.096
Connected to Any HMBT Bank in 1907	0.033	0.178	0.037	0.188
Ln(Bank Age) in 1906	1.996	0.955	2.112	0.940
Ln(Assets) in 1906	-	-	12.311	1.202
Loans/Assets in 1906	-	-	0.629	0.149
Surplus+Profits/Assets in 1906	-	-	0.057	0.051
Cash+Due From Banks/Deposits in 1906	-	-	0.337	0.210
Change in Total Correspondents 1907-10	-0.207	0.899	-0.225	0.895
Change in Ln(Correspondents) 1907-10	-0.057	0.248	-0.063	0.245
Change in Total Respondents 1907-10	0.100	6.327	0.048	5.958
Change in Fraction of Corr in NYC 1907-10	0.015	0.185	0.015	0.177
Change in Fraction of Corr in Big Six 1907-10	0.018	0.180	0.019	0.173
Change in Fraction of NY Corr in Big Six 1907-10	0.020	0.248	0.023	0.245
Change in Fraction of Corr in Other RC 1907-10	0.008	0.217	0.009	0.209

Notes: The table provides summary statistics for the variables included in the closure and network regressions reported in Tables 3 and 6. The "All Banks" sample includes all non-New York City banks; the "Banks with BS" sample includes all non-New York City banks in states that reported balance sheet information.
Source: See text for data sources.

Table 3: Determinants of Bank Closure After the Panic of 1907

	Dependent Variable: Closed Between Jan. 1907 and Dec. 1908					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Respondents+1)	0.008***	0.012***	0.009***	0.013***	0.008***	0.013***
	[0.003]	[0.002]	[0.003]	[0.002]	[0.003]	[0.002]
Ln(Correspondents+1)	-0.008	-0.004	-0.009	-0.005	-0.009	-0.005
	[0.006]	[0.006]	[0.006]	[0.005]	[0.006]	[0.005]
Fraction of Resp that Closed	0.062***	0.051***			0.062***	0.053***
	[0.012]	[0.016]			[0.012]	[0.016]
Fraction of Corr that Closed	0.018***	0.019***			0.015**	0.016***
	[0.006]	[0.005]			[0.007]	[0.006]
Fraction of Corr in NYC			-0.011	0.001	-0.011	0.001
			[0.009]	[0.008]	[0.009]	[0.008]
Connected to Any NYC Trust			0.020*	0.026**	0.020*	0.026**
			[0.011]	[0.011]	[0.011]	[0.011]
Connected to Any HMBT Bank			0.013**	0.016***	0.012*	0.014***
			[0.006]	[0.005]	[0.006]	[0.005]
Ln(Bank Age)	-0.016***	-0.001	-0.016***	-0.001	-0.015***	-0.001
	[0.003]	[0.002]	[0.003]	[0.002]	[0.003]	[0.002]
Ln(Assets)		-0.011***		-0.012***		-0.012***
		[0.003]		[0.003]		[0.003]
Loans/Assets		0.018		0.018		0.018
		[0.016]		[0.016]		[0.016]
Surplus+Profits/Assets		-0.103**		-0.102*		-0.098*
		[0.052]		[0.053]		[0.053]
Cash+Due From Banks/Deposits		-0.004		-0.005		-0.005
		[0.010]		[0.009]		[0.009]
Bank Type Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
County Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Region Controls?	Region	Region	Region	Region	Region	Region
Observations	16161	12113	16161	12113	16161	12113
R-squared	0.070	0.075	0.067	0.074	0.071	0.078

Notes: The table presents the marginal effects from a logit model. Each observation is a bank operating in January 1907. The dependent variable is an indicator variable equal to 1 for banks that closed by December 1908. "County Controls" includes the logarithm of county population, fraction of county population above 2,500, the fraction of the county population that was non-white, the number of farms per capita, and indicators for whether the bank was located in a county with a central reserve or reserve city as well as the distance from the bank to New York City. Standard errors clustered across all banks in a state are presented in parentheses below the coefficients. * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 4: Trends in Interbank Liabilities (1906-1910)

Panel A: Interbank Liability Values (In $000s)

	Big Six National Banks	NYC HMBT Banks	NYC Trust Companies	Other NYC Banks	All Non-NYC Banks
1906	361,971	36,310	115,500	182,412	1,238,779
1907	349,483	29,340	107,556	172,403	1,374,122
1908	530,056	13,443	133,348	248,285	1,365,312
1909	494,509	17,163	136,572	245,820	1,594,350
1910	444,904	14,972	117,230	228,356	1,528,810

Panel B: Interbank Liability Values as a Percentage of U.S. Total

	Big Six National Banks	NYC HMBT Banks	NYC Trust Companies	Other NYC Banks	All Non-NYC Banks
1906	18.71%	1.88%	5.97%	9.43%	64.02%
1907	17.19%	1.44%	5.29%	8.48%	67.59%
1908	23.14%	0.59%	5.82%	10.84%	59.61%
1909	19.87%	0.69%	5.49%	9.88%	64.07%
1910	19.06%	0.64%	5.02%	9.78%	65.49%

Panel C: Interbank Liability Values Relative to 1906 Value

	Big Six National Banks	NYC HMBT Banks	NYC Trust Companies	Other NYC Banks	All Non-NYC Banks
1906	1.00	1.00	1.00	1.00	1.00
1907	0.97	0.81	0.93	0.95	1.11
1908	1.46	0.37	1.15	1.36	1.10
1909	1.37	0.47	1.18	1.35	1.29
1910	1.23	0.41	1.01	1.25	1.23

Notes: The table provides the total interbank liabilities for various groups of banks between 1906 and 1910. It is important to note that reporting periods differ slightly for the different groups of institutions. Data for national banks and New York state banks and trust companies are typically reported for August or September dates whereas the data on U.S. total interbank liabilities reported in Board of Governors (1959) are June values.

Source: Information for New York City national banks come from the Comptroller of the Currency's *Annual Report*. Information on New York City state banks and trust companies come from New York's *Annual Report of the Superintendent of Banks.* Information for non-New York City banks is obtained by subtracting the New York City bank data from the national totals provided by Board of Governors of the Federal Reserve System (1959).

Table 5: Connections to New York City Banks and Trust Companies 1907-1910

	Panel A: Total Connections			
	Respondents in 1907	**Respondents in 1910**	**Change in Resp.**	**% Change in Resp**
HMBT Banks	658	419	-239	-36.32%
Trust Companies	526	508	-18	-3.42%
Big Six Banks	9,650	10,999	1,349	13.98%
Other Banks	3,220	3,522	302	9.38%
Banks That Entered After 1907	0	14	14	-
Total	14,054	15,462	1,408	
	Panel B: Percentage of Total Connections to New York City			
	Respondents in 1907	**Respondents in 1910**	**Change in Resp.**	**% Change in Resp**
HMBT Banks	4.7%	2.7%	-2.0%	-42.12%
Trust Companies	3.7%	3.3%	-0.5%	-12.22%
Big Six Banks	68.7%	71.1%	2.5%	3.60%
Other Banks	22.9%	22.8%	-0.1%	-0.58%
Banks That Entered After 1907	0.0%	0.1%	0.1%	-

Note: The table lists the number of respondents of New York City banks and trust companies and their change between January 1907 and July 1910.
Source: *Rand McNally Bankers Directory* (1907) and Jaremski and Wheelock (2020)

Table 6: Changes in Network Connections (1907-1910)

	ΔTotal Corr.		ΔTotal Resp.		ΔFraction NYC Corr		ΔBig Six/Total Corr		ΔBig Six/Total NYC Corr		ΔFraction Other R.C. Corr	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Connected to Any NYC Trust	-0.028	-0.020	0.133	0.610	-0.062***	-0.066***	0.080***	0.080***	0.208***	0.216***	0.046**	0.046**
	[0.068]	[0.068]	[0.174]	[0.551]	[0.017]	[0.017]	[0.018]	[0.020]	[0.046]	[0.054]	[0.020]	[0.018]
Connected to Any HMBT Bank	-0.070	-0.067	0.057	-0.008	-0.042***	-0.034***	0.145***	0.150***	0.383***	0.390***	0.026***	0.020*
	[0.048]	[0.050]	[0.150]	[0.174]	[0.010]	[0.009]	[0.017]	[0.020]	[0.044]	[0.049]	[0.010]	[0.010]
DLn(# of Corr)					-0.253***	-0.267***	-0.199***	-0.214***	-0.007	-0.011	0.102***	0.110**
					[0.034]	[0.042]	[0.026]	[0.032]	[0.010]	[0.011]	[0.038]	[0.045]
Ln(Bank Age)	-0.185***	-0.122***	-0.209**	-0.010	0.008***	-0.005	0.008***	-0.001	0.010**	0.001	-0.018***	-0.003
	[0.016]	[0.023]	[0.084]	[0.101]	[0.003]	[0.004]	[0.002]	[0.004]	[0.004]	[0.007]	[0.004]	[0.005]
Ln(Assets)		-0.047**		-0.116		0.013***		0.008***		0.006		-0.021***
		[0.019]		[0.222]		[0.003]		[0.003]		[0.004]		[0.003]
Loans/Assets		0.065		0.967		0.017		-0.003		-0.040		-0.029
		[0.147]		[0.585]		[0.018]		[0.015]		[0.026]		[0.022]
Surplus+Profits/Assets		0.168		-0.288		-0.049**		-0.041		0.065		0.087*
		[0.195]		[0.969]		[0.024]		[0.034]		[0.058]		[0.048]
Cash+Due From Banks /Deposits		0.091		0.382		0.017		0.010		0.002		-0.033**
		[0.061]		[0.307]		[0.011]		[0.009]		[0.022]		[0.013]
Bank Type Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Controls?	Region	Region	Region	Region	Region	Region	Region	Region	Region	Region	Region	Region
Observations	14457	11142	14457	11142	14457	11142	14457	11142	9371	7418	14457	11142
R-squared	0.035	0.033	0.048	0.024	0.133	0.159	0.106	0.130	0.110	0.127	0.035	0.045

Notes: The table provides the results of OLS regressions. Each observation is a bank that survived from January 1907 through July 1910. The dependent variables are provided in the column headings. "County Controls" includes the logarithm of county population, fraction of county population above 2,500, the fraction of the county population that was non-white, the number of farms per capita, and indicators for whether the bank was located in a county with a central reserve or reserve city as well as the distance from the bank to New York City. The regressions also control for banks with more than one New York City correspondent in 1907. Standard errors clustered across all banks in a state are presented in parentheses below the coefficients. * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 7: New York City Correspondent Changes 1907-1910

	Banks With One New York City Correspondent in 1907		
	Banks With HMBT Link (N=391)	**Banks With NYC Trust Link (N=113)**	**Other Banks (N=9141)**
Changed NYC Corr. by 1910	55.5%	28.3%	8.1%
Dropped NYC Corr. by 1910	12.0%	13.3%	8.2%
Retained Same NYC Corr. through 1910	32.5%	58.4%	83.7%

Notes: The table examines what happened to a bank's New York City correspondent between 1907 and 1910. The sample only includes banks with a single New York City correspondent in 1907 and that survived through 1910. The columns separate the sample's banks by the type of connection they had in New York City in 1907. A correspondent is considered the same if it has the same name across the two years or was part of a merger that formed the correspondent listed in 1910.
Source: Authors calculations from *Rand McNally Bankers Directory* (1907) and Jaremski and Wheelock (2020)

Appendix

This appendix provides preliminary evidence on the impact on real economic activity of the transmission of financial distress through the interbank network during and after the Panic of 1907. A rich literature on banking panics in historical settings, particularly of U.S. panics, finds that panics tend to exacerbate business cycle downturns. In their *Monetary History of the United States*, Friedman and Schwartz (1963) find a strong relationship between changes in the money supply and economic activity, and document that prior to World War II, most large movements in the money supply were associated with banking panics. Several studies have focused on the Great Depression of the 1930s, notably Bernanke (1983) who finds that in addition to the money supply effects described by Friedman and Schwartz (1963), the banking panics of the Great Depression had "non-monetary" effects that contributed to the contraction in economic activity. And, in a comprehensive study of U.S. business cycles from the 1870s through 2007-09, Bordo and Haubrich (2010) find that contractions associated with financial crises, especially banking panics, tended to be more severe than other business cycle downturns.

In contrast to a large literature finding an association between banking panics and economic recessions, few studies provide direct evidence of the impact on real economic activity of the transmission of financial distress through interbank networks. However, in his comprehensive review of banking panics of the National Banking Era, Sprague (1910) describes the spread of financial distress through interbank relationships and consequent impact on business conditions. Sprague emphasizes the disruption to economic activity caused by payment suspensions as they spread rapidly across the United States through interbank connections. James, et al. (2013) provide support for Sprague's research in finding that suspension periods were associated with large declines in real economic activity. However, direct evidence of transmission through networks remains limited, though two recent studies provide evidence that network transmission likely had real economic effects. Frydman, et al. (2015) find that large non-banking firms with close connections to the New York City trust companies most involved in the Panic of 1907 faced higher borrowing costs than other listed firms, and consequently had lower stock returns, dividend and profit rates, and made fewer investments. Mitchener and Richardson (2019) show that withdrawals of interbank deposits during the banking panics of the Great Depression induced correspondent banks in major cities to contract their business lending.

These findings suggest that transmission of financial distress through the network was an important cause of the decline in economic activity in those eras.

The limited data on real economic activity at a local level precludes a comprehensive study of the transmission of the Panic of 1907 to real variables. However, in this appendix, we provide a preliminary analysis on the transmission using data on commercial failures and regional stock prices.

A.1 State-Level Commercial Failures

We first examine the correlation between interbank connections to New York City and state-level commercial failures. *Dun's Review* published quarterly data on commercial failures in manufacturing, trade, and other industries separately from bank failures. We collected the information on non-bank failures for 1906 through 1909 to provide a view of failures before, during, and after the panic. We use both the total number of commercial failures as well as the value of liabilities of commercial failures as outcome variables.

To match the commercial failure data, we aggregate our network measures up to the state-level. Specifically, we focus on the number of banks in a state that had at least one correspondent in New York City. Moreover, we calculate the average distance of banks in the state from New York City to capture any distance effects. We estimate the following fixed-effects panel model:

$$Failures_{s,t} = a + \beta_t \%NYCCorr_s \times Q_t + \Omega_t NYCDist_s \times Q_t + Q_t + \gamma_s + e_{s,t}, \quad (A1)$$

where $Failures_{s,t}$ is either the logarithm of total commercial failures or the logarithm of the total liabilities of commercial failures in state *s* in quarter *t*; $\%NYCCorr_s$ is the fraction of banks in state *s* that had at least one correspondent in New York City in 1907; $NYCDist_s$ is the average distance of banks in state *s* from New York City; Q_t is a vector of quarter fixed effects; γ_s is a vector of state fixed effects; and $e_{s,t}$ is the error term. The regression framework provides a quarter-by-quarter estimate of the difference in business failures between highly connected states and low connected states while controlling for the average nation-wide failure rate in each quarter and the state average failure rate over time.

Figure A1 reports the vector of coefficients (i.e., β_t) on the interaction between the fraction of banks connected to New York City and the quarter fixed effects. The top panel provides the coefficients when examining the number of commercial failures, while the lower panel provides the coefficients when examining the liabilities of commercial failures. The data show that commercial failures rose both in number and liabilities in more highly connected states during the Panic of 1907 and into 1908. Although the coefficients on $\%NYCCorr_s$ fall short of statistical significance at the 10 percent level for the regression of the number of commercial failures, the coefficient is positive and significant at the 10 percent level or better for the fourth quarter of 1907 as well as for the first, second, and fourth quarters of 1908 for the failure liabilities regression. In indicating that bank connections to New York City boosted commercial failures during the panic and subsequent recession, the results are consistent with transmission of the panic to real economic activity. However, while the analysis shows a correlation between interbank networks and real outcomes, the state-level data are lacking in some ways. Most importantly, because commercial failures are aggregated at the state level, we are unable to test whether the locations of commercial failures coincided with the locations of banks with New York City connections. Approximately 33 percent of banks in the average state had a connection to New York City, but without more disaggregated data we cannot rule out the possibility that commercial failures were concentrated in cities with few New York City connections.

A.2 Regional Stock Market Indices

Stock market data provide another potential measure of real economic activity as prices reflect market conditions and expected profits and dividends of firms. Hence, we looked for evidence of transmission of the panic on regional stock market indices. We obtained monthly observations on stock price indices that exclude banks for eight U.S. cities (other than New York City) from Global Financial Data (GFD). The sample is reduced to seven cities because data for Los Angeles is missing for January 1908. With so few cross-sectional observations, we cannot proceed with a formal regression analysis. Instead, we use a simple comparison of means to compare the performance of non-bank stock market indices in cities with the highest concentrations of interbank connections to New York City with those with lower concentrations.

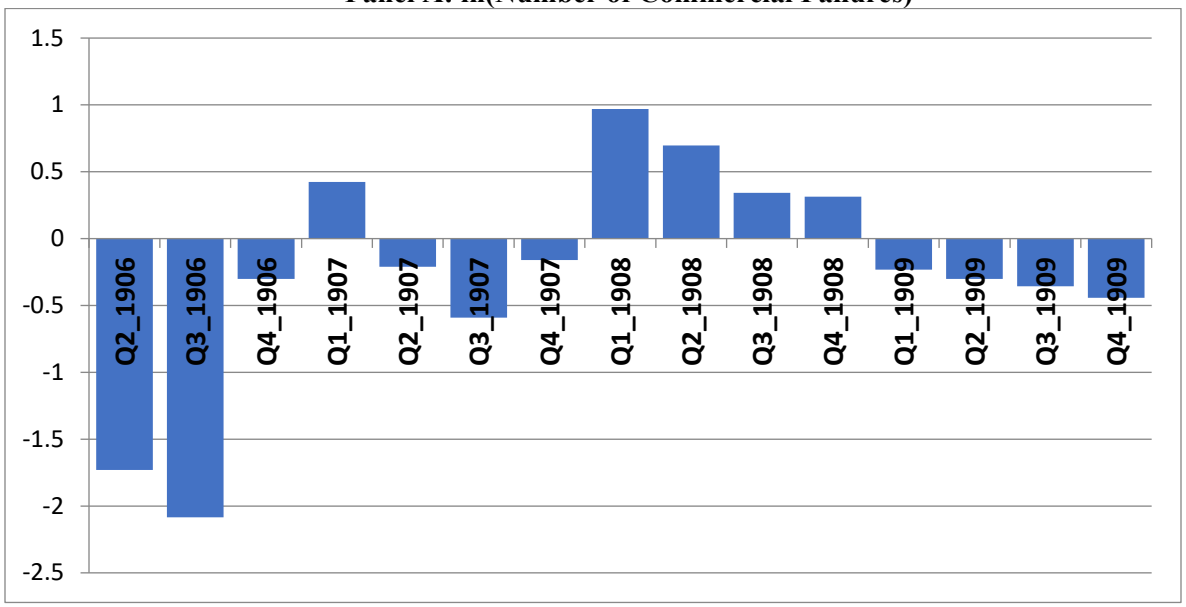
First, we identified the three most highly connected cities (i.e., Boston, Cleveland, and Philadelphia, where between 46-55 percent of local banks had connections to New York City)

and the four least connected cities (i.e., Baltimore, Chicago, San Francisco, and St Louis, where between 36-40 percent of local banks had connections to New York City) based on a natural breakpoint in the distribution. Second, we calculated the average level of stock market indices for each group in each month. Finally, we took the difference in averages between the two groups in each month and normalized that difference to zero in September 1907. Figure A2 provides the resulting normalized mean differences by month. Differences less than zero imply that cities with more intense connectivity to New York City had relatively lower stock price performance during the month compared with the pre-panic month September 1907, while differences larger than zero imply that cities with more intense connectivity had relatively higher stock performance. The data show that the difference between the two averages is negative during the panic months (i.e., October-December 1907), implying that the stock market indices of the cities with more New York City connectivity underperformed in those months. However, the difference is positive in all other months, indicating that the indices of the most connected cities typically outperformed.

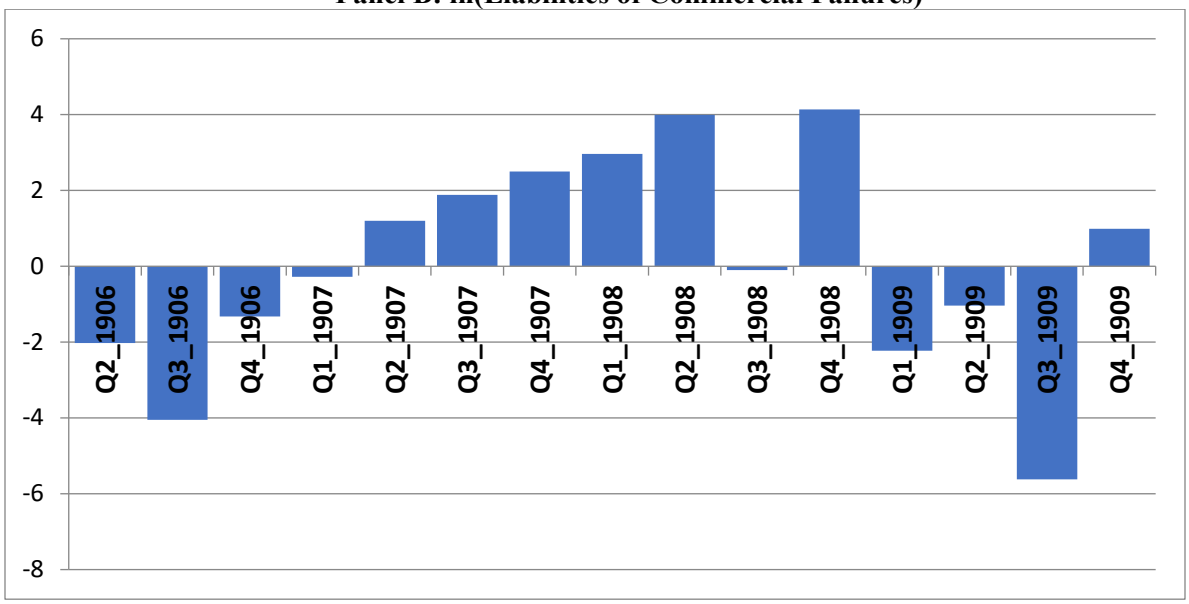
As with our findings for commercial failures, these results are consistent with the transmission of financial distress through the interbank network having had real effects. However, we caution against making causal interpretation because the stock market indices are highly selected and only available for a few large cities. We thus cannot run a formal regression that controls for other important factors or provides statistical significance of our estimates. Moreover, we cannot rule out the potential that the results are not present for smaller locations.

Figure A1: Effect of Interbank Connections to New York City on State Commercial Failures

Panel A: ln(Number of Commercial Failures)

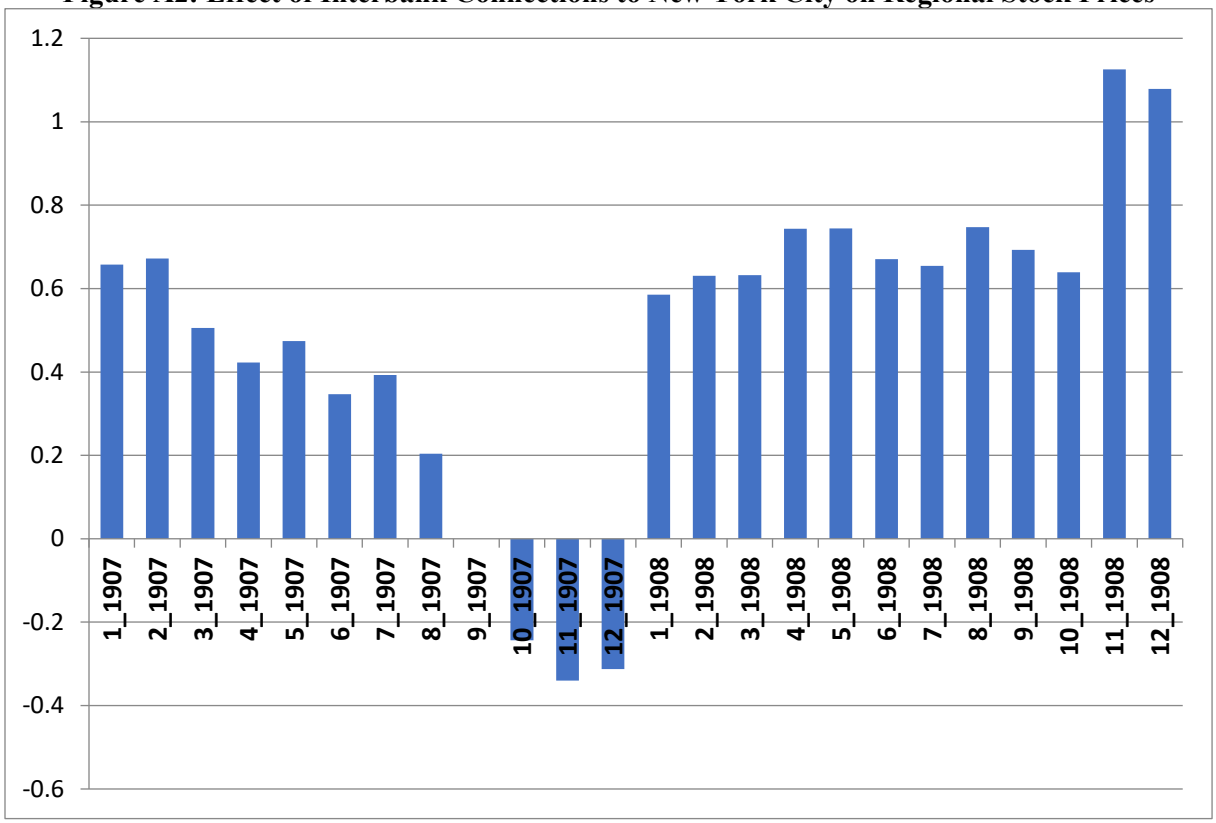


Panel B: ln(Liabilities of Commercial Failures)



Notes: The figures report the vector of coefficients (i.e., β_t) on the interaction between the fraction of banks connected to New York City and the quarter fixed effects in equation (A1).

Figure A2: Effect of Interbank Connections to New York City on Regional Stock Prices



Notes: Figure presents the mean differences between the non-bank stock market indices of cities with a high concentration of connections to New York City and that of cities with a relatively low concentration. The difference is normalized to zero in September 1907.