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Abstract

Liquidity shocks transmitted through interbank connections contributed to bank distress during the Great Depression. New data on interbank connections reveal that banks were much more likely to close when their correspondents closed. Further, after the Federal Reserve was established, banks' management of cash and capital buffers was less responsive to network risk, suggesting that banks expected the Fed to reduce network risk. Because the Fed's presence removed the incentives for the most systemically important banks to maintain capital and cash buffers that had protected against liquidity risk, it likely contributed to the banking system's vulnerability to contagion during the Depression.

JEL Codes: G21, L14, N22

Keywords: Bank Contagion, Great Depression, Interbank Networks, Liquidity Risk, Federal Reserve System

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1. Introduction

This paper investigates the impact of interbank contractual contagion (i.e., contagion arising from contractual relationships among banks) on bank distress during the Great Depression. Despite a large amount of recent research on the causes and consequences of bank distress during the Depression, previous studies have not examined whether or how specific bilateral bank network connections contributed to bank failure risk across the entire system or over the entire period. We do so by mapping the interbank network in detail and examining how network connections affected the risk of bank failure and other closure events.[1] Using interbank network and balance sheet data for the decades prior to the Depression, we also investigate how the founding of the Federal Reserve System (Fed) might have affected network risk. Existing literature criticizes the Fed for failing to offset major liquidity shocks during the Depression. We push further by examining whether there was an additional Fed-related contributor to systemic liquidity risk, namely that the Fed's presence led banks to be more complacent about liquidity risk and, therefore, more vulnerable to liquidity shocks.

The financial crisis of 2008-09 heightened interest in how relationships within the financial system can amplify exogenous shocks. Amplification can occur through multiple channels. For example, distress in one firm can signal potential problems in other firms with correlated positions and trigger withdrawals of short-term debt whether or not the firms are contractually connected. Withdrawals, in turn, may lead many financial institutions to sell risky assets to reduce their balance sheet risk, only to find that asset prices decline even more, magnifying the initial financial distress. For example, during the recent financial crisis, the

[1] We define a closure as any event that extinguishes a bank charter, including a failure that results in a bank being placed into receivership and liquidated or merged with another bank, a voluntary liquidation, or a charter conversion, e.g., a conversion from a state-chartered to a federally-chartered (national) bank. During the Depression, almost all closures were associated with financial distress, whether they were failures, mergers or voluntary liquidations. Importantly, however, we do not treat temporary bank suspensions as closures.

inability of Reserve Primary Fund, a money market mutual fund with a large exposure to Lehman Brothers, to maintain a constant $1 per share price triggered runs on other mutual funds, including many that had little or no counterparty exposure to Lehman or direct connections to Reserve Primary Fund.

Counterparty contagion can also occur through direct contractual obligations between firms. A default by one firm can impose distress on other firms that hold significant liabilities of the defaulting firm. For example, in the recent financial crisis, some observers believed that Goldman Sachs' exposure to AIG would have caused it to fail if AIG had been permitted to fail.[2] In the crisis, banks sought to limit their interbank exposures by dumping various classes of assets, which magnified price declines. As the interbank lending market collapsed in September 2008, banks scrambled to hoard reserves as a means of self-insurance against prospective liquidity needs, which aggravated declines in risky asset prices (Heider, Hoerova, and Holthausen 2015).

Banks continue to have direct contractual exposures to one another through a variety of channels, including interbank loans and deposits, commercial loan participations, and derivative contracts, and bank regulators remain concerned about the systemic risk that may result from such contractual exposures. For examples, the Dodd Frank Act of 2010 requires regulators to write rules that limit the credit exposures of banks to one another, and new liquidity regulations, such as the Liquidity Coverage Ratio, comprise part of Basel III prudential regulation.[3].

In the early 20th century, contractual exposures between banks occurred mainly through correspondent relationships, which from a research perspective have the advantage of being

[2] However, Scott (2012) concludes that this contractual contagion was not as important as the effect of correlated positions during the crisis.
[3] See "Fed Set to Cap How Much Big Banks Can Be Each Other's Customers," *BNA's Banking Report* vol. 110, no. 25, June 18, 2018, p. 862.

readily observable and without the complexity of many types of modern contractual exposures. Most banks maintained deposits with other banks (i.e., their correspondents) for payments and other services, as well as to invest surplus funds or obtain credit. Correspondent relationships were both a source of liquidity risk and a means of mitigating liquidity risk. For correspondent banks, interbank deposits were a source of liquidity risk because they could be withdrawn suddenly, putting the correspondent bank in an illiquid position. However, after controlling for exposure to interbank deposit withdrawal potential, network relationships were also a means of mitigating liquidity risk. For example, Calomiris and Mason (1997) find that when faced with deposit withdrawals in 1931-32, Chicago banks borrowed from other banks to replace lost deposits, thus mitigating the need to liquidate assets. Banks that were better known and had a larger network profile were better able to borrow funds when needed.

The interbank system had a "core-periphery" structure, with large banks in New York City, Chicago and other major cities at the core of a system comprised of local, regional and national nodes connecting banks across the country (James and Weiman 2010). The interbank network dissipated seasonal needs and minor liquidity disturbances across the system, but large shocks that overwhelmed the ability of correspondent banks to provide liquidity resulted in nation-wide banking panics.[4] Panics occurred often in the 19th century, and the liquidity risk associated with interbank deposit withdrawals was an important magnifier of distress during those panics (Calomiris and Gorton 1991; Calomiris and Carlson 2016, 2017; Wicker 2006). Following the Panic of 1907, Congress sought to eliminate panics by establishing the Federal Reserve System in 1913. The System's founders expected that the Fed would greatly reduce the

[4] Acemoglu, et al. (2015) provide a theoretical framework for studying the network's role as a shock propagation and amplification mechanism, and show that a densely connected network enhances financial stability when shocks are small, but beyond a certain point, dense interconnections amplify shocks and increase instability. Other papers that discuss the "robust-yet-fragile" aspects of interconnectedness include Allen and Gale (2007) and Gai, Haldane and Kapadia (2011).

size and importance of the interbank network. However, interbank deposit exposures remained large in the aggregate, making up almost $4 billion, or 6.5 percent of total banking system assets in 1929, and thus were potentially a major source of risk to the banking system.[5]

Studies of local panics at the beginning of the Great Depression find that correspondent relationships contributed to contagion, as did close geographic proximity to distressed institutions (Heitfield, Richardson and Wang 2017; Wicker 1996).[6] However, in a broader study of bank failures during the Depression, Calomiris and Mason (2003) found no evidence that the volume of a bank's interbank deposits affected its failure risk, though they did not explore the impact of bilateral network connections. More recently, based on aggregated data, Mitchener and Richardson (2016) find that outflows of correspondent deposits likely caused banks in major cities to contract their loans and other assets, suggesting that contagion contributed to bank distress. Further, Das, Mitchener and Vossmeyer (2018) find that greater connectedness to the interbank network (reflected in eigenvalue centrality) increased the odds that a bank would close during the Depression, but that a larger contribution to network systemic risk lowered the likelihood of closing. However, neither Das, Mitchener and Vossmeyer (2018) nor earlier studies examine whether or how contagion among related banks (either geographically or through explicit connections) affected survival probability over the course of the Depression. One of the main contributions of our paper is in showing that contagion occurred both through contractual relationships in the interbank network and geographical proximity to other distressed firms.[7]

[5] The correspondent system continues to exist today. However, international banking relationships, and relationships between different types of financial intermediaries, which are not always transparent, have become more important and complex. The relatively straightforward and transparent nature of interbank relationships in the historical period facilitates study of network risk and contagion.
[6] Calomiris and Mason (2003), however, found that geographic proximity had only a small contribution to failure risk, and argue that this may have reflected omitted variables rather than geographic proximity per se.
[7] For interested readers, the Appendix provides a detailed review of the literature on bank distress during the Depression and its potential relationship to liquidity risk through interbank contagion.

Given the severity of liquidity risk in magnifying failures during the Depression, we also consider how the establishment of the Federal Reserve System might have altered banks' incentives to manage liquidity risk associated with their position in the interbank network. Carlson and Wheelock (2018) find that national banks on average held significantly lower ratios of liquid-to-total assets during the 1920s than they had in the 20 years before the Fed was established, including lower ratios in excess of reserve requirements. Here, we probe the cross-sectional variation in banks' liquidity holdings to see how the Fed's presence affected cross-sectional differences in banks' management of liquidity risk associated with their position in the interbank network. We find that, before the founding of the Fed, banks managed network liquidity risk by maintaining higher equity relative to assets when their exposure to network liquidity risk was relatively high. After the founding of the Fed, however, correspondent banks were less prudent in their management of liquidity risk. Reduced prudence by the most systemically important banks in the system likely contributed to the banking system's vulnerability to contagion during the Depression.

To explore the role of contagion on bank closure risk during the Depression and the impact of the founding of the Fed on network liquidity risk management, we use newly digitized data on the entire U.S. interbank network on key dates before the establishment of the Fed (1910), soon after the Fed was founded (1919) and on the eve of the Great Depression (1929). We use information about each national bank's correspondents, local market, and balance sheet to estimate cross-section and panel regression models of bank closure during the Depression. The data indicate that banks were at greater risk of closing when they had more respondents (a proxy for a larger amount of deposits due to respondents, which were a source of liquidity risk from sudden withdrawals). Banks also faced more closure risk if their correspondents closed (presumably because this prevented them from being able to access their own deposits). Moreover, we find that a bank's closure risk was heightened by bank closures in the local markets served by their correspondents. The results indicate, therefore, that contagion through network ties was a significant source of banking instability during the Great Depression. We also find important location-specific closure risks in that banks were more likely to fail when other banks in their local market closed, which could be indicative of either location-specific loan risk or local contagion.

To examine how the founding of the Fed might have affected banks' management of network liquidity risks, we identify two separable aspects of network relationships that affected liquidity risk in the pre-Fed era, consistent with the fact that network relationships could be either a source of liquidity risk or a means of mitigating liquidity risk. One aspect (the amount of deposits due to respondents) created liquidity risk, and the other (the total number of network relationships, which we interpret as a measure of the bank's reputation and credit worthiness within the network, and thus its ability to access resources) mitigated liquidity risk. After controlling for the amount of deposits due to respondents, which would tend to increase risk, the size of a bank's respondent network, i.e., the number of respondents the bank had, should ordinarily mitigate liquidity risk. We find that before the Fed was established, both aspects affected how banks managed their portfolio risk and leverage. Greater exposure to interbank deposits encouraged banks to increase their capital ratios, while more network relationships (holding constant the amount of interbank deposits) led them to hold lower cash and capital ratios.

By contrast, after the Fed was established, correspondent banks appear less sensitive to network liquidity risk. We find that both aspects of network connections had much less impact on banks' risk management decisions in the years after the Fed's founding, suggesting that expected access to liquidity from the Fed reduced cross-sectional differences in perceived liquidity risk for correspondent banks, which likely heightened contagion risk through the interbank network. In essence, the founding of the Fed provided a perception of liquidity risk insurance against the sorts of shocks associated with banking panics in the National Banking era, and in so doing weakened the incentives for correspondent banks to guard against interbank liquidity risks by holding more capital or liquid assets. Ultimately, the Fed failed to provide sufficient liquidity to prevent contagion during the Great Depression, and thus did not fulfill the promise of the System's founders or the expectations of banks that the Fed would insure them against liquidity risk shocks.[8] Our findings thus contribute new information about how the interbank network contributed to banking system instability during the Great Depression.

The paper proceeds as follows: Section 2 describes the data that we use to measure closure and bank contagion. Section 3 provides the results of the empirical analysis of bank closure. Section 4 examines ex ante perceptions of liquidity risk related to the network prior to the Depression, and shows the risk-creating consequences of the founding of the Fed on banks' portfolio and leverage decisions. Section 5 concludes.

2. Data

Our study examines closures of national banks during the Great Depression. Although national banks represented just 30 percent of all U.S. commercial banks in 1929, they held nearly 44 percent of all U.S. bank assets (Board of Governors 1959). We focus on national banks because they faced a common regulatory regime throughout the United States and because

[8] On the Fed's failure to provide adequate liquidity during the Depression, see Friedman and Schwartz (1963), Richardson and Troost (2009), or Bordo and Wheelock (2013).

Annual Reports of the Comptroller of the Currency provide comprehensive end-of-year balance sheets for every national bank. State-chartered banks were subject to various state-specific regulations, and many states did not report consistent or comprehensive balance sheets for individual banks.[9] We digitized year-end balance sheets for all national banks from 1929 through 1934.[10] We assume that a national bank closed in the year after the bank last appeared in the Comptroller's Annual Report. Identifying closures in this way avoids conflating temporary suspensions with terminal bank closures.

We identified the interbank connections of every national bank as reported in the January 1929 edition of *Rand McNally Bankers' Directory.* The Directory provides a complete list of banks in the United States as well as each bank's "principal correspondents."[11] Although the Directory does not define "principal correspondents," the evidence suggests that it lists each bank's largest and most important correspondents.[12] By identifying the correspondents of every bank, the information allows us to identify every bank's respondents and thus observe both sides of the interbank network. For our analysis of pre-Depression changes in bank risk management

[9] Das, Mitchener and Vossmeyer (2018) use balance sheet data as reported in *Rand McNally Bankers' Directory* for both national and state banks in their study of bank survivorship during the Great Depression. However, the balance sheet data reported in Rand McNally for earlier years are more highly aggregated than the data in the Annual Reports of the Comptroller of the Currency. In particular, Rand McNally does not report information on interbank deposits, which is required for our analysis of how the founding of the Fed changed banks' management of network liquidity risk. Hence, we focus on national banks throughout our study and use balance sheet information as reported by the Comptroller.

[10] We drop the few banks that had extreme values as they were likely to be typos in the original document or brand new banks that had not started business.

[11] Directories include listings of private (i.e., unchartered) banks, and bank branches as well as commercial banks, mutual savings banks and institutions, and trust companies. We focus on chartered depository institutions and as such omit (1) private banks (i.e., financial institutions with no charters or regulation) because they typically were small and did not always take deposits, and (2) bank branches because they either mimicked their head office's correspondents or did not list any. We also omit the few banks (i.e., generally less than 1 percent of banks) that did not list any correspondents as we are unsure whether the data are missing or that they had no correspondents.

[12] From the few surviving archival records that contain full correspondent information for comparison, we determined that by 1900 the correspondent lists in Rand McNally cover the vast majority of funds placed in correspondents.

in Section 4, we use similar data on network structure and balance sheets for 1910 and 1919 from the same sources.

We use the list of "Discontinued Banks" in the January 1935 edition of Rand McNally B*ankers'* Directory to determine if and when each state-chartered bank that served as a correspondent of a national bank closed (again, closures of national banks are determined by their omission from Annual Reports of the Comptroller of the Currency).

3. Interbank Connections and Closure Risk During the Great Depression

We estimate limited dependent variable models to examine the role of contagion on bank closure risk during the Great Depression. The models include balance sheet and other bank-specific information, as well as information about the market in which the bank operated. To capture possible contagion, we include the fraction of a bank's correspondents that closed, as well as the fraction of other national banks in the bank's market (i.e., county) that closed. If contagion was important, we expect that a bank was more likely to close, the larger the fraction of its correspondents that closed or the higher the percentage of other national banks in its market that closed. We also include logarithms of the numbers of the bank's respondents and correspondents (in 1929). Having more correspondents might provide a bank with more potential sources of funds if needed. The likely effect of having more respondents is less clear, and likely depended on the size of shocks hitting the banking system. Ordinarily, having more respondents could mitigate risk for a correspondent bank because the seasonal and other demands for funds from the bank's respondents were typically not highly correlated (Carlson and Wheelock 2018). However, a large common shock – like the massive, nationwide liquidity shocks that struck during the Great Depression – could put a great deal of pressure on correspondent banks with a large number of respondents all clamoring for funds at the same time. Thus, while a larger number of respondents might have mitigated liquidity risk arising from correspondent deposits in the pre-Depression era, it might not have done so during the Depression.

Making use of the detailed interbank data, we also control for the composition of a bank's interbank connections. Because the failure rate of national banks was lower than that of state-chartered banks, we hypothesize that banks fared better when more of their correspondents were national banks; hence we include the fraction of a bank's correspondents that were national banks. Similarly, banks with correspondents in Federal Reserve cities might have had better access to liquidity provided by the Fed. To test this, we include the fraction of a bank's correspondents in city with a Federal Reserve Bank or branch office.[13]

In addition to variables meant to capture aspects of interbank connections, we include various balance sheet measures that have often been found to be correlated with the probability of a bank's failing or being acquired. These include the logarithm of a bank's assets, loans-to-assets ratio, capital-to-assets ratio (i.e., the sum of paid in capital, surplus, and undivided profit/total assets), cash-like-assets-to-total-deposits (i.e., cash in vault, due from banks, and due from the Fed)/(individual deposits and due to banks).[14] We also include the logarithm of bank age. Consistent with previous studies across many different periods including the Great Depression, we expect that older and larger banks, those with a lower ratio of loans-to-assets,

[13] In unreported regressions, we decompose the Fed effect into cities within the bank's Fed district, central reserve cities (i.e., New York, Chicago, and St Louis) as distinct from other Fed cities, and looked at the geographic diversity of correspondents. The results in each case are statistically insignificant when the other controls are included.

[14] Individual deposits refer to deposits of firms, households and state and local governments, i.e., deposits other than those of other banks.

and those with higher capital-to-assets or higher cash-like assets-to-total deposits, were less likely to close.[15]

Finally, we include variables that control for aspects of the bank's location and market. Using the Census of Population data from Haines (2004), we start with the 1930 population and urbanization rate of the bank's county to capture the local demand for deposits and loans. We control for other aspects of a bank's market by including the logarithm of the number of other national banks in the bank's county in 1929, and indicator variables for whether the bank was located in a city with a Federal Reserve Bank or branch office, and denoting its Fed district. In addition to controlling for local contagion, the inclusion of local bank closures should also help control for location-specific loan risks related to macroeconomic risks or shocks in the local economy. These types of factors were likely important over the course of the Great Depression when many local waves of bank closures occurred.

We first estimate a cross-sectional probit model where the dependent variable is an indicator variable that takes the value 1 if the bank closed between January 1, 1930 and December 31, 1934.[16] The model takes the form:

$$Closure_{i,c,1929-34} = a + \beta_1 CorrClosures_{i,1929-34} + \beta_2 Interbank_{i,1929} + \beta_3 NBClosures_{c,1929-34} + \beta_4 BalSheet_{i,1929} + \beta_5 X_{c,1930} + FedDist_c + s_s + e_{i,c} \quad (1)$$

$Closure_{i,c,1929-34}$ is an indicator variable for whether bank i in county c closed between 1929 and 1934. $CorrClosures_{i,1929-34}$ is the fraction of the bank i's correspondents that closed by

[15] Historical studies include White (1984), Calomiris and Mason (1997, 2003), Heitfield, Richardson and Wang (2017), Jaremski and Wheelock (2017) and Wheelock and Wilson (2000), the latter of which examines the determinants of closing via merger as well as by failure.

[16] The results are similar if we exclude bank closures in 1933 or 1934.

1934. $Interbank_{i,1929}$ is a vector of interbank variables (observed in 1929) including the logarithm of the number of respondents, the logarithm of the number of correspondents, the fraction of correspondents that were in a Fed Reserve Bank or branch office city, and the fraction of correspondents that were national banks.[17] $NBClosures_{c,1929-34}$ is the fraction of other national banks in county c that closed by 1934. $BalSheet_{i,1929}$ is a vector of balance sheet characteristics (observed in 1929), which includes the logarithms of assets and bank age, as well as loans-to-assets, capital-to-assets, and cash-like assets-to-total-deposits. $X_{c,1930}$ is a vector of county and city controls (observed in 1930), which includes the logarithm of county population, the fraction of county population above 2,500, the logarithm of other national banks in the county, and dummies for whether the bank was located in a Federal Reserve Bank or branch office city. $FedDist_c$ is a vector of Fed District-fixed effects. s_s is a vector of state-fixed effects. $e_{i,c}$ is the error term clustered by county.

Table 1 presents summary statistics for the variables used in the regression broken down by the bank's outcome. The data indicate that the means of all of the variables included in the model are significantly different between surviving and closing banks. On average, banks that survived the Depression were larger and older than banks that closed. Survivors also tended to have higher ratios of capital-to-assets and cash-like-assets-to-total-deposits, and lower ratios of loans-to-assets in 1929 that banks that closed. Thus, as White (1984), Calomiris and Mason (2003), and Das, Mitchener and Vossmeyer (2018) show, banks that had more balance sheet risk ex ante were more likely to fail (or otherwise close) during the Great Depression.

The summary statistics also show that on average, banks that survived the Depression had both more respondents and more correspondents, though the differences in the mean values

[17] We add 1 to the numbers of respondents, correspondents, and number of national bank correspondents before taking logs because many banks had no respondents or national bank correspondents.

between survivors and closing banks are quantitatively small. Survivors also tended to have higher percentages of national banks among their correspondents, and more of their correspondents were located in Fed cities. Finally, banks that survived the Depression generally had smaller fractions of correspondents that closed.

Table 2 presents estimation results (i.e., marginal effects) for equation (1). The coefficients on the balance sheet variables have the expected signs based on previous literature for both the historical and modern period. As suggested by the comparison of mean values, larger banks, older banks, and those with smaller ratios of loans-to-assets and higher ratios of cash-like-assets-to-total-deposits and of capital-to-assets were more likely to survive the Great Depression.

In addition, banks were more likely to close when a larger the fraction of their correspondents closed and when a larger fraction of other national banks in their market also closed. Quantitatively, the effect of local bank closures is somewhat larger than correspondent closures. We estimate that a one standard deviation increase in the fraction of local closed national banks (i.e., 0.453) increased the probability of closure by 3 percent. A one standard deviation increase in the fraction of closed correspondents (i.e., 0.292) increased the probability of closure by 2 percent. With a sample mean closure rate of 33 percent, these effects seem modest except when noting the host of other variables included in the model.

The regression results also indicate that an increase in the number of respondents increased a bank's risk of closing. Although on average banks that survived the Depression had more respondents, the marginal effect of adding another respondent was to increase closure risk. A one standard deviation increase in the logarithm of respondents (i.e., 1.0) increased the probability of closing by 3 percentage points. The severity of the Great Depression likely reduced any diversification benefit from having a large number of respondents. Instead, when banks throughout the country were confronting deposit outflows and turning to their correspondents for help, those with more respondents likely faced more withdrawal pressures.

The interbank distribution variables in column (2) indicate that having more correspondents that were national banks lowered a bank's closure risk. National banks had lower failure rates than state-chartered banks. Moreover, because they were members of the Federal Reserve System, national banks had direct access to the Fed's discount window, and thus could have facilitated access to liquidity for their respondents.

The results reported in Table 2 suggest a role for local and interbank contagion, but do not address the timing of closures. Therefore, we next take advantage of the time-series variation in the data to estimate a panel probit model of the form:

$$Closure_{i,c,t} = a + \beta_1 CorrClosures_{i,t} + \beta_2 Interbank_{i,1929} + \beta_3 NBClosures_{c,t} + \beta_4 BalSheet_{i,t-1} + \beta_5 X_{c,1930} + FedDist_c + FedDist_c * t_t + s_s + t_t + e_{i,c,t} \quad (2)$$

where $Closure_{i,c,t}$ is an indicator variable for whether bank i in county c closed in year t, $CorrClosures_{i,t}$ is the fraction of bank i's correspondents present in 1929 that closed in year t, $NBClosures_{c,t}$ is the fraction of other national banks in county c in 1929 that closed in year t, $BalSheet_{i,t-1}$ is the vector of balance sheet statistics for bank i at the end of the previous year (t-1), t_t is a vector of year fixed effects, and the other variables retain their previous definitions. We add the interaction between the Fed District dummies and the time fixed effects to control for potential differences in discount window policies of the Reserve Banks as documented by Richardson and Troost (2009) and others.

Table 3 presents results of the panel probit regression in equation (2).[18] The pattern of coefficients is similar to those in Table 2. Closure probability is significantly and negatively influenced by asset size, age, and ratios of capital-to-assets and cash-like-assets-to-total-deposits, and is significantly and positively influenced by the ratio of loans-to-assets. Compared with the cross-sectional regression results, the effect of cash-like-assets-to-total-deposits is higher and the other factors are lower, suggesting that liquidity was a larger predictor of bank instability in each year than it was over the entire period.

Focusing on our measures of contagion risk, the coefficients on both the fraction of other national banks in the market that closed and the fraction of correspondent closures remain positive and statistically significant. However, the lagged values of the contagion variables are not statistically significant, suggesting that much of the impact of contagion occurred in the current year rather than in the year preceding closure.

Having shown that correspondent closures and local bank panics contributed to bank closures during the Great Depression, we next examine, in column (5) of Table 3, two specific aspects of interbank contagion. First, we test whether local panics in one area were transmitted through the interbank network to banks in other areas. We do this by calculating the fraction of national banks that closed in the counties where a given bank's correspondents were located.[19] Because the year fixed effects should control for any nation-wide panic that affected all banks, our variable captures any impact caused by distress in the local markets of a bank's correspondents. The results indicate that a high rate of closures in the markets of a bank's correspondents imposed distress on the respondent bank. The evidence thus indicates that the interbank network connections transmitted local shocks to other areas.

[18] We find qualitatively similar results when using a linear probability or Cox proportional hazard model.
[19] The variable label is "Correspondents' Fraction of Other National Banks in County that Closed in Year."

Second, to determine whether the failures of correspondents operated directly through contractual connections, or alternatively were indicative of common shocks, we examine whether a bank's probability of closing was affected by closures of the correspondents of neighboring banks. One can think of this as a placebo test for direct contractual contagion. We do this by calculating the fraction of correspondents of neighboring banks that closed during the year.[20] The results show that closures of the correspondents of neighboring banks had no significant effect on a given bank's closure probability. Thus, we are confident that correspondent closures are independent across neighboring banks and that contagion flowed through direct interbank connections.

While correspondent closures increased a bank's probability of closing, they would have also affected bank balance sheets. Consequently, the closure regressions would underestimate the effect of interbank closures on bank closure risk due to the inclusion of balance sheet controls. Therefore, we examine the impacts of correspondent bank closures on the balance sheets of surviving banks to gauge further the effects of contagion spread through the interbank system. We also include nearby bank closures each year in our model, which captures some combination of time-varying location-specific loan risks and location-specific closure contagion. We estimate the following regressions:

$$\Delta Y_{i,c,t} = a + \beta_1 CorrClosures_{i,t} + \beta_2 NBClosures_{c,t} + u_i + FedDist_c * t_t + t_t + e_{i,c,t} \quad (3)$$

where $\Delta Y_{i,c,t}$ is a vector consisting of the change in the logarithm of assets, loans, cash-like assets, capital, and total deposits, u_i is a vector of bank-fixed effects, and the rest of the variables retain their aforementioned definitions.

[20] In Table 3, the variable is labeled "Other National Banks' Fraction of 1929 Correspondents that Closed in Year."

The estimates reported in Table 4 show that surviving national banks gained deposits and assets when neighboring banks closed, and they lost deposits and assets when more of their correspondents closed. Thus, while an increase in the number of local bank closures tended to increase a bank's own probability of closing, closures of neighboring banks tended to increase the size of banks that did not close. Surviving banks likely gained customers, and thus assets and deposits, from banks that closed, either by acquiring distressed banks or as customers of those banks moved their deposits to healthier banks. On the other hand, the decline in assets that banks experienced when their correspondents closed likely forced some to reduce loans to their own customers. In this way, we can clearly see the potential effect of interbank closures on the balance sheet security of connected banks, while the link with local closures is a bit less clear.

4. Imprudence in Post-Fed Liquidity Risk Management by Correspondent Banks

The high incidence of bank distress during the Great Depression is prime evidence that the Fed did not prevent the sorts of liquidity crises that had plagued the interbank system during the National Banking era.[21] Although panics were not the principal cause of most bank failures during the Depression (Calomiris and Mason 2003), our regression evidence indicates that contagious liquidity shocks were transmitted through the interbank system and heightened bank distress. The Fed should have, and apparently did reduce risks associated with seasonal variation in reserve supply and demand, and thereby largely eliminate seasonal volatility in interest rates

[21] Numerous studies have examined why the Fed did not live up to the promise of its founders. Friedman and Schwartz (1963) argue that the Fed should have done more to prevent the Great Depression, contending that the Fed could have employed both open market operations and discount window lending to increase the money supply, reduce the contraction in nominal income and prices, and prevent the financial distress of many bank borrowers from causing bank distress. Meltzer (2003) shows that the Fed leadership failed to understand the difference between low nominal interest rates and low real interest rates, and mistook the abundance of excess reserves as a sign of monetary slack when in fact it was caused by banks' scramble to shore up their positions in the face of monetary contraction and increasing financial distress. Bordo and Wheelock (2013) point to flaws in the discount window mechanism in the Federal Reserve Act.

and stock returns (Miron 1986; Bernstein et al. 2010; Calomiris 2013; Carlson and Wheelock 2018). The successful elimination of seasonal money market pressures and the absence of significant banking crises during the Fed's first 15 years may have encouraged banks to hold less liquidity themselves and instead rely on the Fed in times of need (Carlson and Wheelock 2018). Further, the presence of the Fed should have reduced perceived liquidity risk in the interbank network and thereby encouraged correspondent banks to take on more balance sheet risk as expressed, for example, by lower ratios of capital-to-assets and liquid-assets-to-total-deposits, defined as (cash items + due from banks and Fed + bonds + stocks)/total deposits. If correspondent banks did lower their guard in response to the introduction of a lender of last resort, then the Fed's mistakes during the Depression were compounded by the ex ante belief that the Fed would be a reliable source of liquidity.

We investigate how the Fed's establishment might have altered perceptions of risk in the interbank system by focusing on the behavior of correspondent banks, which were central to managing the liquidity risk in the banking system. We construct panel datasets consisting of balance sheet and respondent data for correspondent banks in 1910 (before the founding of the Fed), in 1919 (after the Fed's founding) and at the end of 1928 (just prior to the Great Depression). We identify two cross-sectional characteristics of correspondent banks that affected the extent of their liquidity risk prior to the Fed, and measure the influence of those characteristics on capital-to-assets and liquid assets-to-total deposits ratios in 1910. We then investigate whether banks' risk management, as reflected in those two balance sheet ratios, changed after the founding of the Fed.

Our first measure of liquidity risk is the ratio of deposits due to banks to total deposits. Correspondent banks with higher ratios of respondent deposits to total deposits should have maintained a higher capital-to-assets ratio, a higher liquid-assets-to-total-deposits ratio, or both, ceteris paribus. After the founding of the Fed, if correspondent banks believed that the Fed had reduced systemic risk, then those with higher ratios of respondent deposits to total deposits would have reduced one or both of those ratios compared to their levels in 1910.

A correspondent bank's reputation might have mitigated liquidity risk, however, as might a large number of connections to other banks, which would lower risk through diversification so long as the shocks hitting the bank's respondents were not perfectly correlated. Thus, in general, prior to the large common shock experienced during the Depression, more connections should have reduced liquidity risk for a given ratio of due to banks-to-total deposits. Of course, the number of connections a bank has is potentially endogenous. Banks with more connections might have been better known, more diversified in their liquidity risk, or considered more reputable (i.e., the number of respondents should reflect the reputation of the correspondent bank). Therefore, we expect that, controlling for the due-to-banks-to-total-deposits ratio, more respondent connections should be associated with less liquidity risk. If the number of respondent banks is an indicator of higher reputation, or a more diverse network of respondents, then banks with larger respondent networks might have been able to maintain lower capital-to-assets and liquid assets-to-total deposits ratios ceteris paribus.[22] If correspondent banks believed that the founding of the Fed had reduced systemic risk, then those with lower (higher) numbers of respondents would have reduced (increased) the relative sizes of their capital-to-assets and liquid-assets-to-total deposits ratios (after removing the average year effect). Furthermore,

[22] Because the number of respondents is potentially endogenous (an increasing function of) lower risk, it is also possible that more respondents could be correlated with higher capital ratios or higher liquid asset ratios. In our empirical analysis, however, the opposite is true, indicating this reverse causality is not apparent. More respondents, ceteris paribus, is associated with lower capital and cash ratios. That negative covariance indicates that unobservable characteristics about the correspondent bank (a better reputation or a more diverse network of respondents) drive the negative association between the number of respondents and the capital and liquid asset ratios.

average year effects for the capital-to-assets and liquid-assets-to-total deposits ratios should be negative in 1919 and 1929 compared to 1910, if the establishment of the Fed was expected to reduce systemic risk.

We estimate the following model:

$$Z_{i,c,t} = a + \beta_1 Respondents_{i,c,t} + \beta_2 Respondents_{i,c,t} * Fed_t + \beta_3 DuetoBanks_{i,c,t} + \beta_3 DuetoBanks_{i,c,t} * Fed_t + \beta_4 X_{c,t} + u_i + t_t + e_{i,t} \quad (4)$$

where $Z_{i,c,t}$ is either the capital-to-assets or liquid-assets-to-deposits ratio, $Respondents_{i,c,t}$ is a vector of indicator variables for whether the bank i had 0 respondents (excluded group), 1-15 respondents, 16-100 respondents, or more than 100 respondents in year t, Fed_t is an indicator variable for years after the Fed was in operation, and the rest of the variables retain their previous definitions.[23] The levels of our two interbank risk variables provide measures of the effect of each across all periods, whereas the interaction between the variables and the Fed indicator tests whether banks behaved differently after the Fed was established. We include bank fixed effects to control for bank-specific characteristics, but allow banks to vary over time in the size of their respondent networks.

The results in Table 5 show that the data corroborate our hypotheses about liquidity risk perceptions before and after the Fed. Results in the first two columns pertain to the capital-to-assets ratio. The coefficient on the due-to-banks-to-total-deposits ratio of 0.082 in the first column shows that in 1910, having more due-to-banks-to-total-deposits ratio was associated with a higher capital-to-assets ratio. This effect was reversed in 1919 and 1929, however, with the

[23] We chose the cutoff points based on the underlying distribution of respondents. The results are not sensitive to picking different bins for the number of respondents or to using the log number of respondents instead. They are also not sensitive to holding the number of respondents and due to banks fixed at their 1910 values.

total effect being –0.047 (i.e., 0.082 – 0.129). The results are similar for the panel estimates reported in the second column, which are based on data for just 1910 and 1919.

The year effects for 1919 and 1929 are negative and statistically significant in all of the regressions, indicating that banks generally held lower capital/assets and liquid assets/total deposits in the years after the Fed was established. This suggests that banks expected the Fed to reduce systemic risk. Reserve requirements on national banks were lowered when the Fed was established and again in 1917. For our broad measure of liquid assets, reserve requirements generally should not bind for banks holding positive liquid assets in addition to reserves at the Fed. In particular, a loosening of reserve requirements might lower reserves held at the Fed, but that effect likely would be somewhat offset by increased holdings of other liquid assets that could not be used to satisfy reserve requirements. However, the negative year effects on liquid assets after the founding of the Fed suggest that banks chose to hold less liquidity after the introduction of the lender of last resort.

We find a negative association between capital/assets and number of respondents in 1910. The capital-to-assets ratio is lower by 0.012 for banks with 1-15 respondents, by 0.037 for banks with 16-100 respondents, and by 0.080 for banks with 101 or more respondents. After the founding of the Fed, however, this association disappears. In the first column of the table, the net effect for the 1-15 respondent group is 0.003 (i.e., 0.015 – 0.012), for example. The net effects for those with larger size networks are similarly close to zero. Results reported in the second column are similar.

Results are broadly similar for liquid assets. We do not find that banks held more liquid assets as the result of a greater exposure to interbank deposits (the coefficient –0.060 is not statistically different from zero). The absence of a relationship between due to banks/total deposits and the liquidity ratio does not necessarily mean that correspondent banks were unresponsive to network liquidity risk, however, because banks could mitigate such risk by holding more capital. The use of greater equity capital as the means of managing liquidity risk likely reflects the unusually low cost of raising equity in the pre-Depression period which made the raising of additional equity the generally preferred tool for absorbing increased risk (see Calomiris and Wilson 2004, and Calomiris and Oh 2018).

For the years after the founding of the Fed, we find that higher ratios of due to banks-to-total deposits are associated with lower liquid-assets-to-total-deposits ratios, which is consistent with the idea that the founding of the Fed changed how correspondent banks managed interbank liquidity risk. We also observe positive reversals of the negative coefficients in the liquid-assets-to-total-deposits ratio regressions for the effects of respondent network size, as well as significant negative year effects for 1919 and 1929.

Overall, these findings lend support to the view that prior to the founding of the Fed correspondent banks managed their capital and liquidity in response to network liquidity risks, but that in the years after the Fed was established, they were less responsive to such risks. Banks likely expected that the Fed would supply any additional liquidity that was needed and, hence, that the systemic liquidity risk associated with interbank connections had been reduced. Correspondent banks not only reduced their average capital and liquid asset ratios, they reduced them even more if they had large due to banks/total deposits ratios and relatively small numbers of respondents. The impact of interbank contagion during the Depression was thus likely magnified by a pre-Depression perception that the Fed would reduce systemic risk.

5. Conclusion

Using newly digitized data that identify all interbank network relationships before and during the Great Depression, we explore how contractual connections among banks affected liquidity risk. We find large effects. Banks with more respondents (a proxy for the greater liquidity risk associated with more deposits due to respondent banks) were more likely to close. Banks whose correspondents closed (making it harder for them to access their own deposits) were also more likely to close. In addition, we also find that the interbank network transmitted shocks across locations as banks in one location suffered when their correspondents were located in other markets with higher numbers of bank closures.

For liquidity risk to have contributed to bank closures, the amount of risk experienced during the Depression must have exceeded the liquidity risk management precautions that banks had undertaken prior to the crisis. The Depression was an extremely adverse event that produced losses and increased risks that overwhelmed the risk management precautions that banks had undertaken in the form of capital and liquid asset buffers. Compounding the problem, systemically important banks acted as though they expected the Fed to provide liquidity risk insurance that had not existed before the Fed's founding. Before the Fed was established, bank capital and cash ratios varied with cross-sectional differences in the two network influences that we identify as important to their liquidity risk (interbank deposit exposure and number of network connections). Those correlations largely disappeared after the founding of the Fed, suggesting that correspondent banks no longer perceived a need to hold extra capital or liquidity against systemic risk in the interbank network. Thus, when the Fed failed to deliver on the promise of the System's founders that the central bank would end the problem of banking panics, banks were even more exposed to network liquidity risk than they would have been in pre-Fed days. Hence, the response of banks to the creation of a lender of last resort likely made the banking collapse worse than it otherwise would have been. An important lesson from that experience is that lender of last resort policy requires an understanding of the incentives that the policy creates as well as the actual execution of policy when a crisis occurs.

Appendix: Literature on Interbank Contagion During the Great Depression

On the eve of the Great Depression in 1929, the United States had some 24,970 commercial banks (Board of Governors 1959). By 1934, that number had shrunk to 15,348. The decline was due mostly to failures, voluntary liquidations, mergers, and acquisitions of unhealthy banks.[24] Economists and historians have long been interested in the causes of bank distress during the Great Depression, at least since Friedman and Schwartz (1963) attributed the Depression to banking panics and collapse of the stock of money. One strand of the literature has focused on banking panics, and attempted to determine whether local or national panics caused waves of bank failures that could not otherwise be explained by fundamentals (Temin 1976; White 1984; Calomiris and Mason 1997, 2003; Richardson 2007). Another strand has focused on the causes and consequences of interbank connections in propagating contagion and contributing to the demise of banks or collapse of bank lending (e.g., Heitfield, Richardson and Wang 2017; Mitchener and Richardson 2016). Our paper brings these strands together in a bank-level analysis of how network connections mattered for failure risk, after taking other influences into account.

Temin (1976) challenged the Friedman and Schwartz (1963) interpretation of the events of the Great Depression. He argued that rather than the cause of the Depression, bank failures primarily reflected the collapsing economy. White (1984) and Calomiris and Mason (1997, 2003) provide supporting evidence, showing that fundamental influences were often at the heart of bank failures. White (1984) shows that the pattern of bank failures that occurred during 1930 was similar to the 1920s, when many small, rural banks failed due to weakness in the farm economy. White uses logit regressions to examine the microeconomic determinants of bank

[24] The vast majority of closed banks were either acquired by or merged into other banks. Because most mergers and acquisitions at the time involved distressed banks, we treat any bank whose charter ended as a result of a merger or acquisition as closed, similar to banks that failed and were placed into receivership or that voluntarily liquidated.

failures in the final quarter of 1930 based on failures of national banks and a stratified random sample of non-failing banks from the same cities or local areas. He finds that deteriorating asset values was a primary cause of bank failures, and that the failures in 1930 can be predicted a year in advance with some accuracy, suggesting that the causes of failures in that year were not fundamentally different from those of earlier years. However, he finds that regressions estimated on earlier data do not forecast bank failures in 1931-32 well, suggesting that the later failures had fundamentally different causes.

Calomiris and Mason (1997, 2003) pursue the causes of Depression-era bank failures, first by studying patterns of failures during a banking panic in Chicago in June 1932 (Calomiris and Mason 1997), and then by a detailed microeconomic study of the causes of bank failures from 1930 to 1933 (Calomiris and Mason 2003). In their study of the Chicago panic, the authors estimate logit and hazard models to test various hypotheses about the causes of failures during the panic. Similar to White's (1984) analysis of the banking panic episode of 1930, Calomiris and Mason (1997, 2003) show that both in the case of the Chicago Panic of 1932, and for the nationwide episodes identified as panics by Friedman and Schwartz (1963), bank failures were similar to those occurring outside those windows of time, and are similarly predictable from bank balance sheet and income statement information observable prior to the distress event. They reject the null hypothesis that characteristics of banks that failed during the panic differed from those of banks that failed in other months. The authors conclude that the failures that occurred during panics reflected the relative weakness of those banks in the face of a common asset value shock rather than illiquidity per se or contagion. Calomiris and Mason (2003) find no evidence that deposits due to, or due from, other banks contributed to failure risk. However, that evidence does not distinguish across banks based on their differences within the network (correspondent or respondent banks), differences in the size of their exposures, or interactions between due to and due from (i.e., the "two-sided liquidity risk" emphasized by Calomiris and Carlson 2017). We show that modeling the network and taking these factors into account reveals an important relation between interbank liquidity risk and bank failure risk.

Richardson (2007) revisits the "insolvency versus illiquidity" debate using information about the causes of bank suspensions as recorded by contemporary Fed officials. Whereas White (1984) and Calomiris and Mason (1997, 2003) focused exclusively on national banks or Fed member banks, respectively, because of a lack of balance sheet information about non-member banks, the Fed information used by Richardson reports on suspensions by all types of banks. From those reports, Richardson concludes that both illiquidity and insolvency were substantial sources of bank distress during the Depression. Moreover, the information suggests that contagion played some role in that the closure of a correspondent was the primary cause of nearly 6 percent of suspensions occurring between January 1929 and March 1933. Although this evidence is suggestive, the interpretation of the language used by examiners remains somewhat unclear, and the accuracy of their causal inferences is unknown. Our analysis shows that liquidity risk as measured by network exposures had identifiable consequences for failure risk after controlling for other fundamental influences.

Heitfield, Richardson and Wang (2017) examine further the impact of contagion on bank failures by focusing on the banking panic of 1930, triggered by the collapse of Caldwell and Company, a Nashville based financial holding company (Wicker 1996). The authors estimate hazard models of the determinants of bank failures in three states (Alabama, Mississippi, and Tennessee) during 1930-31. A key feature of their analysis is the inclusion of variables that capture geographic proximity and contractual (correspondent) connections between banks. The study finds that geographic proximity to other failed banks was an important source of contagion causing bank failures. Interbank correspondent connections also were important, though somewhat less so than geographic proximity. These findings are suggestive, but apply only to a subset of banks during a specific period. Furthermore, as Calomiris and Mason (2003) note, geographic attributes per se are easily confounded with location-specific omitted variables.

Other than Heitfield, Richardson and Wang (2017), we are unaware of any direct evidence that specific bilateral interbank connections help explain bank distress during the Great Depression. However, Mitchener and Richardson (2016) find that outflows of interbank deposits contributed significantly to the decline in aggregate commercial bank lending during the Depression. Their evidence shows that the interbank network was a conduit for transmitting economic distress, with suspensions by local banks putting pressure on their city correspondents. It seems likely that the stresses on the system they identify as important for reducing the supply of lending were also a factor in causing failures and suspensions. Until now, however, researchers have been unable to test whether network connections between respondents and correspondents contributed to failures. By digitizing the complete set of correspondent connections among U.S. banks in 1929, we have the data that enable us to test whether interbank connections help explain the disappearance of banks during the Great Depression.

Das, Mitchener and Vossmeyer (2018) construct a detailed bank-level mapping of the interbank network for the Great Depression. Their focus is on estimating the extent to which network attributes of banks, in combination with individual banks' balance sheet characteristics, contributed to systemic risk. Their study provides valuable evidence of the importance of network connections, but differs from our study in several ways. First, and most importantly, we study specific bilateral connections between the failure risks of correspondents and respondents.

In our model, we consider bilateral network influences that should have mattered from the perspective of liquidity risk. We find that having more respondents (which should be correlated with total deposits due to banks) positively affected the risk of closure. We also find that the failure of a correspondent (which should have reduced a respondent's access to liquidity) additionally affected the risk of failure. Das, Mitchener and Vossmeyer (2018) focus on the contribution of network risk to systemic risk, and do not model these sorts of specific influences in the same way. They measure instead each bank's importance in the network (e.g., captured by eigenvalue centrality which treats respondent and correspondent connections the same) and use that attribute to estimate the effect of network influences on failure rates.

Second, in our study, we control for location-specific differences in the riskiness of the loan portfolios of banks. We do so by including location characteristics and measures of local bank failure rates as controls, in addition to measures of bank balance sheet characteristics. We believe that doing so avoids the risk of over-estimating network liquidity risk influences. Das, Mitchener and Vossmeyer (2018) do not include similar local bank closure risk- and location-specific controls, which may affect their estimate of the contribution of network connections to systemic risk.

Finally, we restrict our sample to national banks using data from the official Office of the Comptroller of the Currency reports of their balance sheets. Das, Mitchener and Vossmeyer (2018) include in some of their estimates data for state-chartered banks as reported in Rand McNally Bankers' Directory. While Das, Mitchener and Vossmeyer (2018) focus only on the Depression and find in their robustness checks no difference in their main findings when they drop state banks, the balance sheet data for state banks reported in Rand McNally Bankers' Directory are less complete and less reliable for the pre-Depression years. Most importantly, Rand McNally Bankers' Directory only reports five balance sheet items before the mid-1920s: Paid-in Capital, Surplus, Deposits, (Loans+Discounts+Stocks+Bonds), and (Cash+Exchanges). Without total assets, deposits due to banks, or a separation of loans and discounts from stocks and bonds, we would be unable to carry out our examination of the leverage or liquid assets measures for the pre and post-Fed period. Moreover, Mitchener and Jaremski (2015) find that many states had not yet begun to report official individual balance sheets even as late as 1910, indicating that some of Rand McNally's numbers for earlier years were either missing, estimated, or obtained from communication with each bank itself. As a result, we have chosen to focus on the sample of data that is consistently measured before and during the Great Depression and contains sufficient balance sheet items to estimate the necessary regressions to identify changes in interbank risk-taking after the Fed.

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Table 1: Summary Statistics of Regression Varables

	Closed Banks (N=2049)		Surviving Banks (N=4807)		
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Difference**
Ln(Asssets) in 1929	13.68	1.19	14.00	1.16	0.318*
Loans/Assets in 1929	53.9%	14.0%	51.1%	13.5%	-0.029*
Capital/Assets in 1929	14.6%	5.8%	15.0%	5.9%	0.004*
Cash-Like Assets/Total Deposits in 1929	18.7%	9.7%	19.3%	10.2%	0.006*
Ln(Bank Age) in 1929	2.94	0.80	3.14	0.80	0.199*
Fraction of Other National Banks in County in 1929 that Closed By End of 1934	51.1%	47.8%	37.5%	42.2%	-0.136*
Ln(# of Respondents+1) in 1929	0.40	0.91	0.44	1.00	0.040*
Ln(# of Correspondents+1) in 1929	1.34	0.35	1.35	0.37	0.015*
Fraction of Correspondents in 1929 that Closed By End of 1934	32.9%	30.1%	28.6%	28.6%	-0.043*
Fraction of Correspondents in Fed Reserve Bank or Branch City in 1929	37.4%	30.0%	42.4%	29.2%	0.050*
Fraction of Correspondents That Are National Banks in 1929	78.5%	26.2%	81.1%	24.6%	0.026*

Notes: Table provides the summary stastics for the variables included in regression. Dollar values are deflated to 1929 using Officer (2008). The "Difference" column provides the mean difference between surviving and closing banks. * denotes mean differences that are statistically significant at the 10% or greater level

Table 2: Predicting National Bank Closure During Great Depression - Cross-Section (1929-1934)

	Closed Before Dec. 1934	
	(1)	(2)
Ln(Assets) in 1929	-0.104***	-0.105***
	[0.011]	[0.011]
Loans/Assets in 1929	0.269***	0.270***
	[0.053]	[0.053]
Capital/Assets in 1929	-0.423***	-0.412***
	[0.126]	[0.126]
Cash-Like Assets/Total Deposits in 1929	-0.428***	-0.426***
	[0.085]	[0.085]
Ln(Bank Age)	-0.025***	-0.024**
	[0.009]	[0.009]
Fraction of Other National Banks in County in 1929 that Closed By End of 1934	0.067***	0.067***
	[0.017]	[0.017]
Ln(# of Respondents+1) in 1929	0.030***	0.030***
	[0.009]	[0.009]
Ln(# of Correspondents+1) in 1929	0.004	0.003
	[0.021]	[0.020]
Fraction of Correspondents in 1929 that Closed By End of 1934	0.058***	0.063***
	[0.020]	[0.020]
Fraction of Correspondents in Fed Reserve Bank or Branch City in 1929		-0.013
		[0.027]
Fraction of Correspondents That Are National Banks in 1929		-0.054**
		[0.026]
State-Fixed Effects?	Yes	Yes
Fed District Fixed Effects?	Yes	Yes
Location Controls?	Yes	Yes
Observations	7,173	7,173
R-squared	0.0956	0.0967

Notes: The table presents the marginal effects from a probit regression. The dependent variable is an indicator variable either for whether the bank closed by the specified year. Each observation is a national bank in 1929. "Location Controls" includes the logarithm of county population, fraction of county population above 2,500, the logarithm of other national banks in county, and dummies for whether the bank was located in a Federal Reserve Bank city or whether the bank was located in a Federal Reserve Branch Office city. Robust standard errors clustered by county are presented in parentheses below the coefficients. Dollar values are deflated to 1929 using Officer (2008). * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 3: Predicting National Bank Closure During Great Depression - Panel (1929-1934)

	Closed During Year				
	(1)	(2)	(3)	(4)	(5)
L.Ln(Assets)	-0.244***	-0.245***	-0.228***	-0.237***	-0.249***
	[0.045]	[0.042]	[0.035]	[0.038]	[0.042]
L.Loans/Assets	0.689***	0.688***	0.704***	0.732***	0.700***
	[0.152]	[0.143]	[0.131]	[0.138]	[0.145]
L.Capital/Assets	-0.449*	-0.443*	-0.286	-0.301	-0.412
	[0.265]	[0.261]	[0.252]	[0.261]	[0.258]
L.Cash-Like Assets/Total Deposits	-1.330***	-1.335***	-1.300***	-1.331***	-1.337***
	[0.201]	[0.198]	[0.191]	[0.197]	[0.199]
Ln(Bank Age)	-0.039*	-0.039*	-0.055***	-0.055**	-0.037*
	[0.021]	[0.021]	[0.021]	[0.022]	[0.021]
Fraction of Other National Banks in County in 1929 that Closed in Year	0.724***	0.731***	0.726***	0.749***	0.714***
	[0.087]	[0.090]	[0.081]	[0.088]	[0.085]
Fraction of Other National Banks in County in 1929 that Closed in Previous Year		0.156**		0.176**	
		[0.078]		[0.078]	
Correspondents' Fraction of Other National Banks in County that Closed In Year					0.867***
					[0.170]
Ln(# of Respondents+1) in 1929	0.096***	0.096***	0.116***	0.120***	0.099***
	[0.026]	[0.025]	[0.024]	[0.026]	[0.025]
Ln(# of Correspondents+1) in 1929	0.053	0.054	0.044	0.046	0.025
	[0.041]	[0.041]	[0.041]	[0.042]	[0.041]
Fraction of 1929 Correspondents that Closed In Year	0.297***	0.297***	0.293***	0.297***	0.287**
	[0.097]	[0.096]	[0.095]	[0.098]	[0.114]
Fraction of 1929 Correspondents that Closed In Previous Year		0.002		0.010	
		[0.077]		[0.079]	
Other National Banks' Fraction of 1929 Correspondents that Closed In Year					-0.080
					[0.284]
Fraction of Correspondents in Fed Reserve Bank or Branch City in 1929			-0.080	-0.082	-0.028
			[0.055]	[0.057]	[0.054]
Fraction of Correspondents That Are National Banks in 1929			-0.118**	-0.125**	-0.169***
			[0.054]	[0.057]	[0.058]
State-Fixed Effects?	Yes	Yes	Yes	Yes	Yes
Fed District Fixed Effects?	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects?	Yes	Yes	Yes	Yes	Yes
Fed District X Year Effects?	Yes	Yes	Yes	Yes	Yes
Location Controls?	Yes	Yes	Yes	Yes	Yes
Observations	30,023	30,023	30,023	30,023	30,023

Notes: The table presents the coefficients from a probit model with random effects. The dependent variable is an indicator variable either for whether the bank closed in the following year. Each observation is a national bank in a specific year. "Location Controls" includes the logarithm of county population, fraction of county population above 2,500, the logarithm of other national banks in county, and dummies for whether the bank was located in a Federal Reserve Bank city or whether the bank was located in a Federal Reserve Branch Office city. Robust standard errors clustered by county are presented in parentheses below the coefficients. Dollar values are deflated to 1929 using Officer (2008). * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 4: Effect of Correspondent Closures on Balance Sheets of Surviving Banks (1929-1934)

	ΔLn(Assets)		ΔLn(Loans)		ΔLn(Cash-Like Assets)		ΔLn(Capital)		ΔLn(Deposits)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fraction of Local National Banks that Closed in Year	0.063***	0.063***	0.060***	0.060***	0.123***	0.113***	0.013	0.013	0.074***	0.073***
	[0.013]	[0.014]	[0.016]	[0.016]	[0.028]	[0.028]	[0.011]	[0.011]	[0.016]	[0.016]
Fraction of Local National Banks that Closed in Previous Year		-0.002		0.000		-0.048**		-0.000		-0.003
		[0.009]		[0.012]		[0.024]		[0.009]		[0.011]
Fraction of 1929 Correspondents that Closed in Year	-0.048***	-0.042**	-0.068***	-0.069***	-0.096**	-0.092**	0.001	0.003	-0.063***	-0.054***
	[0.018]	[0.018]	[0.022]	[0.023]	[0.039]	[0.039]	[0.015]	[0.015]	[0.021]	[0.021]
Fraction of 1929 Correspondents that Closed In Previous Year		0.023**		-0.002		0.014		0.006		0.029**
		[0.010]		[0.013]		[0.029]		[0.010]		[0.012]
Bank Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fed District X Year Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,605	22,605	22,605	22,605	22,605	22,605	22,605	22,605	22,605	22,605
R-squared	0.058	0.058	0.064	0.064	0.134	0.134	0.033	0.033	0.103	0.103

Notes: The table presents the marginal effects from a ordinary least squares regression. The dependent variable is specified by the column heading. Each observation is a national bank in a specific year. Only banks that were present all years from 1929 through 1934 are included. Robust standard errors clustered by county are presented in parentheses below the coefficients. Dollar values are deflated to 1929 using Officer (2008). * denotes significance at 10%; ** at 5% level and *** at 1% levels.

Table 5: Effect of Interbank Liquidity Risk on Balance Sheet Risk Before and After the Fed (1910, 1919, and 1929)

	Capital/Assets		Liquid Assets/Total Deposits	
	1910-29	**1910-19**	**1910-29**	**1910-19**
	(1)	(2)	(3)	(4)
1-15 Respondents	-0.012***	-0.008***	-0.026***	-0.021**
	[0.002]	[0.003]	[0.008]	[0.009]
1-15 Respondents * Post-Fed	0.015***	0.019***	0.024***	0.024***
	[0.002]	[0.002]	[0.008]	[0.009]
16-100 Respondents	-0.037***	-0.025***	-0.072***	-0.048**
	[0.007]	[0.008]	[0.021]	[0.020]
16-100 Respondents * Post-Fed	0.053***	0.056***	0.100***	0.102***
Fed	[0.007]	[0.006]	[0.020]	[0.020]
101+ Respondents	-0.080***	-0.062***	-0.057*	-0.038
	[0.014]	[0.017]	[0.032]	[0.039]
101+ Respondents * Post-Fed	0.089***	0.088***	0.093***	0.100***
	[0.010]	[0.010]	[0.025]	[0.026]
Due to Banks/Total Deposits	0.082***	0.041***	-0.060	-0.001
	[0.010]	[0.011]	[0.038]	[0.041]
Due to Banks/Total Deposits * Post-Fed	-0.129***	-0.138***	-0.267***	-0.310***
	[0.011]	[0.012]	[0.038]	[0.040]
Yr=1919	-0.072***	-0.071***	-0.021***	-0.019***
	[0.001]	[0.001]	[0.005]	[0.006]
Yr=1929	-0.075***		-0.025***	
	[0.002]		[0.006]	
Bank Fixed Effects?	Yes	Yes	Yes	Yes
Location Controls?	Yes	Yes	Yes	Yes
Observations	21,136	14,565	21,136	14,565
R-squared	0.562	0.660	0.043	0.060

Notes: Tables presents the results of either an OLS. Each observation is a national bank-year. The sample includes all national banks in either 1910, 1919, and 1929 or in 1910 and 1919. "Location Controls" includes the logarithm of county population. Robust standard errors clustered by county are presented in parentheses below the coefficients. * denotes significance at 10%; ** at 5% level and *** at 1% levels.