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Did Doubling Reserve Requirements Cause the 1937-38 Recession? New Evidence on the Impact of Reserve Requirements on Bank Reserve Demand and Lending

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Abstract

In 1936-37, the Federal Reserve doubled member banks' reserve requirements. Friedman and Schwartz (1963) famously argued that the doubling increased reserve demand and forced the money supply to contract, which they argued caused the recession of 1937-38. Using a new database on individual banks, we find that higher reserve requirements did not generally increase banks' reserve demand or contract lending because reserve requirements were not binding for most banks. Aggregate effects on credit supply from reserve requirement increases were therefore economically small and statistically zero.

JEL codes: E51, E58, G21, G28, N12, N22
keywords: reserve requirements, reserve demand, excess reserves, money multiplier

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1. Introduction

Today, U.S. banks have enormous holdings of reserve deposits with the Federal Reserve (Fed), all of which are "excess" reserves in the legal sense following the elimination of reserve requirements in March 2020.[1] The Fed's large-scale asset purchases during and after the financial crisis of 2007-08, and again during the Covid-19 pandemic in 2020-21, flooded the banking system with reserves. The Fed has sought to manage reserve volumes and implement monetary policy through various means, including the payment of interest on reserve balances and operation of a reverse repo facility.

The potential for excess reserves to fuel an expansion of money and credit, and possibly an acceleration of inflation, has been a concern voiced by many observers, some of whom have argued for raising reserve requirements as a means of responding to inflationary pressures, particularly in light of potential Fed reluctance to sell assets.[2] With required reserve ratios set to zero, the Fed's asset purchases created a sea of excess reserves and made reserves and Treasuries closer substitutes because reserves, per se, are not needed to satisfy any unique requirement. Some observers have also noted that by making reserves and Treasuries closer substitutes, the payment of interest on reserves has further weakened the power of open market and repo operations to affect money and credit growth at banks.[3] These arguments could potentially justify reimposing reserve requirements as a means of preventing inflation. Furthermore, some

[1] See https://www.federalreserve.gov/monetarypolicy/reservereq.htm

[2] Several commentators (e.g., Stella 2009, Calomiris 2013) argue that in a rising interest rate environment, the capital losses suffered by the Fed from sales of longer-term Treasury securities and mortgage-backed securities on its balance sheet could potentially create political problems for the Fed, both through the appearance of contributing to the government deficit (a result of accounting conventions), and through the potential effects on the prices of mortgage-backed securities. If the Fed intends to hold to maturity much of the securities it acquired recently, it could resort to using alternative tools for monetary tightening, such as paying higher interest rates on excess reserves, use of reverse repurchase agreements, or increases in reserve requirements.

[3] Bräuning (2017), Smith (2019), Belongia and Ireland (2021).

observers argue for increasing reserve requirements for prudential reasons as an alternative to the current liquidity requirements on banks which treat holdings of reserves and Treasuries as equivalent (Calomiris, Heider and Hoerova 2017).

Banks' current disposition toward holding a substantial share of their total assets as excess reserves illustrates a more general phenomenon: banks have always based their balance sheet allocations (including their excess reserves-to-assets ratios) on microeconomic tradeoffs involving risks, expected returns, and liquidity. To implement monetary policy effectively, policymakers must understand those tradeoffs, in particular the preferences that determine the demand for reserves.

An early example of dramatic swings in banks' reserve holdings was in the 1920s and 1930s. In the 1920s, liquid assets, such as cash, reserve deposits with the Fed, and Treasury securities, comprised only a small share of total U.S. bank assets. Liquid asset ratios (whether narrowly or broadly defined) grew dramatically after 1929, however, and remained elevated throughout the 1930s. Those changes reflected an increased and persistent preference of banks for holding liquid assets rather than more capital to reduce bank failure risk (Calomiris and Wilson 2004).

In setting monetary policy in the 1930s, the Federal Reserve faced the major challenge of understanding banks' apparent increased demand for reserves. Fueled by inflows of gold from abroad, U.S. bank reserves grew rapidly in the mid-1930s, and banks accumulated large stocks of reserves in excess of legal requirements. By 1936, Fed officials worried that if banks' apparent preference for a high level of excess reserves disappeared, they might then grow their deposits and loans dramatically, resulting in higher inflation or financial instability. Fed officials

considered increasing reserve requirements on the System's member banks to forestall that possibility, but they recognized that an increase in requirements could depress economic activity if it produced an immediate increase in reserve demand and a consequent contraction in money and credit. Officials understood that the impact of higher reserve requirements depended on whether the ongoing surge in excess reserves reflected a stable preference for holding liquid assets. However, after determining that most banks had sufficient excess reserves and other liquid assets to absorb a substantial increase in reserve requirements without reducing their current lending, the Federal Reserve Board decided to increase requirements, which it did in three steps on August 16, 1936, and March 1 and May 1, 1937. In total, the increases doubled the required reserve ratios on the demand and time deposits of member banks (see Table 1).[4]

Following the doubling of reserve requirements, the U.S. economy entered a serious recession. Friedman and Schwartz (1963) famously blamed the recession on the Fed's action, arguing that it increased reserve demand and thereby reduced the volume of deposits that could be built upon the existing monetary base. The Friedman and Schwartz interpretation has been widely accepted among economists, policymakers, and textbook authors (e.g., Romer, 1992, 2009; Mishkin, 1989, pp. 399-400).

Despite being the dominant view, the impact of higher reserve requirements on the ratio of reserves to deposits is hardly clear in the aggregate data. Friedman and Schwartz (1963, p. 804) focus on the ratio of deposits to reserves, which was trending downward throughout the second half of the 1930s, as shown in Figure 1. The ratio reached a local peak in June 1936,

[4] At the time, the Fed's reserve requirements applied only to the System's member banks, which consisted of all banks with federal charters (i.e., national banks) and state-chartered banks that elected to join the System. The Monetary Control Act of 1980 extended the Fed's requirements to all depository institutions, including state-chartered non-Fed member banks, savings institutions, and credit unions.

regaining its March 1935 level after having fallen to a local minimum in January 1936. It then declined from June to October 1936 but varied little from October 1936 until November 1937 (ranging between 4.93 and 5.12). The ratio was nearly constant (varying between 4.96 and 4.98) from March through June 1937, despite the reserve requirement increases on March 1 and May 1. In fact, the ratio *rose* from 4.96 in May 1937 to 5.12 in August 1937. Thus, none of the three hikes was followed by a meaningful drop in the aggregate ratio of deposits to reserves that would suggest the reserve requirement increases caused a contractionary effect upon the economy.

Although inspection of the time variation in the aggregate deposits-to-reserves ratio casts doubt on the Friedman and Schwartz (1963) contention that the doubling of reserve requirements sharply reduced the money multiplier, it is possible that the behavior of the ratio reflected a combination of shocks of which the hike in reserve requirements was just one. Thus, we must look to disaggregated evidence to discern whether higher reserve requirements increased banks' demand for reserves or reduced their lending.

To that end, this paper reports new empirical evidence on the impact of the doubling of reserve requirements in 1936-37 to test the competing views of the contemporary Fed and Friedman and Schwartz (1963). We use detailed call report data on individual banks' reserve holdings and loans in 1935 and 1937 to test directly for the first time on a nationwide basis the determinants of reserve demand in 1935 and whether banks responded to the doubling of reserve requirements by curtailing their lending.

We find no evidence of a decline in lending associated with the doubling of reserve requirements on member banks on average, though loan growth was somewhat lower among banks with greater exposure to the hike in requirements. To arrive at these findings, we construct

three nationwide matched samples of Fed member and nonmember banks (based on different matching criteria) to test for differences in loan growth from 1935 to 1937 between member and nonmember banks. We refine estimates of loan growth using additional information to control for bank-specific differences within the matched samples. In addition to comparisons of means, we also employ Abadie's (2005) stacked difference-in-difference treatment effect estimation method to test more formally for differences in loan growth. Across our various formulations and methods, we find no economically meaningful or statistically significant differences in lending on average between member banks (which were subject to the reserve requirements) and nonmember banks (which were not subject to the requirements). Higher reserve requirements reduced excess reserves and increased the level of total reserves but had smaller effects on broad measures of bank liquid assets due to substitution among different types of liquid assets.

Cross-sectionally, member banks with lower excess reserves had slower loan growth during 1935-37, suggesting there was a lending response to the hike in reserve requirements by *some* banks. However, our results suggest that the aggregate effects of higher reserve requirements on lending were small because (i) few banks were bound by reserve requirements in the sense that they could not offset an increase in required reserves by reducing other liquid assets, and (ii) banks with high levels of excess reserves tended to increase their lending which offset reduced lending by banks that were bound by reserve requirements. Thus, we conclude that the doubling of reserve requirements could not have been an economically significant cause of the recession of 1937-38 – at least not through any effect on the demand for reserves or supply of loans.[5] Although the increase in reserve requirements had little or no impact on aggregate

[5] The doubling of reserve requirements was not the only monetary policy action taken during 1936-37. As Friedman and Schwartz (1963, p. 544) acknowledge, a Treasury Department policy of sterilizing gold inflows begun in December 1936 substantially slowed the growth of bank reserves. Hanes (2006) and Irwin (2012) contend that gold sterilization was likely more important than the doubling of reserve requirements. Meltzer (2003) also ascribes an

bank lending, we find that the increase made reserves and Treasuries less substitutable and that the level of banks' reserve holdings became more correlated with bank characteristics. Our results suggest that the increase in reserve requirements gave the Fed more scope to implement monetary policy through open market operations, an objective that Fed officials had sought with the increase.

Section 2 discusses the Fed's use of reserve requirements as a monetary policy tool after 1935. Section 3 describes the construction of our nationwide matched samples of member and nonmember banks. Section 4 explains our matched sample methodology. Section 5 explains our approaches for estimating the effect of reserve requirement increases on bank lending growth (and growth in liquid asset holdings) during 1935-37 and presents our empirical findings. Section 5.1 presents our first empirical approach, where we employ the stacked difference-in-difference method of Abadie (2005) to show that member banks did not display lower loan growth than non-member banks during 1935-37. We augment those initial findings with additional evidence showing no differences in the serial correlation of loan growth between member and nonmember banks. Further, we report simple differences in the mean loan growth of members and nonmembers for 1935-37 which reveal no evidence of lower loan growth among member banks. In Section 5.2 and an appendix we pursue a second approach in which we allow cross-sectional

important role to gold sterilization. He dismisses the August 1936 increase in reserve requirements as unimportant but does see more impact from the second and third increases in 1937. Similarly, Velde (2009) attributes the monetary contraction to both the doubling of reserve requirements and gold sterilization and finds that monetary contraction was one of multiple causes of the 1937-38 recession. He argues that higher reserve requirements also reduced the demand for government and corporate debt, but had little discernable impact on aggregate bank lending, suggesting that if reserve requirement increases mattered it was not via the money multiplier channel emphasized by Friedman and Schwartz (1963). Eggertsson and Pugsley (2006) also suggest a monetary, but non-Friedman and Schwartz (1963), explanation for the recession focused on Fed and Treasury communications that they argue raised expectations of deflation. In addition to various monetary explanations, several other macroeconomic studies blame the recession on various non-monetary factors, such as tax increases (e.g., Calomiris and Hubbard 1995; McGrattan 2012) and supply shocks (e.g., Hausman 2014). The planned wind-down of the Reconstruction Finance Corporation may also have altered bank behavior during the period.

differences in banks' responses to vary with the bindingness of their preexisting reserve requirements on their reserve holdings. Our estimates and conclusions are not altered by allowing for this cross-sectional difference in responses. In Section 6, we present an analysis of narrow and broad reserve demand in 1935-37 to investigate whether the increases in reserve requirements in 1936 and 1937 reduced the substitutability between reserves and Treasuries and consider the implications of those findings for monetary policy today.

2. The Fed's Intent and the Impact of Doubling Reserve Requirements on Reserve Demand and Lending

The Banking Act of 1935, passed in August 1935, gave the Federal Reserve's Board of Governors the authority to change reserve requirements. By mid-1936, Fed officials decided to use their new authority to reduce the volume of excess reserves in the banking system and thereby limit the possibility that the ongoing rapid accumulation of reserves would fuel excessive loan growth and inflation.

Reserve requirements were the Fed's primary monetary policy tool in the mid-1930s for three main reasons. First, Fed officials believed that raising reserve requirements would lessen the potential for a *future* surge in money and credit, and hence inflation, but not contract lending or slow the economic recovery.[6] Second, the Fed sought to wrest control over monetary policy away from the Treasury, and given the size of Treasury money-creating authority relative to the Fed's portfolio of Treasury securities, open market sales could easily have been undone by

[6] Friedman and Schwartz (1963, p. 526) criticize the Fed for not waiting until the need for tightening was immediate. An argument can be made, however, that by acting in advance, the Fed made its policy more predictable, thereby injecting less uncertainty into the market. Furthermore, acting in advance avoided lags associated with identifying a surge in lending and reacting to it.

Treasury operations.[7] Third, the size of the Fed's securities portfolio was small compared with the volume of excess reserves, which further limited the scope for open market sales. At the time, the Fed was also not permitted to pay interest on reserve balances. Hence, raising required reserve ratios was the only viable option for significantly reducing excess reserves.[8]

The influences on reserve demand are many. Banks might demand reserves because they reduce liquidity risk or insolvency risk, and because they offer a less costly way of reducing those risks than raising equity capital. Friedman and Schwartz (1963) argue that the banking panics of 1930-33 caused banks to demand high levels of excess reserves, and that banks responded to the doubling of reserve requirements by contracting their lending and deposits in an effort to rebuild their excess reserves.[9] By contrast, Fed officials at the time interpreted the high levels of excess reserves as largely idle balances that could be absorbed easily without slowing the economic recovery, let alone causing a recession. Fed officials considered raising requirements as preventative, soaking up balances that could fuel a *future* rapid increase in lending and inflation without curtailing current lending.

After the first reserve requirement increase in August 1936, Federal Reserve staff studied member banks' liquid asset holdings to determine how easily banks could absorb additional increases. From the analysis, Fed officials concluded that a prospective credit boom could be averted by raising reserve requirements without causing reserve demand to rise significantly. For example, one internal Fed staff memorandum circulated in January 1937 (Goldenweiser 1937),

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[7] Meltzer (2003, Chapter 6) discusses the Treasury Department's influence on monetary policy in the 1930s that resulted from legislative changes and creation of the Exchange Stabilization Fund.

[8] Banks also rarely borrowed reserves from the Fed so raising the discount rate would have also been ineffective. Friedman and Schwartz (1963, pp. 522-23) point out that several other technical and internal political factors also favored the use of reserve requirements as a tool.

[9] Others have questioned various aspects of this view, including Frost (1971), Wilcox (1984), and Calomiris and Wilson (2004).

which served as the basis for the discussion at a January 25, 1937 meeting of the Fed's governors and Reserve Bank presidents, noted that only 61 member banks (constituting about a fifth of member bank assets) would be unable to meet the proposed further increase in requirements simply by shifting a portion of their assets from deposits held at other banks to deposits held at the Fed. Moreover, even those potentially constrained banks had additional liquid assets (mainly Treasuries) from which they could fund an increase in required reserves.[10] The memo (pp. 3-4) concluded that "[i]n acting at this time the Board can do so with the definite assurance that it will not arrest recovery which is still far from complete." The staff's main concern was that higher requirements might depress Fed membership in rural areas. The Fed reported some of these same findings in its 1937 *Annual Report* (Board of Governors 1938, pp. 4-6).

Our paper is most closely related to two recent contributions. First, Calomiris, Mason and Wheelock (2011) examine 26 mutually exclusive subsets of Fed member banks and show that the aggregate rise in the reserve-to-deposit ratio identified by Friedman and Schwartz (1963) did not occur among banks in every Federal Reserve district or class of member banks. The ratio rose in some districts but declined or remained constant in others. Calomiris, Mason and Wheelock (2011) suggest that fundamental influences affecting some banks more than others likely produced a rise in aggregate reserve demand in 1936-37 that was unrelated to the increase in reserve requirements.[11] Calomiris, Mason and Wheelock (2011) do not investigate reserve demand at the bank level, however, or test whether changes in reserve requirements affected bank lending. By contrast, Park and Van Horn (2015) use a difference-in-difference regression

[10] In Board of Governors of the Federal Reserve System (1938, p. 6), the Fed also noted that when New York City banks sold their Treasuries to meet higher reserve requirements, the Fed made open market purchases to offset the effect on Treasury yields. See also Chandler (1971), pp. 316-17.

[11] Cargill and Mayer (2006) find that, in the aggregate, member banks' reserves rose relative to those of nonmember banks, but Calomiris, Mason and Wheelock (2011) point out that there were important geographic differences between member and nonmember banks on average that can account for the aggregate difference.

approach to compare loan growth among individual Fed member and nonmember banks in New York state. They find that member banks did not reduce their lending in response to higher reserve requirements and conclude that the doubling of reserve requirements likely did not cause the recession of 1937-38.[12] Park and Van Horn's analysis, being limited to New York banks, cannot inform movements among the many banks elsewhere in the country although it augments our own analysis which excludes New York City banks, as we discuss further below.

We use detailed call report data on individual banks' reserve requirements and reserve holdings in 1935 and 1937 to estimate directly for the first time on a nationwide basis the determinants of reserve demand in 1935 and whether banks responded to the doubling of reserve requirements by curtailing their lending. We construct nationwide matched samples of Fed member and nonmember banks (based on different matching criteria) to test for differences in their loan growth from December 1935 to December 1937. We refine those estimates using additional information to control for bank-specific differences within the matched samples.

It would be hard to gauge precisely when banks became aware of the possibility that reserve requirements might be increased. Although the enabling legislation was passed in mid-1935, the first increase in reserve requirements was not announced until July 14, 1936. Of course, member banks might have gotten wind of the action before it was announced. Our approach to gauging the "treatment effect" of the three hikes in reserve requirements is to treat the interval from January 1936 through December 1937 as the treatment period, which we regard

[12] Park and Van Horn (2015) use quarterly summaries of balance sheet data from Annual Reports of the State of New York Banking Department over 1935-38 for member and nonmember banks in New York state. They focus on the impact on total loan growth, but also test for differential impacts on different types of loans and on the growth of banks' securities holdings and cash. They differentiate between New York City and other banks, and between small and large banks. They find no impact of changes in reserve requirements on bank lending, and no differential impacts between members and nonmember. However, they do find that in response to changes in reserve requirements, member banks increased their cash holdings and reduced their securities relative to nonmembers.

as a conservative assumption. This assumes, we think correctly, that banks would not have increased reserve holdings many months in advance of their effective date, in anticipation of the August 1936 increase, even if they had been aware that an increase was a possibility.

Our work examines the impact of reserve requirement changes on bank-level loan growth and reserves throughout the United States. In doing so, we estimate the extent to which reserve requirements were binding ("bindingness") on individual banks, controlling for fundamental determinants of reserves demand, and in turn estimate the impact of reserves bindingness on loan growth. Like Park and Van Horn (2015) we find no evidence that reserve requirement increases affected loan growth on average, thus casting further doubt on the view that the doubling of reserve requirements was a significant cause of the recession of 1937-38. We also show that the increase in reserve requirements reduced the substitutability of reserve deposits at the Fed and other liquid assets, which likely put the Fed in a better position to implement monetary policy through open market operations as Fed officials had sought. Thus, we conclude that raising reserve requirements was a fundamentally sound policy given the constraints on the Fed at the time.

3. Bank Reserve Measures Disaggregated by Bank Type and Location

The Banking Act of 1935 required Federal Reserve member banks to hold balances with Federal Reserve Banks to satisfy their legal reserve requirements. Vault cash and other liquid assets such as deposits at other commercial banks (correspondent balances) and Treasury securities would not satisfy reserve requirements.[13] Nonetheless, banks held substantial liquid

[13] Significant statutory changes to reserve requirements were last made under the Monetary Control Act of 1980. Since then, vault cash has counted toward legal reserve requirements. In 2008, the Fed was permitted to pay interest on reserves and has since done so.

assets other than deposits with the Fed to meet unexpected payments flows and investment opportunities, and to reduce asset risk. Banks also maintained correspondent balances with banks in major cities, especially in central reserve city banks in New York City and Chicago, to facilitate interregional payments and commercial transactions. The leading correspondent banks in those cities held substantial deposits for other banks located throughout the country (indeed throughout the world). The Fed was aware of the substitutability among different categories of reserves and cash assets. As previously noted, Fed officials estimated that most banks had sufficient excess reserves to satisfy an increase in required reserves while others could shift balances from their correspondents to the Fed. Few, if any, would have to sell securities or contract their lending.

Table 1 lists the prevailing required reserve ratios by bank location and deposit type.[14] Reserve requirements were imposed on net demand deposits and time deposits.[15] Figure 2 shows that, in the aggregate, the ratio of excess reserves to total deposits for Fed member banks fell from levels of 5 to 7 percent of total deposits before the first increase in reserve requirements to 2 and 3 percent in June 1937 and December 1937, respectively. Excess reserves increased after 1937 in part due to a reduction in reserve requirements in April 1938.

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[14] The National Bank Acts of the 1860s established three tiers of federally-chartered banks, i.e., national banks, based on their location. National banks in central reserve cities, which in the 1930s were Chicago and New York City, were subject to higher reserve requirements than banks in designated reserve cities and all other locations (which were referred to as country banks). The Federal Reserve Act established required reserve ratios for national banks, all of which were required to be Fed members, and state-chartered banks that elected to become members. The Banking Act of 1935 authorized the Federal Reserve Board to adjust required reserve ratios as it deemed appropriate.

[15] As of December 1935, net demand deposits were defined to include the demand deposits of individuals, firms, governments, and due to other banks, less deposits due from banks and cash items in the process of collection. The Banking Act of 1935 changed the reserve base and reduced aggregate required reserves. According to the November 1938 *Federal Reserve Bulletin*, "the new method of computing net demand deposits [under the Banking Act of 1935] resulted in a reduction of about $35,000,000 in required reserves of all member banks. Requirements of central reserve city banks were increased by $45,000,000, while those of country banks were reduced by $75,000,000 and those of reserve city banks taken as a whole showed a small decline." (p. 961)

Figure 3 shows semi-annual data on cumulative changes since June 1936 in various components of cash assets measured relative to total deposits. The figure reports data for all member banks and for mutually exclusive categories of member banks: country banks (non-reserve city members); reserve city member banks (reported separately by Fed District); and central reserve city member banks in New York City and Chicago. The figure shows that for most aggregates, reserve deposits at the Fed (the only component of cash assets that met statutory reserve requirements) increased relative to bank deposits over the period when reserve requirements were raised. In most cases, however, increases in reserves were offset by declines in other cash assets such that broader measures of liquidity changed little, if at all. In addition to reserves-to-deposits, the figure plots the difference between "narrow" cash assets and reserves, and the difference between "broad" cash assets and the "narrow" cash assets measure.[16] Narrow cash assets includes reserve balances, vault cash, cash items in the process of collection, and net balances due from other banks. Broad cash assets are narrow cash assets plus bank holdings of U.S. Government securities (hence the difference between the broad and narrow measures reflect banks' holdings of Treasuries). The timing of the changes in reserve requirements are indicated by vertical lines in the figure, while the evolution of broad cash assets-to-deposits is shown by the heavy black line connecting the semi-annual bars. We review these data as background and to emphasize the importance of regional heterogeneity and consider the different margins of cash asset substitution that were relevant for different banks.

As Figure 3 shows, the data for most of the aggregates exhibit an increase in reserves-to-deposits after the first increase in reserve requirements in August 1936, but there were several

[16] The data are aggregations of individual bank balance sheet reports collected as part of the Fed's supervisory role. They are comprehensive, including all member banks. To our knowledge the analysis performed here, related to Figure 3, has not been done before, although there is a related discussion in Calomiris, Mason and Wheelock (2011).

exceptions, particularly affecting reserve city banks in the Minneapolis, Chicago, St. Louis and New York Districts and central reserve city banks in Chicago. The reserves-to-deposits ratio of reserve city banks in the Boston District fell after the second reserve requirement increase. The variation across bank types and Fed districts is consistent with thinking of the ratios as reflecting fundamental demand-side influences related to differing local circumstances rather than the common treatment effect of higher reserve requirements. Regionally disaggregated measures of economic activity reveal substantial heterogeneity in economic conditions during the 1937-38 recession which likely contributed to interregional differences in reserve demand (Calomiris, Mason and Wheelock 2011).

The most sustained increases in reserves-to-deposits were among New York City central reserve city banks. From June 1936 to June 1937, reserves of New York City banks rose by $643 million and the ratio of reserves to deposits increased substantially. Those banks faced special liquidity risks associated with the increase in reserve requirements as member banks moved cash from New York City correspondents to the Fed. New York City banks alone lost some $220 million of interbank deposits between June 1936 and June 1937.

Even more importantly, Figure 3 shows that banks in all locations seem to have been able to fund any increases in reserve holdings by reducing other cash assets. Country banks, as well as reserve city banks in the Minneapolis, Boston, Kansas City, Dallas, Chicago, and Cleveland Districts, primarily funded their increases in reserves by reducing other narrow cash assets, as illustrated by the bars for (narrow cash – reserves)/deposits. Reserve city banks in the Richmond, Atlanta, San Francisco and St. Louis Districts, and New York City central reserve city banks, mainly funded increases in reserves by reducing their government bond holdings, as illustrated by the bars for (broad cash – narrow cash)/deposits. Looking at the substitution that occurred in

all the locations shown in Figure 3, the only group of banks that saw an increase in reserves not funded by other liquid assets were reserve city banks in the Philadelphia District. While this evidence is not conclusive, it is highly suggestive that one should not expect to see important changes in loan supply resulting from the increases in reserve requirements in 1936-37.

In summary, while the aggregate increase in reserves-to-deposits appears generally consistent with the Friedman and Schwartz (1963) narrative, banks responded to the increase in reserve requirements by adjusting the composition of their liquid assets without significantly changing their total cash assets-to-deposits ratios. Furthermore, the substantial variation across bank types and Fed districts in cumulative reserve changes, and the negative or zero changes in reserves observed in many cases, also run counter to the Friedman and Schwartz narrative. That evidence, combined with Park and Van Horn's (2015) microeconomic evidence for New York, is highly suggestive. However, it remains conceivable that the changes in reserve requirements affected lending at the bank level or more generally across the United States. That possibility motivates our analysis of a nationwide sample of individual banks to measure bank-specific reactions to the reserve requirement increases.

4. Matched-Pair Samples of Member and Nonmember Banks

This section describes our data and procedures for constructing three nationwide matched-pair samples of member and nonmember banks. The key challenge for constructing a nationwide sample is in finding plausible matches, given that members and nonmembers were systematically different. Membership was not a random outcome. In particular, larger banks in urban locations were more likely to choose to become members of the Federal Reserve System. At the time, most member and nonmember banks operated as unit (i.e., single location) banks,

and banks differed from one another primarily because of their locations (which implied different risk exposures, different business strategies, differences in size, etc.).

Any defensible strategy for constructing a nationwide matched sample of member and nonmembers must find a balance in dealing with two facts: On the one hand, the best matches are of member and nonmember banks located in the same town or city and of roughly similar size (given that size is relevant for the degree of loan portfolio diversification). On the other hand, it can be hard to find matches of similarly-sized banks in the same town or city because member banks were more prevalent in cities while nonmembers were more often located in small towns and rural areas, and because member banks tended to be larger than nonmember banks. Further, many member banks operating in the twelve cities with Federal Reserve Banks had very different business models than nonmember banks in those cities and member banks located elsewhere. In particular, many large member banks in Fed cities operated large correspondent networks, which complicates comparisons of member and nonmember banks of similar size in those cities.[17] For that reason, we exclude banks located in the twelve Federal Reserve Bank cities from all of our matched samples.

We collected balance sheet data from the December 1937 call reports for 500 member banks. We constructed the sample to ensure that both rural and urban areas were represented and that banks were drawn from all Fed Districts. After eliminating banks that were not present in 1933 and 1935, we were left with 458 member banks with balance sheet information from the December call reports for 1933, 1935 and 1937. For each country member bank and the remaining reserve city member banks, we then sought to identify a nonmember bank of similar

[17] Jaremski and Wheelock (2017; 2020) examine the relationship between correspondent banking networks and the location of Federal Reserve Banks.

size and location. Our analysis requires that both the member bank and its match were present in the data throughout 1933-37. We used the Calomiris-Mason (2003a,b) database to identify member banks and obtain their balance sheet information, and *Rand McNally Bankers Directories* (January 1934, 1936, and 1938) to identify nonmember banks and obtain their balance sheet information as of December 1933, December 1935, and December 1937.

If one requires that member banks and their nonmember matches be located in the same town and be of near identical size, and if one omits the twelve Federal Reserve Bank cities, the remaining matched sample is relatively small and less representative of the entire nation. Alternatively, if one matches banks across similar but not identical locations or permits matches to occur despite larger differences in size, the matched sample becomes larger and more representative of the nation as a whole. Our solution to this tradeoff is to consider various alternative matched samples (sometimes being relatively restrictive about matching, but other times allowing greater size differences between members and nonmembers or sampling similar but not identical locations). We compare average loan growth rates of member and nonmember banks in the various samples. In addition, in the appendix, we report refined matched-sample comparisons where we use estimates of the regression parameters from an analysis of only member banks to adjust for bank characteristic differences (such as remaining differences in size and balance sheet ratios) between matched member and nonmember banks. Such adjustments may be especially helpful when there are larger differences in the sizes of a member and its nonmember match.

When identifying a nonmember bank to match with each member bank we looked first for the nonmember bank in the same city with total assets in December 1935 closest to that of the

member bank.[18] In our narrowest sample (labeled Sample 1), we included only country banks in our search for matches and required that a matching nonmember bank be located in the same town or city as the member and have total assets within 40 percent of the total assets of the member bank. Based on that search criteria, we identified a sample consisting of 28 bank-pairs (i.e., 28 members and 28 nonmembers located in the same town or city with total assets within 40 percent of each other).[19] Next, we broadened our sample somewhat by allowing banks located in different towns (but in the same state) to match under the assumption that county banks located nearby to each other (even if not in the same town) would have similar business models. However, when looking outside a member bank's town for a match we required that the nonmember bank had total assets within 20 percent of the member bank's total assets. From those prospective matches, we choose as the match the nonmember country bank located closest geographically to our member country bank. When expanding the sample to include banks located in different towns, we focused exclusively on agricultural states to help ensure a homogeneous sample (i.e., matches with similar business models).[20] This procedure yielded an additional 65 matches for a total of 93 matched bank pairs in what we label Sample 2.

Finally for Sample 3 we broadened our sample to include banks located in reserve cities (other than the 12 cities with Federal Reserve Banks). For each reserve city member bank, we searched for the nonmember bank located in the same city with total assets closest to that of the member bank. If there were no nonmember banks in the same city with total assets within 40

[18] As noted previously, bank branching outside of headquarters cities was prohibited in most states in the 1930s.
[19] We excluded as potential matches non-corporate, i.e., mutual or privately-owned, banks and savings institutions, and banks that were newly chartered after 1933 or became members of the Federal Reserve System between 1935 and 1937.
[20] We define agricultural states as those where earnings from agriculture comprised at least 20 percent of total state earnings in 1935. The 23 states meeting this criterion are: AL, AR, AZ, GA, IA, ID, KS, KY, LA, MN, MS, MT, NC, ND, NE, NM, OK, SC, SD, TN, TX, WV, and WY.

percent of the member bank's total assets, we searched among nonmember banks located elsewhere in the state and selected as the match the nonmember bank located closest geographically to the member bank among those with total assets within 20 percent of the member's total assets. As before, we restricted ourselves to agricultural states when adding matches that included member and nonmember banks located in different cities. Adding these bank pairs gave us a total of 107 matches.

Table 2 reports characteristics of member and nonmember banks for the three samples, and Figures 4-6 provide maps illustrating the locations of the matched pairs for each of the three matched samples. *Rand McNally Bankers Directories* report a smaller set of bank characteristics for nonmember banks than call report data on member banks, so our comparisons reflect its reporting of bank information. Although in Samples 2 and 3 we restricted our additional matches to agricultural states where we believe matched comparisons would be more appropriate due to similarities in bank business models and risk exposures, the maps show that nevertheless we were able to construct a regionally diverse national sample of matched comparisons.

Table 2 shows that on average members and nonmembers differed along several dimensions for all three matched samples. The average loan growth rate from 1933 to 1935 was lower among member banks, but average loan growth from 1935 to 1937 was slightly higher among member banks (except for Sample 2, where the opposite was true). This suggests that controlling for differences in loan growth from 1933 to 1935 could be important (because of mean reversion) when examining loan growth from 1935 to 1937. Member banks in all three samples were also larger on average but had lower equity-to-asset ratios than their nonmember counterparts. These data all point to potential advantages from refined comparisons of mean loan

growth of members and nonmembers that control for differences in average size, loan growth during 1933-35, and equity-to-asset ratios.

5. Empirical Findings on Loan Growth

Our empirical approach employs data on reserve holdings, loans, deposits and other attributes of Fed member and nonmember banks to capture the effects of reserve requirement changes on loan growth at the individual bank level. We use balance sheet data from member bank call reports for 1933-37, and more limited balance sheet data for nonmember banks from *Rand McNally Bankers Directory*.

First, in Section 5.1, we examine the effect of reserve requirement changes on bank lending using the Abadie (2005) difference-in-difference approach to estimate the effects of the increase in reserve requirements on changes in member and nonmember bank loan growth between 1933-35 and 1935-37. Loan growth is a key variable of interest in identifying any economic effect from reserve requirement changes. If reserve requirements led banks to increase liquid assets, they would have done so by reducing loans, which would have implied a contractionary effect on the economy. By comparing changes in Fed member and nonmember banks' loan growth we are able to gauge whether the treatment effect of an increase in reserve requirements (which affected only member banks) caused member banks' loan growth to be lower than that of nonmember banks. By restricting our comparisons to matched samples, and by controlling for observable differences in member and nonmember banks, such as lagged loan growth, we believe our loan growth comparisons are a reasonable approach to identifying the treatment effect.

As a robustness check and refinement, in Section 5.2, we pursue a second approach that allows us to make additional use of data for member banks to control for bank-specific differences in the extent to which individual banks were more or less bound by their reserve requirements. We provide details and report the results from that analysis in the appendix.

5.1 Difference in Difference Regressions

Our dependent variable in the difference-in-difference analysis is the loan growth rate for 1935-37 minus loan growth rate for 1933-35 (LG 1935-37 – LG 1933-35). In applying Abadie's (2005) method, we specify a quadratic functional form (varying from quadratic either in the direction of cubic or linear does not affect our findings). We control for the two characteristics that we observe for both member and nonmember banks: capital-to-assets, and (log of) total assets.

We report two regression estimates of the treatment effect. Column (1) of Table 3 reports the result for our largest matched sample of member and nonmember banks. Given that our list of observable control variables is limited to log(assets) and capital-to-assets, a matched sample is appealing because it is likely to control for unobservable differences that are specific to the locations of the matched pairs. Column (2) reports the estimated treatment effect when we include in our sample all other member banks for which we initially obtained data (not just those with a matched nonmember bank). Both estimates of the treatment effect of the reserve requirement changes on loan growth are small, positive (implying a higher growth rate for member banks, contrary to the hypothesis that reserve requirements reduced loan growth for members), and statistically insignificant from zero. Hence, the findings indicate no statistically

significant or economically meaningful differences in loan growth between member and nonmember banks during the treatment period, 1935-37.

The Abadie (2005) methodology is designed to ensure that difference-in-difference estimates are not driven by differences in pre-trends across treated and control samples. We also performed additional tests to see whether the serial dependence in loan growth was similar for member and nonmember banks. Table 4 reports two regressions for loan growth over 1935-37: column (1) for members and column (2) for nonmembers. We include loan growth over the period 1933-35 in the regression as well as the two controls (capital-to-assets and log of assets). The coefficients on lagged loan growth are both very small, positive, and statistically insignificantly different from zero, suggesting that loan growth during 1935-37 was uncorrelated with loan growth during 1933-35 for both member and nonmember banks. This implies that differences in pre-trends in loan growth were not likely to have been important influences on loan growth for either members or nonmembers in 1935-37.

Given evidence of a lack of serial dependence in loan growth, it is useful to note that simple comparisons between members and nonmembers of loan growth in 1935-37 (shown in Table 2) confirm the results from the Abadie (2005) methodology. The differences in loan growth between comparable members and nonmembers are small for each of the three matched samples, and in two of the three matched samples (samples 1 and 3), average loan growth among member banks slightly exceeded that of nonmembers, while in sample 2 member bank loan growth was only slightly lower (0.094 compared to 0.106). This further corroborates that member bank loan growth was not generally lower than that of nonmember banks during 1935-37. In formal tests for differences in mean loan growth between members and nonmembers, we

find that the small differences in means are never close to statistically significant (although, given the sample sizes, these are low-power tests).

5.2 Controlling for Differences in the Bindingness of Reserve Requirements

Although our matching criteria guarantee that pairs of banks will be similar in location and size, such matches are never perfect, and remaining differences could affect measured loan growth rate differences between member and nonmember banks. It would be desirable to control as much as possible for those remaining differences in bank characteristics when estimating the difference in loan growth due to the reserve requirement increase. Accordingly, we refined our estimates by taking account of differences across member banks in the extent to which reserve requirements were binding on them. We briefly describe our approach and results here, and present full details and results in the appendix.

Our refinement posits that member banks were not identical in their exposure to the treatment effect. As the Fed's 1936 survey of its members indicated, some banks happened to have high levels of excess reserves when reserve requirements were increased and thus were less exposed to the increase. Ideally, exposure to the regulatory shock should be measured as the quantity of excess reserves the member bank held at the time of the shock less the quantity of excess reserves that the bank's fundamentals warranted. We find that member banks differed cross-sectionally in their exposure to the hike in reserve requirements, and so we construct refined matched sample comparisons that take those differences (as well as size and other observable characteristic differences) into account. Controlling for those differences should make our estimate of the average treatment effect more accurate.

To refine our matched sample estimates we use regressions to estimate adjustment factors for each member and nonmember bank that reflect its particular characteristics. We first use a forecasting model to estimate the "warranted" ratio of excess reserves-to-total reserves in December 1935 for member banks. We estimate this model because we hypothesize that excess reserves of a given amount are not equally beneficial to all banks. Desired excess reserve ratios will likely differ across banks because they face different liquidity risks and other attributes. Those with greater liquidity risks, for example, might be relatively reluctant to reduce their excess reserve ratios, and thus more inclined to contract loan supply, in response to a reserve requirement increase. We use the regression residuals to measure the degree of "bindingness" of the legal reserve constraint, i.e., the difference between the actual excess reserves ratio observed in 1935 and the warranted ratio we estimate as a function of bank attributes. The "bindingness" of reserve requirements is assumed to be greater for banks with smaller (positive) differences between actual excess reserve ratios and warranted ratios.

Our forecasting model predicts a bank's excess reserve ratio in 1935 from its loan growth rate from 1933 to 1935, its asset size (log of total assets), equity-to-assets ratio, ratio of demand deposits to total deposits,[21] whether it was a national bank rather than a state-chartered member bank, whether it was a reserve city or central reserve city bank rather than a country bank, and its Federal Reserve district. We take each of these as reflecting fundamental bank attributes that could forecast a higher or lower excess reserves ratio in December 1935. Note that these variables are not all plausibly exogenous to the choice of holding excess reserves, but they are still valid as predictors of excess reserve ratios.

[21] Our demand deposits measure is the sum of demand deposits of individuals (i.e., households, firms and state and local governments), net interbank deposits, and U.S. Government deposits, less cash items in the process of collection. It is the net demand deposit aggregate to which the required reserve ratio applied.

Next, we estimated a loan growth regression for 1935-37 for member banks that includes the difference between a bank's excess reserve ratio and an estimate of its warranted ratio. Estimation of this regression indicates that bank loan growth from 1935 to 1937 was positively (and statistically significantly) related to the difference between the actual and warranted excess reserve ratio in 1935.

Finally, for each of our three matched samples, we refine estimates of loan growth from 1935 to 1937 for both member and nonmember banks. As previously noted, mean loan growth during this period was higher among member banks than nonmember banks in Samples 1 and 3. In Sample 2, nonmember banks grew slightly faster on average (10.6 percent compared with 9.4 percent for member banks), but that difference is not statistically significant. Further, as noted in our comparison of member and nonmember bank characteristics, differences exist in average size, average loan growth from 1933 to 1935, and average equity-to-asset ratios. Thus, we used the coefficient estimates from the loan growth regression to produce refined loan growth rates for 1935-37 for member and nonmember banks in each of our three matched samples under the assumption that regression coefficient estimates from the member bank sample are similarly useful for adjusting for cross-sectional differences in the characteristics of both members and nonmembers. We also allow member banks' idiosyncratic differences in excess reserve slack to affect their loan growth. The means and standard deviations of the refined loan growth rates are reported in the appendix. As with the simple means reported in Table 2, the mean refined loan growth rates for member banks were higher than those of nonmember banks in Samples 1 and 3, and essentially identical to that of nonmembers in Sample 2. Thus, supporting the simple comparisons of mean loan growth reported in Table 2 and results from the difference-in-

difference regressions reported in Table 3, the refined estimates reveal no evidence of lower mean loan growth among member banks.

6. Restoring Potency to Monetary Policy When Reserves are not Scarce

We conclude that the Fed was correct to believe that raising reserve requirements would reduce excess reserve slack but have little impact on near-term loan growth. Fed officials determined that most banks could meet the new requirements out of existing excess reserves or by reducing balances held with correspondents. Others could sell Treasury securities and thereby obtain some of the excess reserves of other banks. In the event, sales of Treasuries were modest and largely offset by Fed purchases. The Fed purchased approximately $100 million of Treasury securities in April 1937, at least partly in response to pressure from the Treasury Secretary (Calomiris and Wheelock 1998). Yields on Treasury securities rose only modestly, with yields on Treasury bills, for example, rising from around 30 basis points in January 1937 to a peak of 74 basis points in the first week of May before falling back to average some 40-60 basis points over the remainder of 1937. Over the same period, yields on long-term U.S. Government bonds, which were approximately 2.50 percent at the beginning of 1937, rose to 2.80 percent in April and May and ranged between 2.60 and 2.80 percent throughout the remainder of 1937.[22]

Although the announcement of higher reserve requirements might have affected market outcomes in other ways, as we note in the introduction, we find no evidence that the doubling of reserve requirements increased banks' demand for liquid assets (relative to deposits) or curtailed their lending. We also believe that the logic of the Fed's increase in reserve requirements – to increase the potency of future monetary policy by reducing the substitutability between reserves

[22] Board of Governors of the Federal Reserve System (1943, p. 461 and p. 473).

and other cash assets on the margin – was sound. As recent research (e.g., Bräuning 2017, Smith 2019, Belongia and Ireland 2021) has argued, the impact of open market operations on Treasury yields, deposit creation, and bank lending may be limited if Treasuries and reserves are close substitutes on the margin. From that perspective, one can see the Fed's decision to hike reserve requirements as increasing the power of monetary policy by reducing the substitutability between reserves and other cash assets. Before reserve requirements were raised, most banks faced little risk of a shortfall in their required reserves, and so, on the margin, reserves and Treasuries were close substitutes. But after reserve requirements were hiked, and excess reserve ratios fell correspondingly, more banks had to be concerned about maintaining their excess reserve balances, which might have made them less willing to supply reserves elastically in exchange for Treasuries.

By reducing the substitutability of reserves and Treasuries, the demand for reserves became more closely linked to bank fundamentals. This can be corroborated by comparing the *change* in the *relative* "goodness of fit" of models of reserve demand (i.e., deposits at the Fed) and broad liquid asset demand (which, in addition to reserves, also includes cash assets such as interbank deposits and Treasuries) in 1935 and 1937. We estimate reduced-form regressions of reserves/assets and a broad measure of liquid assets/assets in 1935 and 1937 on lagged loan growth, (log of) total assets, demand deposits/total deposits, capital/assets, and indicator variables for national banks, reserve city banks, and Federal Reserve district. The regressions are estimated on the Federal Reserve member banks for which we have data throughout 1933-37 (472 observations for 1937 and 458 observations for 1935). Table 5 reports sample statistics for these data and Table 6 reports regression estimates.

Our approach is in the spirit of Barnett (1982), which argues that simple sum aggregation (such as creating a measure of M2 combining deposits and cash) is inferior to weighted sum aggregation (such as a Divisia quantity index) unless the components of the sum are perfect substitutes. Barnett shows that traditional aggregates fail the perfect substitutes test by comparing their forecasting performance with Divisia measures. Similarly, when reserves and other cash assets are close substitutes (as we hypothesize they were in 1935), then broad measures of cash assets should be more closely related to the determinants of reserve demand than narrower measures.[23] And, when increases in reserve requirements reduce the substitutability between reserves and other cash assets, broad measures of liquid assets should become less closely related to the fundamental determinants of reserve demand while narrower measures should become more closely related to them.

Our focus is on the change in the relative R^2 of regressions of reserves and broad cash assets. Changes in the variance of the error term can cause R^2 to rise or fall over time, but not cause a change in relative R^2. Shown in Table 6, in 1935, the adjusted R^2 was only 0.169 for the reserve demand regression (with bank reserves held at the Fed relative to total bank assets as the dependent variable), but in 1937, the adjusted R^2 for reserves/assets rises to 0.506. In 1935, the adjusted R^2 for a broad cash assets/total assets regression is 0.408, but in 1937, the adjusted R^2 falls to 0.305. Similar patterns are apparent if we use total deposits rather than total assets in the denominators of the dependent variables.[24] Thus, the relative goodness of fit between

[23] We do not follow Barnett (1982) by constructing an alternative Divisia index of bank liquid assets both because we lack the data to do so (e.g., interest rates on interbank deposits) and because it is not obvious that it would be appropriate to use Barnett's method of constructing an ideal index to weight components of cash assets held by banks using their yields. Reserves are held only by banks, but Treasuries are held by the public and banks. It is not clear that banks are the marginal investor in Treasuries. They could be at a corner solution, where the relative yields are not equal to their relative value to bank holders.

[24] In 1935, the R^2 is only 0.132 for a narrow reserve demand regression (with bank reserves held at the Fed relative to total bank deposits as the dependent variable), but in 1937, the R^2 for reserves at the Fed/deposits rises to 0.419. In 1935, the R^2 for a broad cash assets/deposits regression is 0.218, but in 1937, the R^2 falls to 0.175.

fundamental variables and the demand for reserves at the Fed increased both absolutely and relative to the fit for broad cash assets, suggesting that reserves and other cash assets, such as Treasuries, were less substitutable after the doubling of reserve requirements.

From a similar perspective, it is also interesting to examine the magnitude and precision of the coefficient estimates in the four regressions in Table 6. The variables that are associated only with fundamental (rather than regulatory) influences on the demand for cash assets, i.e., equity-to-assets, loan growth rate 1933-35, and asset size tend to be statistically significant more often in the broad cash asset regressions (for both 1935 and 1937). For example, the coefficient on the ratio of equity to assets (which many authors have found to negatively covary with the cash-to-assets ratio) is negative and significant in the broad cash asset regressions but is only marginally significant in the reserves regressions for either 1935 or 1937. Similarly, loan growth from 1933 to 1935 enters negatively in both broad cash asset regressions. It enters in the 1935 reserves regression (but not the 1937 regression) with a much smaller and less statistically significant coefficient than in the broad cash asset regression for 1935. Bank size enters positively only in the two broad cash asset regressions.[25] Federal Reserve district location did not affect a bank's regulatory requirements but could have been correlated with local economic conditions that should matter for risk. Federal Reserve district dummies are much more significant in the broad cash asset regressions, and to the extent that a few of them are statistically significant in the reserves regression, it is only the case for the regression for 1937.

By contrast, variables such as whether the bank is a national bank, whether it is a reserve city or central reserve city bank, and the bank's ratio of demand deposits to total deposits – the

[25] We expected size to enter negatively, given the economies of scale in managing liquidity and portfolio risk. We interpret our contrary finding as reflecting systematic differences in bank business models (and therefore higher risks) that are positively correlated with size.

list of characteristics that can be interpreted as reflecting regulatory requirement treatment differences or fundamental influences correlated with those regulatory treatment differences – enter significantly in the reserves regressions (and sometimes in both the reserves and broader cash assets regressions).

Interestingly, the coefficient on demand deposit share is positive and highly statistically significant in all four regressions. The fact that it is significant in the reserves regressions is not surprising given that reserve requirements were higher for demand deposits than time deposits. But the variable has a similar magnitude and statistical significance for the broad cash assets regressions. Indeed, for 1935, the coefficient estimate is a bit larger (0.189) than in the reserve regression (0.130). This suggests that liquidity risk from demand deposits of individuals was relatively high. This fact also informs our discussion of excess reserve ratios and analysis reported in the appendix, where we find a significant negative effect on excess reserves from the demand deposit share. The evidence here indicates that the reserve requirement on demand deposits was likely higher than what was warranted by their relative liquidity.

In summary, our regression findings for cash asset demand are consistent with the hypothesis that banks were mainly targeting broad liquidity in 1935 and viewed cash and Treasuries as close substitutes. After the Fed increased reserve requirements, however, the demand for reserves became more closely reflective of the need to satisfy a regulatory requirement, implying that the Fed was correct to believe that the reserve requirement increases would leave it better positioned to influence bank balance sheets by varying the supply of reserves than it had been before.

Today, banks face no reserve requirements and possess large amounts of reserves and Treasuries, and those assets are close substitutes. The close substitutability of reserves and Treasuries could hamper monetary policy implementation to control inflation, requiring a larger open market sale to have a desired policy impact than in an environment where the substitutability of reserves and Treasuries was less. As reserves are withdrawn, banks will hold more Treasuries with relatively little effect on Treasury yields or potentially on deposit creation and lending. This implies that a massive amount of open market sales (or repo lending) might be required to deal with a surge in inflation. Some observers note that the Fed could raise the rate of interest paid on reserves substantially as an alternative means of combatting inflation. However, doing so could significantly reduce the Fed's remittances to the Treasury, and perhaps even result in accounting losses that would erode the Fed's capital and cause it political difficulties.[26] There are also inherent limitations to using high interest rates on reserves to contract lending. For example, if the Fed raised interest rates on reserves to very high levels, banks might substitute entirely away from Treasuries and, at this corner solution, the interest rate paid to banks on reserves could substantially exceed market interest rates paid to holders of Treasuries, which is not allowed under the statute that authorized the payment of interest on reserves.

Still another approach that has not been taken (so far) is for the Fed to restore the scarcity of reserves by reimposing reserve requirements. The findings in Table 6 suggest that raising reserve requirements in the mid-1930s reduced the substitutability between reserves and Treasuries. This likely enhanced the Fed's ability to implement monetary policy using

[26] When it released the System's income and expense data for 2022, the Federal Reserve Board announced that most Reserve Banks had experienced accounting losses since September and were accumulating a deferred asset (Federal Reserve Board - Federal Reserve Board announces Reserve Bank income and expense data and transfers to the Treasury for 2022).

conventional tools, i.e., open market operations, by increasing the impact of a given volume of open market operations on Treasury yields, bank deposit creation and lending. Conceivably, reserve requirements could be reinstated today while continuing to pay interest on reserves to avoid creating a new tax on banks (say, by paying at a constant difference of a few basis points below the repo rate). The experience of the 1930s suggests that at least in some circumstances, reserve requirements can be used effectively in the implementation of monetary policy.

References

Abadie, A. (2005). "Semiparametric Difference-in-Differences Estimators," *Review of Economic Studies* 72, pp. 1-19.

Barnett, William A. (1982). "The Optimal Level of Monetary Aggregation," *Journal of Money, Credit and Banking* 14 (4), pp. 687-710.

Belongia, Michael T., and Peter N. Ireland (2021). "The Transmission of Monetary Policy Shocks Through the Markets for Reserves and Money," Working Paper, Boston College.

Board of Governors of the Federal Reserve System (1938). Twenty-fourth Annual Report of the Board of Governors of the Federal Reserve System. Washington, D.C.: Board of Governors.

Board of Governors of the Federal Reserve System (1943). *Banking and Monetary Statistics, 1914-1941*. Washington, D.C.: Board of Governors.

Bräuning, Falk (2017). "The Liquidity Effect of the Federal Reserve's Balance Sheet Reduction on Short-Term Interest Rates," *Current Policy Perspectives* 18 (1), Federal Reserve Bank of Boston, October, pp. 1-19.

Calomiris, Charles W. (2013). "Volatile Times and Persistent Conceptual Errors: U.S. Monetary Policy 1914-1951," in *The Origins, History and Future of the Federal Reserve: A Return to Jekyll Island*, edited by Michael Bordo and William Roberds, Cambridge University Press, pp. 166-218.

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

Calomiris, Charles W., Florian Heider and Marie Hoerova (2017). "A Theory of Bank Liquidity Requirements," Working Paper.

Calomiris, Charles W., and R. Glenn Hubbard (1995). "Internal Finance and Investment: Evidence from the Undistributed Profits Tax of 1936-1937," *Journal of Business* 68, October 1995, pp. 443-87.

Calomiris, Charles W., Matthew Jaremski, and David C. Wheelock (2022). "Interbank Connections, Contagion and Bank Distress in the Great Depression," *Journal of Financial Intermediation* 51, July 2022.

Calomiris, Charles W., and Charles M. Kahn (1991). "The Role of Demandable Debt in Structuring Optimal Banking Arrangements," *American Economic Review* 81 (3), pp. 497-513.

Calomiris, Charles W., and Joseph R. Mason (2003a). "Fundamentals, Panics and Bank Distress During the Depression," *American Economic Review* 93 (5), pp. 1615-47.

Calomiris, Charles W., and Joseph R. Mason (2003b). "Consequences of Bank Distress During the Great Depression," *American Economic Review* 93 (3), pp. 937-47.

Calomiris, Charles W., Joseph R. Mason and David C. Wheelock (2011). "Did Doubling Reserve Requirements Cause the Recession of 1937-1938? A Microeconomic Approach." NBER working paper 16688, January 2011.

Calomiris, Charles W., and David C. Wheelock (1998). "Was the Great Depression a Watershed for American Monetary Policy?" in *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century*, edited by M.D. Bordo, C. Goldin, and E.N. White, Chicago: University of Chicago Press, pp. 23-65.

Calomiris, Charles W., and Berry Wilson (2004). "Bank Capital and Portfolio Management: The 1930s 'Capital Crunch' and Scramble to Shed Risk," *Journal of Business* 77 (2), pp. 421-56.

Cargill, Thomas F. and Thomas Mayer (2006). "The Effect of Changes in Reserve Requirements During the 1930s: The Evidence from Nonmember Banks." *Journal of Economic History* 66 (2), June, pp. 417-32.

Chandler, Lester V. (1971). *American Monetary Policy 1928-1941*. New York: Harper and Row.

Efron, Bradley and Robert J. Tibshirani (1993). *An Introduction to the Bootstrap*. Dordrecht: Springer Science.

Eggertsson, Gauti B. and Benjamin Pugsley (2006). "The Mistake of 1931: A General Equilibrium Analysis." *Monetary and Economic Studies*, December, pp. 1-58.

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

Frost, Peter A. (1971). "Banks' Demand for Excess Reserves." *Journal of Political Economy* 79 (4), July, pp. 805-25.

Goldenweiser, E. A. (1937). "Member Bank Reserves." Board of Governors of the Federal Reserve System, Division of Research and Statistics memo, January 14, 1937.

Hanes, Christopher (2006). "The Liquidity Trap and U.S. Interest Rates in the 1930s." *Journal of Money, Credit, and Banking* 38 (1), February, pp. 163-94.

Hausman, Joshua K. (2014). "What was Bad for GM was Bad for America: The Automobile Industry and the 1937-38 Recession." Working paper.

Irwin, Douglas A. (2012). "Gold Sterilization and the Recession of 1937-1938." *Financial History Review* 19 (3), December, pp. 249-67.

Jaremski, Matthew and David C. Wheelock (2017). "Banker Preferences, Interbank Connections, and the Enduring Structure of the Federal Reserve System." *Explorations in Economic History* 66, October 2017, pp. 21-43.

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

McGrattan, Ellen R. (2012). "Capital Taxation During the U.S. Great Depression." *Quarterly Journal of Economics* 127 (3), pp. 1515-50.

Meltzer, Allan H. (2003). *A History of the Federal Reserve, Volume 1: 1913-1951*. Chicago: University of Chicago Press.

Mishkin, Frederic S. (1989). *The Economics of Money, Banking, and Financial Markets*. Second edition. Glenview, IL.

Park, Haelim and Patrick Van Horn (2015). "Did the Reserve Requirement Increases of 1936-37 Reduce Bank Lending? Evidence from a Quasi-Experiment." *Journal of Money, Credit and Banking* 47 (5), August 2015, pp. 791-818.

Ramirez, Carlos D., and Wayne Zandbergen (2014). "Anatomy of Bank Contagion: Evidence from Helena, Montana During the Panic of 1893," George Mason University Working Paper.

Romer, Christina (1992). "What Ended the Great Depression?" *Journal of Economic History* 52 (4), December, pp. 757-84.

Romer, Christina (2009). "The Lessons of 1937," *The Economist*, June 18.

Smith, A. Lee (2019). "Do Changes in Reserve Balances Still Influence the Federal Funds Rate?" *Economic Review*, Federal Reserve Bank of Kansas City, pp. 5-34.

Stella, Peter (2009). "The Federal Reserve Balance Sheet: What Happened and Why it Matters," IMF Working Paper WP/09/120.

Velde, François (2009). "The Recession of 1937—A Cautionary Tale." *Economic Perspectives*, Federal Reserve Bank of Chicago, Fourth Quarter, pp. 16-37.

Wilcox, James A. (1984). "Excess Reserves in the Great Depression." NBER working paper no. 1374.

Appendix

This appendix describes in detail our refined loan growth measures for member and nonmember banks and comparisons of means of those measures for each of our three matched samples. Our refined measures combine the advantages of a matched sample with the advantages of a regression. In our application, the information we derive from the matched sample calculations and the information we derive from the regressions are complementary. Our regressions provide useful information for refining the matched sample estimates, but they cannot be used as an alternative means of capturing the average treatment effect. This reflects data limitations for nonmember banks. Our regression analysis is performed only on member banks, for which we have rich data on which to base estimates of reserve demand. We employ the matched sample approach to gauge the average treatment effect of the increase in reserve requirements but use coefficient estimates from regressions estimated using data for member banks to refine the matched sample calculations of the average treatment effect. Using the coefficient estimates to adjust for both member and nonmember banks requires us to assume that bank asset size, for example, covaries with loan growth for member and nonmember banks similarly, *ceteris paribus*.

Assuming initially, for simplicity, that member and nonmember banks differ in no other ways, and allowing for the possibility that member bank treatment effects may contain both a common (average) exposure to the treatment and an idiosyncratic bank-specific exposure, the matched sample comparison of loan growth can be written as:

$$ALG(NM) - ALG(M) = T + \Sigma I_i / N \qquad (1)$$

where ALG(NM) is the average loan growth rate of nonmember banks from December 1935 to December 1937, ALG(M) is the average loan growth rate of member banks over that same period, T is the average treatment effect of the reserve requirement increase on member banks, I_i is the idiosyncratic treatment effect component of the reserve requirement increase for each member bank (after taking into account its average, T)[27], N is the number of member banks, and Σ is the summation of the N observations of I_i . We assume that bank-specific variation in treatment is captured by the following characteristic:

$$I_i = z\,[(\text{ExcRes/TR})_{i,1935} - (\text{WarrentedExcRes/TR})_{i,1935}], \qquad (2)$$

where z is a parameter to be estimated, ExcRes/TR is observed excess reserves/total reserves in December 1935, and WarrentedExcRes/TR is the "warranted" excess reserves/total reserves ratio as of December 1935. WarrentedExcRes/TR is the predicted value derived from a cross-sectional regression that predicts a bank's excess reserves ratio from fundamentals. Excess reserves are defined as reserves in excess of the legal requirement just prior to the treatment effect (i.e., in December 1935, reflecting the annual year-end frequency of our data). The coefficient z is estimated from the following second OLS regression:

$$LG\,(M)_i = \alpha + \beta X_i + z\,[(\text{ExcRes/TR})_{i,1935} - (\text{WarrentedExcRes/TR})_{i,1935}], \qquad (3)$$

where $LG\,(M)_i$ is the loan growth rate of member bank (M_i) over the period December 1935 to December 1937, α is the constant term in the regression, β is a vector of coefficient estimates, and X_i is a vector of exogenous control variables relevant for loan growth over the period

[27] Note that for the entire sample of member banks, $\Sigma\, I_i / N = 0$ by construction. But for subsamples of matched pairs, it can deviate from zero.

December 1935 to December 1937. Note that T will be present in the estimate of α, but it cannot be derived from an estimate of α. We derive our estimate of T below.

An estimate of T can be derived from a refined matched sample calculation by combining the information in equations (1), (2) and (3) as follows:

$$T = ALG(NM) - ALG(M) - 1/N \{\Sigma z [(ExcRes/TR)_{i,1935} - (WarrentedExcRes/TR)_{i,1935}]\} \quad (4)$$

where $ALG(M) = (1/N) \Sigma LG(M)_i$. For simplicity, when writing equation (1), we assumed that the member and nonmember banks' observable balance sheet characteristics are identical. We now relax that assumption and further refine the matched sample calculation by correcting for any differences in the X_i observables of member and nonmember banks by rewriting equation (1) as follows:

$$ALG(NM) - ALG(M) = T + \Sigma T_i/N + \beta \Sigma X_j/N - \beta \Sigma X_i/N, \quad (1)'$$

where j indexes nonmember banks and the estimated β is used to adjust for member and nonmember bank characteristics (such as size). The coefficient β is estimated from a loan growth (1935-1937) cross-sectional regression (equation (3)) using the member bank sample. This implies the following reformulation of equation (4), from which we arrive at an estimate of T, the average effect of reserve requirement changes on bank lending:

$$T = ALG(NM) - ALG(M) - 1/N \{\Sigma z [(ExcRes/TR)_{i,1935} - (WarrentedExcRes/TR)_{i,1935}]\}$$

$$- \beta \Sigma X_j/N + \beta \Sigma X_i/N \quad (4)'$$

In our analysis, we construct matched samples of member and nonmember banks in various ways and estimate models of both the demand for reserves in 1935

(WarrentedExcRes/TR) and loan growth rates from 1935 to 1937. We report those models below, where we show that our finding that reserve requirements had no discernible average treatment effect on loan growth is robust to various sample choices and calculation methods. Our estimate of T is always statistically zero, and in two of three matched comparisons the difference is slightly positive, i.e., that on average member bank loan growth *exceeded* comparable nonmember bank loan growth, which is contrary to the hypothesis that the doubling of reserve requirements should have reduced member bank loan growth relative to that of nonmember banks. Hence, we conclude that the doubling had no economically or statistically significant effect on aggregate loan growth.

Our main variable of interest for gauging the economic consequences of the treatment effect T, i.e., the doubling of reserve requirements, is the difference between the loan growth rates of member and matched nonmember banks during 1935-37. We also examine changes in banks' other cash asset holdings (the buffer of correspondent balances and Treasuries that banks could use to accumulate more reserve deposits at the Fed without having to shrink their lending). We expect this variable to be more responsive than loans to T because it could act as a buffer to avoid having to adjust loan growth.

As described above, we first use a forecasting model to estimate the "warranted" ratio of excess reserves-to-total reserves in December 1935 for member banks. We use that estimate to measure the degree of "bindingness" of the legal reserve constraint, i.e., the difference between the actual excess reserves ratio observed in 1935 and the warranted ratio we estimate as a function of bank attributes. The "bindingness" of reserve requirements is assumed to be greater for banks with smaller (positive) differences between actual excess reserve ratios and warranted ratios. We estimate this model because we hypothesize that excess reserves of a given amount

are not equally beneficial to all banks. Desired excess reserve ratios will likely differ across banks because they face different liquidity risks and other attributes. Those with greater liquidity risks, for example, might be relatively reluctant to reduce their excess reserve ratios, and thus more inclined to contract loan supply, in response to a reserve requirement increase. That is why we measure the degree of bindingness of excess reserves with $[(\text{ExcRes/TR})_{i,1935} - (\text{WarrentedExcRes/TR})_{i,1935}]$ rather than simply $(\text{ExcRes/TR})_{i,1935}$.[28]

Our forecasting model predicts a bank's excess reserve ratio in 1935 from its loan growth rate from 1933 to 1935, its asset size (log of total assets), equity-to-assets ratio, ratio of demand deposits to total deposits,[29] whether it was a national bank rather than a state-chartered member bank, whether it was a reserve city or central reserve city bank rather than a country bank, and its Federal Reserve district. We take each of these as reflecting fundamental bank attributes that could forecast a higher or lower excess reserve ratio in December 1935. Note that these variables are not all plausibly exogenous to the choice of holding excess reserves, but they are still valid as predictors of excess reserve ratios.

Our second stage regressions include the same variables (except the ratio of demand deposits to total deposits, given the possibility of a mechanical relationship between demand deposits and loans that results from the fact that banks lend by crediting demand deposits to the borrower) plus the residual from the first regression. Table A1 reports summary statistics for the variables in the first regression, which was estimated using data from the Calomiris-Mason

[28] In results not reported here, as an alternative measure of bindingness in the second-step regression for loan growth from 1935 to 1937, we substituted the ratio of excess reserves to total reserves in 1935 for the difference between actual and warranted reserves. The coefficient estimate was 0.07, which is the same as the coefficient on our preferred measure of bindingness (the actual less warranted excess reserve ratio) reported in Table 6.

[29] Our demand deposits measure is the sum of demand deposits of individuals (i.e., households, firms and state and local governments), net interbank deposits, and U.S. Government deposits, less cash items in the process of collection. It is the net demand deposit aggregate to which the required reserve ratio applied.

(2003a,b) database for all 5426 member banks operating in 1933-35, and Table A2 reports statistics for the variables in the second regressions which were estimated using data for the sample of 458 member banks with data for 1933, 1935, and 1937 described previously.

In the first column of Table A3, labeled ExcRes/TR 1935, we report the regression results for the ratio of excess reserves to total reserves in 1935. Many of the variables are highly statistically and economically significant, and adjusted R^2 is non-trivial (.106). We hesitate to interpret the signs of these coefficients because this is not a structural model, and our framework does not depend on any particular interpretation of the coefficients. We offer the following observations, however, with those important caveats in mind. Banks with larger assets should be able to diversify better both portfolio risk and deposit withdrawal risk, implying a negative coefficient, which is what we observe. Our finding that deposit mix matters (and that more demand deposits lead to lower excess reserves) can be interpreted in two ways. First, it might be that reserve requirements were set excessively high for demand deposits compared with the true liquidity risk attendant to issuing them, which encouraged banks to hold fewer excess reserves against them. Alternatively, one could view this result as confirming studies finding that time deposits (which were withdrawable prior to maturity) could be a greater source of liquidity risk than demand deposits. For example, Ramirez and Zandbergen (2014) in their study of Montana banks in the 1890s found that time deposits were a more important source of liquidity risk during bank runs than demand deposits. However, when demand deposits are defined to include interbank deposits, that is unlikely to still be true. Many authors have pointed to interbank deposits (which are part of our demand deposit measure) as particularly important for liquidity risk (e.g., Calomiris and Kahn 1991, Calomiris and Carlson 2017, Calomiris, Jaremski and Wheelock 2022). We provide additional evidence in Section 6 in favor of the former

interpretation, i.e., that required reserves on demand deposits may have been higher than warranted by their fundamental liquidity risk.

We also find that national banks and banks in reserve cities had lower excess reserve ratios, *ceteris paribus*. This suggests that fundamental liquidity risks were lower for those banks or that the requirements they faced were excessive relative their fundamental liquidity risks (when compared to other banks). Reserve ratios also varied significantly across Fed districts, likely reflecting differences in location-specific risks and economic conditions.[30]

The difference between a bank's actual ExcRes/TR_35 and its predicted value WarrentedExcRes/TR_35 appears as a regressor in the analysis of loan growth from 1935 to 1937 in the regression labeled LG 1935-37 in the second column of Table A3. Note that the key regressor in the second regression, $[(\text{ExcRes/TR})_{i,1935} - (\text{WarrentedExcRes/TR})_{i,1935}]$, captures differences across banks in their exposure to the treatment. The idiosyncratic component has a zero mean by construction for our entire sample of member banks and is orthogonal to the average treatment effect of the reserve requirement.

Our loan growth model hypothesizes that banks with greater slack (i.e., those with more excess reserves relative to their warranted level of excess reserves) were less affected by the reserve requirement treatment than other banks, and therefore had higher loan growth from 1935 to 1937, ceteris paribus. As shown in Table A3, as expected, the coefficient estimate on $[(\text{ExcRes/TR})_{i,1935} - (\text{WarrentedExcRes/TR})_{i,1935}]$ is positive and statistically significant (as reflected in the fact that the lower bound of the 95 percent confidence interval is greater than

[30] Note that an indicator variable is necessarily omitted for one of the Federal Reserve Districts (the Second Federal Reserve District, which is New York), implying that all indicator variables should be interpreted as values relative to that of the New York District.

zero).[31] The standard deviation of $[(ExcRes/TR)_{i,1935} - (WarrentedExcRes/TR)_{i,1935}]$ is 0.27. Thus, a bank with slack that is one standard deviation above the mean experienced loan growth from 1935 to 1937 that was roughly two percentage points higher (0.079 x 0.27). This produces non-trivial variation in loan growth within our sample, as average loan growth from 1935 to 1937 for our sample was 11 percent with a standard deviation of 17 percent. In results not reported here, we also experimented with additional regressions to test for nonlinearity in the effect of slack on loan growth and found no evidence of nonlinearity.

The third column of Table A3 reports a regression analogous to the loan growth regression but for the growth rate of other cash assets (i.e., liquid assets other than reserves at the Fed) from 1935 to 1937. As we (and Fed officials at the time) hypothesize, other cash assets served as a buffer to insulate bank lending from an increase in required reserves. Consistent with that interpretation, the coefficient on $[(ExcRes/TR)_{i,1935} - (WarrentedExcRes/TR)_{i,1935}]$ in the regression for other cash assets (0.125) is much larger than in the loan growth regression and is also statistically significantly greater than zero.

To derive an aggregate effect from the reserve requirement increases that occurred in 1936 and 1937, we turn to our matched samples. As already noted, the coefficient estimate for $[(ExcRes/TR)_{i,1935} - (WarrentedExcRes/TR)_{i,1935}]$ has no aggregate implication for the effect of reserve requirements on loan growth. However, the coefficient is useful for refining our matched sample estimates of the aggregate treatment effect (T), as described in equation (4)′ above.

[31] The confidence intervals reported for the regressions in the second and third columns of Table A3 are based on heteroscedastic-consistent bootstrap estimates of the distributions of the covariates, as described in Efron and Tibshirani (1993), to account for the inclusion of the generated regressor (ER/TR) – (WER/TR) 1935 in those regressions.

For each of our three matched samples, in Table A4 we report refined estimates of loan growth from 1935 to 1937 for member and nonmember banks. As previously noted, mean loan growth during this period was higher among member banks than nonmember banks in Samples 1 and 3. In Sample 2, nonmember banks grew slightly faster on average (10.6 percent compared with 9.4 percent for member banks), but that difference is not statistically significant. As noted in our comparison of member and nonmember bank characteristics, differences exist in average size, average loan growth from 1933 to 1935, and average equity-to-asset ratios. Our refined estimates of matched sample differences control for those differences. Here we assume that regression coefficient estimates from the member bank sample are similarly useful for adjusting for cross-sectional differences in the characteristics of both members and nonmembers. We also allow member banks' idiosyncratic differences in excess reserve slack to affect their loan growth. (Note that although the average of this variable for all member banks is zero by construction, its average can deviate from zero for subsamples.)

These refined matched comparisons yield the following results: in Samples 1 and 3, member bank loan growth for 1935-37 is higher (by 4.9 percentage points in Sample 1, and by 2.0 percentage points in Sample 3), but member and nonmember loan growth rates are essentially identical in Sample 2 (the member bank average is only 0.4 percentage points lower). None of the differences between member and nonmember bank means is close to being statistically significant. While the statistical power is particularly low in the Sample 1 comparison, we note that in none of the samples do we find an *economically significant* estimate of lower average loan growth for member banks; indeed, in two of the samples we find that member banks had higher loan growth on average. We recognize, however, that the standard errors related to the mean differences reported in Table A4 are large, implying that one cannot

reject either large positive or large negative differences in member vs. nonmember loan growth on the basis of these estimates alone. Said differently, confidence bands on the estimated difference would be wide enough to encompass both large and positive economic differences. The weak statistical power of these estimates leads us to place much greater weight on the results using the Abadie (2005) technique. The results in Table A4 are useful for showing that allowing for cross-sectional differences in the bindingness of reserve requirements apparently has little effect on estimated effects.

We conclude that the reserve requirement increases in 1936 and 1937 had no significant impact on aggregate bank loan growth from 1935 to 1937. This result aligns with the simple graphical analysis of Figure 3, with our Abadie (2005) difference-in-difference regressions in Table 3, and with the simple means comparisons for the three matched samples in Table 2.[32]

How can we reconcile our finding that, on average, members and nonmembers had similar loan growth rates during 1935-37 with our cross-sectional finding that loan growth was lower for at least some of the member banks? Consistent with the Fed's survey results discussed above, we believe that the main way is to point to the small number of member banks for which reserve requirements were binding. Furthermore, the fact that we found no evidence for a nonlinear relationship between bindingness and loan growth among member banks suggests the possibility of a general equilibrium effect: reduced lending by member banks with binding reserve requirement constraints seems to have been offset by increased lending by member banks with slack reserve requirement constraints.

[32] We reiterate that, although our analysis omits New York City banks, Park and Van Horn (2015) found that changes in reserve requirements had no significant impact the loan growth rates of New York banks.

Table 1. Member Bank Reserve Requirements, June 21, 1917 - December 31, 1941

(Percent of Deposits)

Class of Deposits and Bank	June 21, 1917 - Aug. 15, 1936	Aug. 16, 1936 - Feb. 28, 1937	Mar. 1, 1937 - Apr. 30, 1937	May 1, 1937 - Apr. 15, 1938	Apr. 16, 1938 - Oct. 31, 1941	Nov. 1, 1941 - Dec. 31, 1941
On net demand deposits:						
Central reserve city	13	19.50	22.75	26.00	22.75	26.00
Reserve city	10	15.00	17.50	20.00	17.50	20.00
Country	7	10.50	12.25	14.00	12.00	14.00
On time deposits:						
All member banks	3	4.50	5.25	6.00	5.00	6.00

Source: Board of Governors of the Federal Reserve System (1943).

Table 2: Three Matched Samples, Member and Nonmember Banks, Statistics for Loan Growth 1933-35 and 1935-37, Capital/Assets in 1935, and Total Assets in 1935

Variable	Sample	Mean	St. Dev.	Median	Max	Min
Loan Growth (Members) 1933-35	1	-0.032	0.136	-0.013	0.223	-0.326
Loan Growth (Members) 1933-35	2	-0.013	0.183	-0.009	0.703	-0.450
Loan Growth (Members) 1933-35	3	0.003	0.206	-0.007	0.859	-0.450
Loan Growth (NonMem) 1933-35	1	0.000	0.227	-0.049	0.711	-0.357
Loan Growth (NonMem) 1933-35	2	-0.007	0.183	-0.040	0.711	-0.420
Loan Growth (NonMem) 1933-35	3	0.007	0.198	-0.035	0.711	-0.420
Loan Growth (Members) 1935-37	1	0.099	0.184	0.076	0.495	-0.312
Loan Growth (Members) 1935-37	2	0.094	0.175	0.060	0.601	-0.312
Loan Growth (Members) 1935-37	3	0.108	0.173	0.075	0.601	-0.312
Loan Growth (NonMem) 1935-37	1	0.065	0.146	0.049	0.422	-0.185
Loan Growth (NonMem) 1935-37	2	0.106	0.171	0.071	0.703	-0.280
Loan Growth (NonMem) 1935-37	3	0.092	0.175	0.071	0.703	-0.491
Capital/TotalAssets (Members) 1935	1	0.140	0.050	0.142	0.273	0.066
Capital/TotalAssets (Members) 1935	2	0.153	0.066	0.144	0.371	0.046
Capital/TotalAssets (Members) 1935	3	0.148	0.065	0.139	0.371	0.046
Capital/TotalAssets (NonMem) 1935	1	0.160	0.048	0.170	0.248	0.071
Capital/TotalAssets (NonMem) 1935	2	0.161	0.063	0.153	0.391	0.050
Capital/TotalAssets (NonMem) 1935	3	0.161	0.066	0.151	0.391	0.050
TotalAssets (Members) 1935	1	4,553	12,987	1,379	69,12	340
TotalAssets (Members) 1935	2	2,099	7,284	845	69,12	81
TotalAssets (Members) 1935	3	3,548	8,656	956	69,12	81
TotalAssets (NonMem) 1935	1	3,424	9,011	1,150	48,25	309
TotalAssets (NonMem) 1935	2	1,723	5,084	770	48,25	66
TotalAssets (NonMem) 1935	3	3,055	6,810	975	48,25	66

Variable Definitions: LoanGrowth is annual percentage growth rate of total loans (divided by 100); Capital/TotalAssets is total equity capital (the sum of paid in capital, surplus and undivided profits) divided by total assets; TotalAssets is total assets (in $ thousands); Member and NonMem refer to Federal Reserve member and nonmember banks.

Data Sources: For member banks: Reports of Condition and Income (call reports); for nonmember banks: *Rand McNally Banker Directory* (January 1934, 1936, and 1938).

Table 3 – Abadie (2005) Stacked Regression Estimation of Treatment Effect

	(1) Dependent Variable: LG 1935-37 – LG 1933-35	(2) Dependent Variable: LG 1935-37 – LG 1933-1935
Treatment Effect	0.0145 (0.0371)	0.0074 (0.0305)
Observations	210	543

Notes: Standard errors in parentheses. These regressions follow the methodology of Abadie (2005), using a second order polynomial and the "sle" command (ABSDID procedure in Stata 15.1). Control variables include capital-to-assets and ln(total assets).

Variable Definitions: LG = loan growth rate. Treatment Effect measures the differential in loan growth rate relative to prior period loan growth rate (as defined by the dependent variable) for member banks, which were subject to the reserve requirement increases in 1936 and 1937.

Data Source: For member banks: Reports of Condition and Income (call reports); for nonmember banks: *Rand McNally Banker Directory* (January 1934, 1936, and 1938).

Table 4 – Loan Growth Serial Dependence, Member and Nonmember Banks

	Dependent Variable: Loan Growth Rate 1935-37 (Member Banks)	Dependent Variable: Loan Growth rate 1935-37 (Nonmember Banks)
LoanGrowth 1933-35	0.0668	0.00440
	(0.0931)	(0.0923)
*ln*Total Assets 1935	-0.00696	-0.0371***
	(0.0129)	(0.0114)
Capital/Assets 1935	-0.800**	-0.131
	(0.315)	(0.227)
Intercept	0.324	0.372***
	(0.203)	(0.0939)
Observations	107	107
R^2	0.085	0.075

Notes: Robust standard errors in parentheses; * $p < .10$, ** $p < .05$, *** $p < .01$.

Variable Definitions: LoanGrowth is loan growth rate, *ln*Total Assets is log of total assets, Capital/Assets is total capital (paid in capital plus surplus and undivided profits) divided by total assets.

Data Source: For member banks: Reports of Condition and Income (call reports); for nonmember banks: *Rand McNally Banker Directory* (January 1934, 1936, and 1938).

Table 5: Summary Statistics Banks Used in Reserves and Broad Cash Assets Regressions

Variable	Obs	Mean	St. Dev.	Median	Max	Min
RES/TA 1935	458	0.090	0.062	0.070	0.408	0.008
Broad CA/TA 1935	458	0.497	0.169	0.503	0.897	0.111
LoanGrowth 1933-35	458	0.016	0.208	-0.018	1.813	-0.450
*ln*TotalAssets 1935	458	15.539	2.085	15.390	21.545	11.307
DemandDep/TotDep 1935	458	0.461	0.189	0.470	0.958	0
Capital/TotalAssets 1935	458	0.133	0.056	0.121	0.386	0.045
National Bank 1935	458	0.895	0.307	1	1	0
Res City Bank 1935	458	0.472	0.500	0	1	0
RES/TA 1937	472	0.117	0.047	0.107	0.411	0.027
Broad CA/TA 1937	472	0.501	0.151	0.514	0.896	0.130
LoanGrowth 1935-37	472	0.113	0.177	0.107	0.411	0.027
*ln*TotalAssets 1935	472	15.626	2.065	15.539	21.539	11.250
DemandDep/TotDep 1937	472	0.475	0.189	0.486	0.931	0
Capital/TotalAssets 1935	472	0.125	0.050	0.114	0.390	0.045
National Bank 1935	472	0.883	0.321	1	1	0
Res City Bank 1935	472	0.443	0.497	0	1	0

Variable Definitions: RES/TA is the ratio of reserves to total assets; Broad CA/TA is the ratio of broad cash assets to total assets, where broad cash assets is the sum of vault cash, cash items in the process of collection, net deposits due from banks, and government securities held by banks; LoanGrowth is annual percentage growth rate of total loans; *ln*TotalAssets is the log of total assets; DemandDep/TotalDep is the ratio of (demand deposits + US Government deposits + net deposits due to banks – cash items in the process of collection) to total deposits; Capital/TotalAssets is the ratio of total equity to total assets. National Bank is an indicator equal to 1 for national banks; and Res City Bank is an indicator equal to 1 for banks located in reserve or central reserve cities.

Data Source: Reports of Condition and Income (call reports). See Calomiris and Mason (2003 a,b).

Table 6 – Regressions for Reserves/Assets and Broad Cash Assets/Assets, 1935 and 1937

	Dependent Variable: RES/TA 1935	Dependent Variable: Broad CA/TA 1935	Dependent Variable: RES/TA 1937	Dependent Variable: Broad CA/TA 1937
LoanGrowth 1933-35	-0.029**	-0.100***		
	(0.014)	(0.032)		
LoanGrowth 1935-37			0.002	-0.045
			(0.009)	(0.035)
*ln*TotalAssets 1935	-0.001	0.014***	0.001	0.021***
	(0.002)	(0.005)	(0.001)	(0.005)
DemandDep/TotDep 1935	0.130***	0.189***		
	(0.018)	(0.041)		
DemandDep/TotDep 1937			0.130***	0.092**
			(0.010)	(0.039)
Capital/TotalAssets 1935	-0.114*	-0.669***	-0.076*	-0.411***
	(0.061)	(0.141)	(0.040)	(0.150)
National Bank 1935	-0.012	0.029	-0.013**	0.038*
	(0.010)	(0.023)	(0.006)	(0.022)
Res City Bank 1935	-0.004	0.042**	0.016***	0.015
	(0.008)	(0.020)	(0.005)	(0.018)
FR DIST 01	-0.006	-0.006	-0.017**	-0.043
	(0.013)	(0.029)	(0.007)	(0.028)
FR DIST 03	-0.025*	-0.057**	-0.026***	-0.075**
	(0.013)	(0.030)	(0.008)	(0.030)
FR DIST 04	-0.015	0.060**	-0.022***	0.023
	(0.013)	(0.029)	(0.007)	(0.028)
FR DIST 05	0.006	0.057**	-0.010	0.014
	(0.012)	(0.028)	(0.007)	(0.027)
FR DIST 06	-0.020	0.072**	-0.031***	-0.012
	(0.012)	(0.029)	(0.007)	(0.028)
FR DIST 07	0.013	0.143***	-0.013*	0.088***
	(0.012)	(0.028)	(0.007)	(0.027)
FR DIST 08	-0.014	0.060*	-0.031***	-0.008
	(0.013)	(0.031)	(0.008)	(0.030)
FR DIST 09	-0.011	0.091***	-0.020**	0.060*

	(0.014)	(0.032)	(0.008)	(0.032)
FR DIST 10	-0.000	0.137***	-0.027***	0.083***
	(0.013)	(0.030)	(0.008)	(0.030)
FR DIST 11	-0.002	0.136***	-0.027***	0.095***
	(0.013)	(0.030)	(0.008)	(0.030)
FR DIST 12	-0.012	0.055**	-0.030***	0.027
	(0.012)	(0.028)	(0.007)	(0.027)
Intercept	0.076*	0.180*	0.073***	0.127
	(0.040)	(0.092)	(0.023)	(0.088)
Observations	458	458	472	472
R^2	0.200	0.430	0.524	0.330
Adjusted R^2	0.169	0.408	0.506	0.305

Notes: Robust standard errors in parentheses; * $p < .10$, ** $p < .05$, *** $p < .01$.

Variable Definitions: See Table 5.

Data Source: Reports of Condition and Income (call reports). See Calomiris and Mason (2003 a,b).

Table A1: Summary Statistics for the 5426 Banks Used in the First-Stage Regression

Variable	Mean	St.Dev.	Median	Max	Min
ExcessReserves/TotalReserves 1935	0.422	0.276	0.422	1.076	-2.414
OtherCashAssets/TotalAssets 1935	0.191	0.115	0.171	0.762	0.000
Loans/TotalAssets 1935	0.320	0.131	0.309	0.954	0.005
LoanGrowth 1933-35	-0.009	0.192	-0.042	2.798	-0.715
*ln*TotalAssets 1935	14.045	1.335	13.837	21.545	11.224
National Bank 1935	0.872	0.334	1.000	1.000	0.000
Res City Bank 1935	0.068	0.251	0.000	1.000	0.000
DemandDeposits/TotalDeposits 1935	0.388	0.181	0.375	0.967	0.000
Capital/TotalAssets 1935	0.150	0.060	0.138	0.816	0.025

Variable Definitions: ExcessReserves/TotalReserves is the ratio of excess reserves to total reserves; OtherCashAssets/TotalAssets is the ratio of cash assets other than reserves to total assets, where other cash assets is the sum of vault cash, cash items in the process of collection, net deposits due from banks, and government securities held by banks; Loans/TotalAssets is the ratio of total loans to total assets; LoanGrowth is the annual percentage growth rate of total loans; *ln*TotalAssets is the log of total assets; National Bank is an indicator equal to 1 for national banks; Res City Bank is an indicator equal to 1 for banks located in reserve or central reserve cities; DemandDeposits/TotalDeposits is the ratio of (demand deposits + US Government deposits + net deposits due to banks – cash items in the process of collection) to total deposits; and Capital/TotalAssets is the ratio of total equity to total assets.

Data Source: Reports of Condition and Income (call reports). See Calomiris and Mason (2003 a,b).

Table A2: Summary Statistics Banks Used in the Second-Stage Regressions

Variable	Mean	St.Dev.	Median	Max	Min
LoanGrowth 1935-37	0.108	0.175	0.086	1.389	−0.609
LoanGrowth 1933-35	0.016	0.208	−0.018	1.813	−0.450
National Bank 1935	0.895	0.307	1.000	1.000	0.000
Res City Bank 1935	0.472	0.500	0.000	1.000	0.000
(ExcRes/TR)−(WarrantedExcRes/TR) 1935	0.019	0.274	0.014	0.537	−2.539
Capital/TotalAssets 1935	0.133	0.056	0.121	0.386	0.045
*ln*TotalAssets 1935	15.539	2.085	15.390	21.545	11.307
OtherCashAssets/TotalAssets 1935	0.236	0.125	0.229	0.700	0.013
OtherCashAssetGr 1935-37	0.018	0.248	−0.021	1.586	−0.601

Variable Definitions: ExcRes/TR is the ratio of excess reserves to total reserves; WarrantedExcRes/TR is warranted excess reserves, as defined in the text and as derived in Table A3. OtherCashAssets/TotalAssets is the ratio of cash assets other than reserves to total assets, where other cash assets is the sum of vault cash, cash items in the process of collection, net deposits due from banks, and government securities held by banks; LoanGrowth is the annual percentage growth rate of total loans; *ln*TotalAssets is the log of total assets; National Bank is an indicator equal to 1 for national banks; Res City Bank is an indicator equal to 1 for banks located in reserve or central reserve cities; Capital/TotalAssets is the ratio of total equity to total assets; and OtherCashAssetGr is the annual percentage growth rate of OtherCashAssets.

Data Source: Reports of Condition and Income (call reports). See Calomiris and Mason (2003 a,b).

Table A3: Regressions for Excess Reserves/Total Reserves in 1935 (Col. 1), Growth Rate of Total Loans 1935-37 (Col. 2), and Growth Rate of Other Cash Assets 1935-37 (Col. 3)

	Dependent Variable: ER/TR 1935	Dependent Variable: LG 1935-37	Dependent Variable: OCAGr 1935-37
LoanGrowth 1933-35	-0.073***	0.255	-0.092
	(0.021)	(0.086, 0.413)	(-0.195, 0.002)
*ln*TotalAssets 1935	-0.019***	-0.023	-0.007
	(0.004)	(-0.034, -0.012)	(-0.024, 0.010)
DemandDep/TotalDep 1935	-0.219***		
	(0.024)		
Capital/TotalAssets 1935	0.162**	-0.423	0.223
	(0.075)	(-0.768, -0.063)	(-0.273, 0.766)
(ExcRes/TR −(WarrantedExcRes/TR) 1935		0.079	0.125
		(0.028, 0.144)	(0.050, 0.217)
National Bank 1935	-0.055***	0.006	0.037
	(0.011)	(-0.039, 0.053)	(-0.046, 0.117)
Res City Bank 1935	-0.043**	0.047	-0.068
	(0.020)	(0.005, 0.090)	(-0.142, 0.010)
FR DIST 01	0.005	0.015	-0.057
	(0.020)	(-0.039, 0.074)	(-0.182, 0.079)
FR DIST 03	-0.076***	-0.013	-0.022
	(0.014)	(-0.068, 0.045)	(-0.149, 0.101)
FR DIST 04	0.024	0.026	-0.046
	(0.016)	(-0.034, 0.085)	(-0.164, 0.069)
FR DIST 05	0.076***	-0.007	-0.071
	(0.017)	(-0.056, 0.044)	(-0.194, 0.047)
FR DIST 06	0.104***	0.074	-0.110
	(0.019)	(0.011, 0.143)	(-0.231, 0.012)
FR DIST 07	0.139***	0.078	-0.089
	(0.016)	(0.011, 0.149)	(-0.195, 0.011)
FR DIST 08	0.099***	0.035	-0.150

	(0.018)	(-0.054, 0.123)	(-0.272, -0.033)
FR DIST 09	0.073***	-0.085	-0.030
	(0.018)	(-0.180, 0.010)	(-0.152, 0.089)
FR DIST 10	0.181***	0.000	-0.062
	(0.015)	(-0.062, 0.064)	(-0.173, 0.043)
FR DIST 11	0.159***	0.013	-0.079
	(0.016)	(-0.059, 0.085)	(-0.212, 0.058)
FR DIST 12	-0.000	0.052	0.009
	(0.018)	(-0.010, 0.117)	(-0.111, 0.140)
Constant	0.737***	0.467	0.145
	(0.067)	(0.256, 0.676)	(-0.165, 0.454)
Observations	5426	458	458
Adj. R^2	0.106	0.136	0.030

Notes: Robust standard errors in parentheses in Column 1; * $p < .10$, ** $p < .05$, *** $p < .01$. Values in parentheses in columns 2 and 3 indicate the lower and upper bounds of 95% confidence intervals, as estimated by applying a heteroscedastic-consistent bootstrapping procedure described in Efron and Tibshirani (1993) to estimate distributions of the estimators.

Variable definitions: In the regressions in columns 2 and 3, (ExcRes/TR–WarrantedExcRes/TR) is the predicted value derived from the regression shown in the first column of this table. FRDIST01 is an indicator equal to 1 if the bank resides in the First Federal Reserve District, etc.; see the notes to Tables A1 and A2 for other definitions. Note that an indicator variable is necessarily omitted for one of the Federal Reserve Districts (the Second Federal Reserve District, which is New York), implying that all indicator variables should be interpreted as values relative to that of the New York District.

Data Source: Reports of Condition and Income (call reports). See Calomiris and Mason (2003 a,b).

Table A4: Simple and Refined Loan Growth Rate 1935-37 Statistics

Variable	Sample 1 Mean (standard dev.)	Sample 2 Mean (standard dev.)	Sample 3 Mean (standard dev.)
LoanGrowth(members)	0.099	0.094	0.108
	(0.184)	(0.175)	(0.173)
LoanGrowth(nonmembers)	0.065	0.106	0.092
	(0.146)	(0.171)	(0.175)
p-value	**0.444**	**0.639**	**0.510**
Adj LoanGrowth(members)	0.346	0.324	0.338
	(0.182)	(0.187)	(0.336)
Adj LoanGrowth(nonmem)	0.297	0.328	0.318
	(0.146)	(0.175)	(0.319)
p-value	**0.269**	**0.857**	**0.413**
Obs	**28**	**93**	**107**

Notes:

Adj LoanGrowth(nonmembers) = LoanGrowth(nonmembers) 1935-37– (–0.0228 x *ln*TotalAssets 1935) – (0.255 x LoanGrowth(nonmembers) 1933-35) – (–0.423 x Capital/Assets 1935)

Adj LoanGrowth(members) = LoanGrowth(members) 1935-37 – (–0.0228 x *ln*TotalAssets 1935) – (0.0784 x (ER/TR)–(WarrantedExcRes/TR 1935)) – (0.255 x LoanGrowth(members) 1933-35) – (–0.423 x Capital/Assets 1935) - (–0.0060 x National Bank 1935)

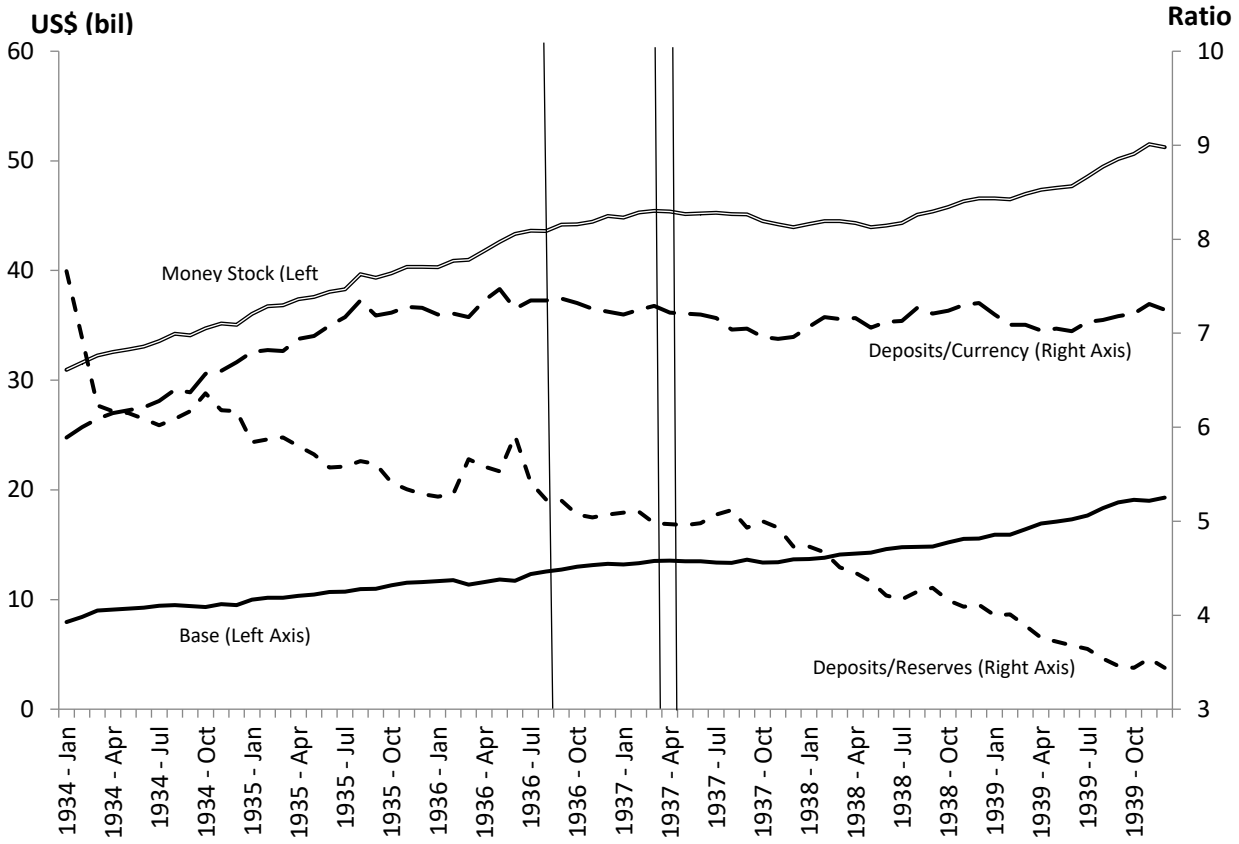
p-values are for t-tests of equality of Adj LoanGrowth(nonmembers) and Adj LoanGrowth(members) means for indicated sample.

Standard Deviations are included in parentheses.

Variable definitions: LoanGrowth is annual percentage growth rate of total loans; Adj LoanGrowth is defined above; Member and Nonmember refer to member and nonmember banks; ER/TR is the ratio of excess to total reserves; and WarrantedExcRes/TR is warranted excess to total reserves as described in the text and Table A3.

Data Sources: For member banks: Reports of Condition and Income (call reports); for nonmember banks: *Rand McNally Banker Directory* (January 1934, 1936, and 1938).

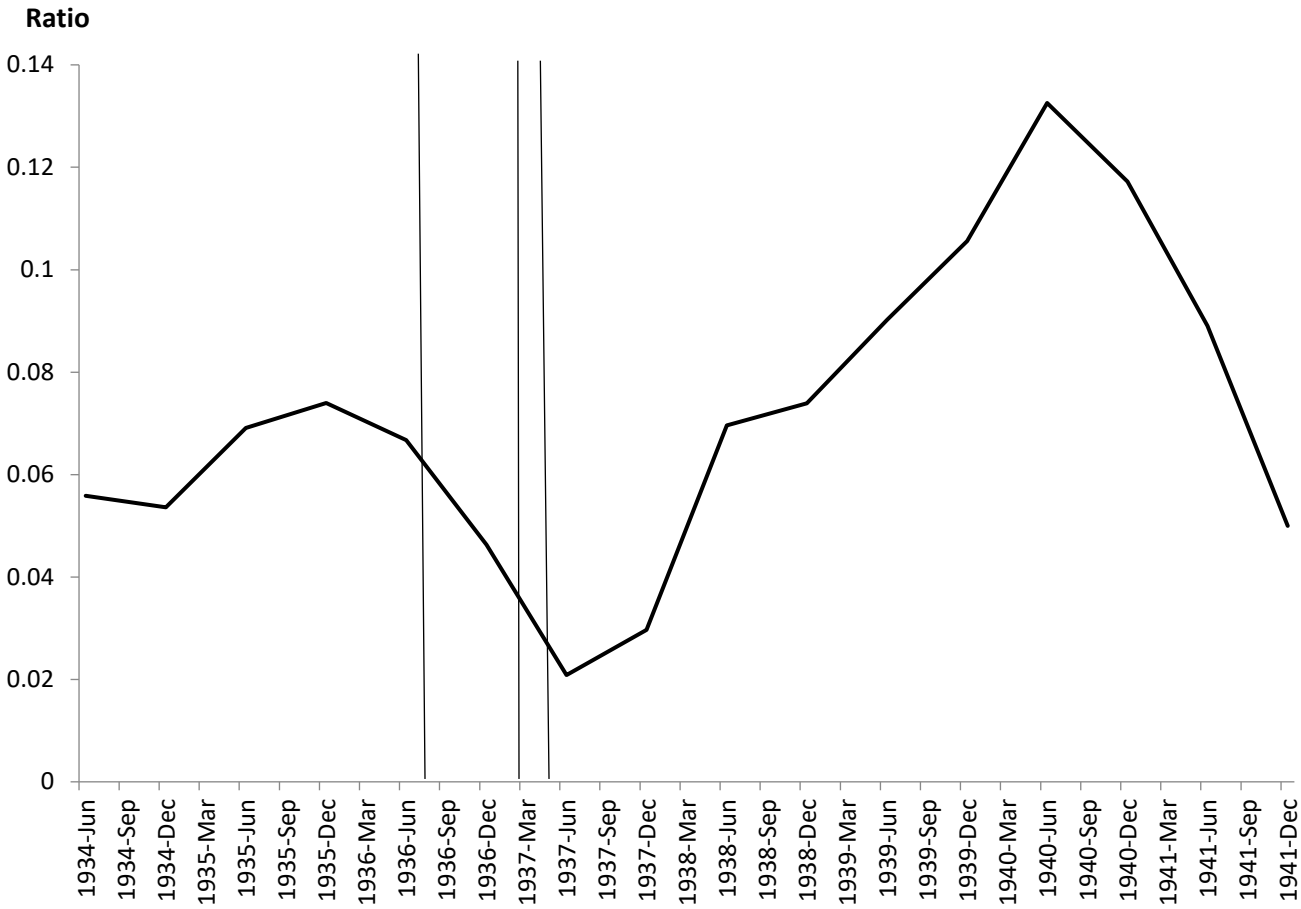
Figure 1: Money Stock and Determinants, 1934-39



Notes: Money Stock is the sum of currency held by the public and deposits (demand and time) at commercial banks; Deposits/Reserves is the ratio of deposits at commercial banks to bank reserves; Deposits/Currency is the ratio of deposits at commercial banks to currency held by the public; and Base is the sum of vault cash and bank reserves (referred to as "High-Powered Money" by Friedman and Schwartz (1963)). The vertical lines reflect the dates when the Federal Reserve implemented increases in reserve requirements.

Source: Friedman and Schwartz (1963, Tables A-1 and B-3).

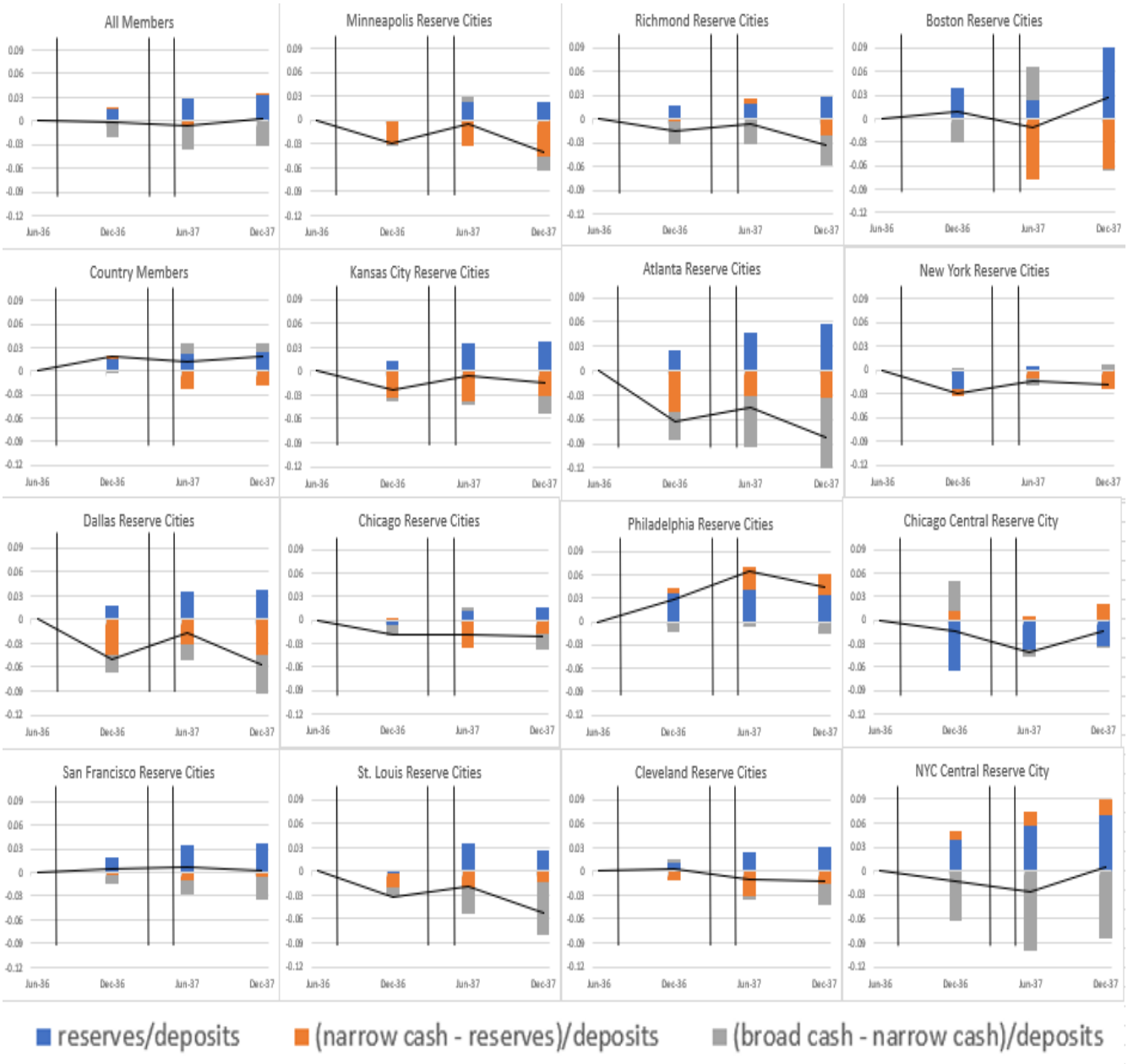
Figure 2: Excess Reserves/Deposits, All Member Banks



Notes: Excess reserves are reserves of all member banks at the Federal Reserve less required reserves. Deposits are total member bank deposits. Vertical lines identify the months in which reserve requirements were raised, i.e., August 1936, March 1937 and May 1937.

Source: Board of Governors of the Federal Reserve System (1943).

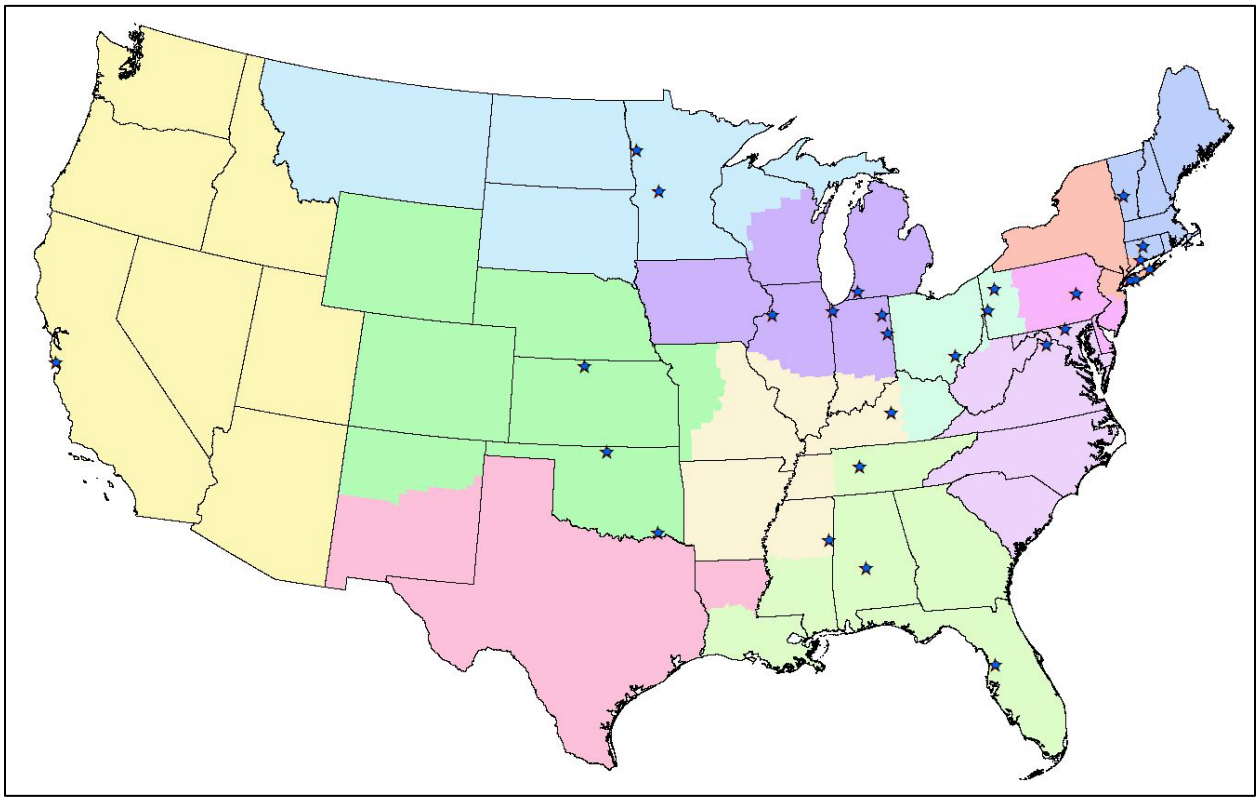
Figure 3: Contributors to Cumulative Changes in Liquid Assets



Note: The figures plot cumulative changes in measures of liquid assets from June 1936 through December 1937 for all Federal Reserve member banks, country member banks, reserve city banks in each Fed district, and central reserve city banks in Chicago and New York City. The measures of liquid assets are scaled by total deposits, and include reserves held at Federal Reserve Banks, a "narrow cash" aggregate less reserves, and a "broad cash" aggregate less "narrow cash" ("narrow cash" and "broad cash" are defined in the text). The vertical lines indicate dates of increases in reserve requirements and the connecting line indicates the cumulative change in "broad cash" from June 1936.

Source: Board of Governors of the Federal Reserve System (1943)

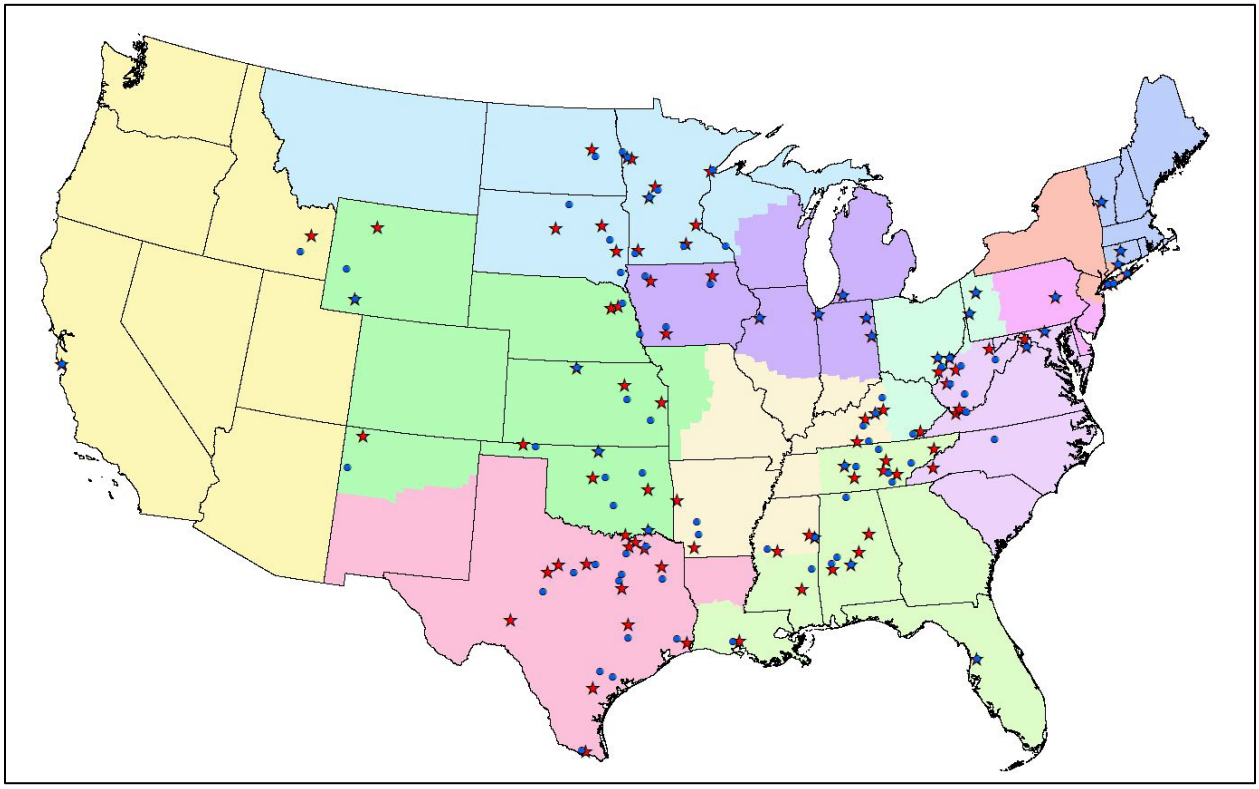
Figure 4: Locations of Member and Nonmember Bank Matches, Sample 1



Note: Stars indicate the locations of member banks and their nonmember bank matches, Sample 1.

Source: See text.

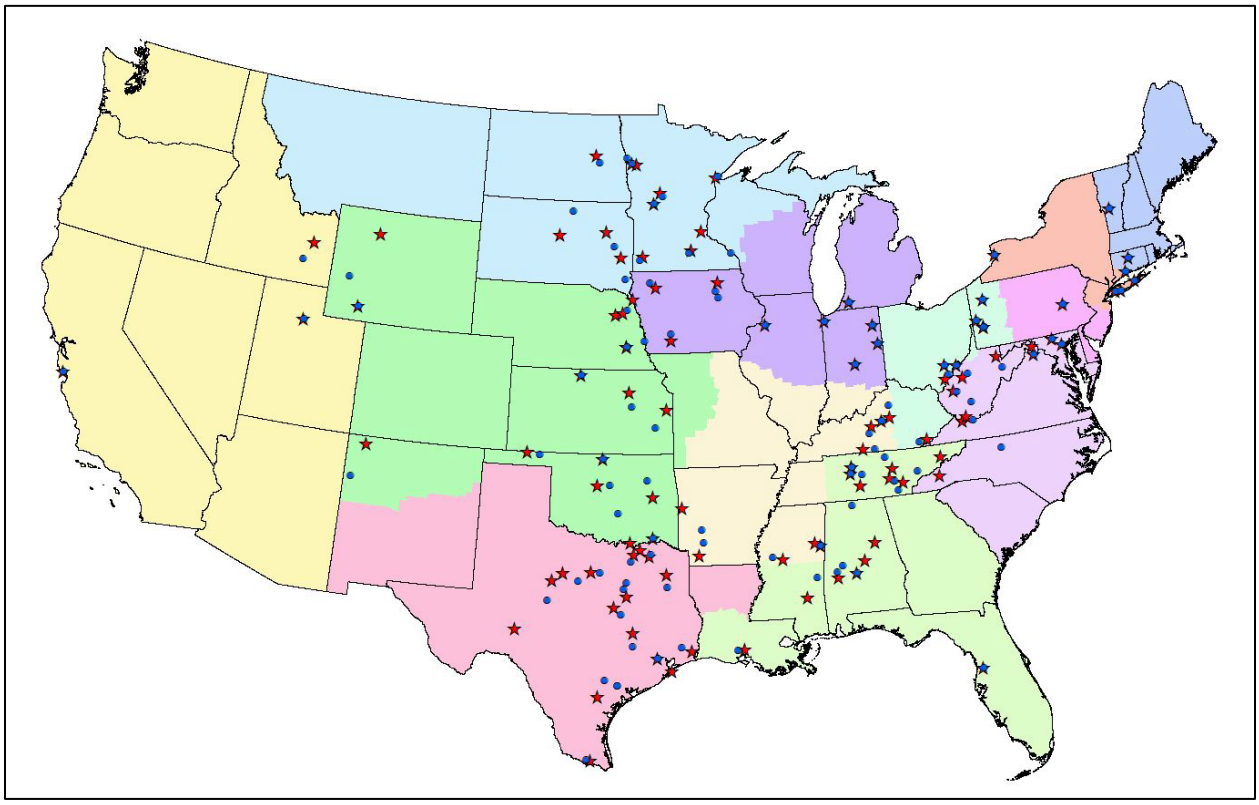
Figure 5: Locations of Member and Nonmember Bank Matches, Sample 2



Note: Blue stars indicate locations of member bank and nonmember matches when both banks were located in the same city or town. Red stars and blue dots indicate the locations of member banks and nonmember banks when members and nonmember matches were not located in the same city or town.

Source: See text.

Figure 6: Locations of Member and Nonmember Bank Matches, Sample 3



Note: Blue stars indicate locations of member bank and nonmember matches when both banks were located in the same city or town. Red stars and blue dots indicate the locations of member banks and nonmember banks when members and nonmember matches were not located in the same city or town.

Source: See text.