Widespread agreement exists that the Federal Reserve did not add enough reserves to the banking system in the early 1930s to prevent banking panics and a sharp monetary contraction. But banks should have been able to obtain ample reserves through the discount window. This paper argues that concerns about the use of the discount window to fund stock market speculation in early 1929 and about the quality of collateral in the 1930s conflicted with the Federal Reserve’s mandate to provide emergency liquidity assistance. It presents evidence, based on a panel of Federal Reserve district-level data, of a sharp decline in the demand for borrowed reserves consistent with a tightening of the terms of access to the discount window. The change in policy mattered: bank failures varied inversely with the amount of borrowed reserves provided during the currency drains of the Great Depression.

*JEL classification:* E44, E52, E58, N120  
*Keywords:* Lender of last resort, Fed, Interwar period, Bank run

I wish to thank participants at the University of Florida’s Finance Department seminar and the meetings of the International Atlantic Economic Association for comments. I also wish to thank Daniel Martin and Yanbin Wu for excellent research assistance. Any errors are my own.

*Department of Finance, Insurance and Real Estate  
Warrington College of Business  
303E Stuzin Hall, PO Box117148  
University of Florida, Gainesville, FL 32611  
brian.gendreau@warrington.ufl.edu
The Discount Window and the Great Depression

One of main purposes of the Federal Reserve Act was to provide the banking system with a lender of last resort. The creators of the Federal Reserve envisaged that the new central bank, by providing liquidity to banks faced with sudden deposit withdrawal demands, would prevent a recurrence of the panics that had swept the U.S. banking system in the 19th and early 20th centuries. Yet in the early 1930s banking panics occurred again and on an even larger scale than before the creation of the Federal Reserve. Many economists, including Milton Friedman and Charles Kindleberger, believed that the Federal Reserve could have mitigated the banking panics by providing more reserves through open market purchases but failed to do so. Milton Friedman further believed that the Fed could have prevented the Great Depression by providing enough reserves to prevent a decline in the money supply. But even if the Fed failed to provide adequate reserves through open market operations banks should have been able to obtain the reserves they needed through the discount window. Did the Federal Reserve tighten access to the discount window during the Great Depression when it was needed the most?

Several researchers believe that the Federal Reserve became less willing to discount bank paper for banks during the 1930s. Clark Warburton (1952) maintained that as bank failures became frequent during the 1930s Federal Reserve banks adopted “an extremely hard-boiled attitude” toward member banks that needed to borrow to meet deposit withdrawals. Alfred Chandler (1971, pp. 232-233) argued that stringent collateral requirements for borrowing adopted by Federal Reserve Banks contributed to bank closings and the liquidation of loans by surviving banks during the Great Depression. More generally, Allan Meltzer (1986) attributed the 1931-33 bank failures to the Federal Reserve’s failure to follow Bagehot’s rule for a lender of last resort, which is to lend large amounts on any collateral that is marketable in the ordinary course of business at a penalty rate of interest. David Wheelock (1991) concluded that a significant down-shift in the demand for borrowed reserves occurred during the Great Depression based on a dummy variable for the depression years in a time-series model of New York district and New York City bank borrowing. He estimated that the shift can account for 10% of the decline in borrowed reserves between 1929 and 1930. While Wheelock attributed the shift principally to
a decline in economic activity, he also cited a change in bank willingness or ability to borrow and a possible insufficiency of eligible collateral as factors.

Recent studies taking a quasi-experimental approach have found that Federal Reserve Bank discount window policies affected financial stability and real economic activity during the Great Depression. Richardson and Troost (2009) examined the consequences of different lending policies adopted by the Federal Reserve Banks of Atlanta and St. Louis during the Great Depression. They argue that the Atlanta Fed was more active in providing emergency credit to banks than the St. Louis Fed, resulting in different bank failure rates, lending levels, commercial activity, and the timing of the recovery across the two districts. Jalil (2014) extended their analysis to the entire border of the Atlanta Federal Reserve District and found that the willingness of the Atlanta Fed to engage in liquidity intervention reduced the incidence of bank suspensions by 34 to 72 percent. Ziebarth (2003), examined a border in Mississippi between Federal Reserve districts that had different policies on liquidity provision and found that the policy differences translated into different bank failure rates and levels of real output.

This paper explores explicitly whether the Federal Reserve System as a whole altered its discount window lending policy during 1922-33. It estimates a model of member bank borrowing with parameters that measure the Fed’s willingness to lend and then tests for a structural break. A downward shift in the demand for borrowed reserves consistent with a tightening of the terms of access to the discount window policy would provide evidence that the Federal Reserve stepped away from its role as provider of emergency liquidity. This study differs from earlier studies such as Gendreau (1990) and Wheelock (1991) in that its estimates are based on a panel of data from the twelve Federal Reserve districts observed monthly from 1922-33. The panel provides twelve times as many observations as time-series data, and allows an assessment of the impact of changes in discount window policy on bank failures over time and across districts. The paper begins with a brief review of the Federal Reserve’s administration of the discount window during the System’s first twenty years of operation.

1. **Administration of the discount window: 1914-33.**

The Federal Reserve Act sought “to furnish an elastic currency” by establishing a discount facility for member banks. Federal Reserve banks were authorized to discount commercial bills for member banks at a rate of interest that was to be set “with a view of accommodating commerce and business.” The Act
limited discounts to commercial bills — paper or acceptances arising out of commercial, industrial, or agricultural transactions. This was keeping with its authors’ belief in the real bills doctrine, which held that credit should expand and contract flexibly with business or agricultural needs, but should not be made available to support activities thought to be speculative in securities or commodities markets. In 1916 the act was amended to allow banks to borrow on their own promissory notes, not to exceed 15 days, secured by eligible paper or U.S. government securities.

The founders of the Federal Reserve also believed that the discount mechanism would provide sufficient liquidity to meet banks’ emergency credit needs. Banking panics, they thought, would no longer occur because banks would be able to obtain the resources needed to meet deposit withdrawals by discounting eligible assets.¹

The Federal Reserve Act provided no specific guidance on how the discount window should be administered. Following an initial period of experimentation with penalty discount rates the Federal Reserve adopted a policy that attempted to encourage borrowing on commercial bills while bolstering a traditional bank reluctance to borrow. In practice, Federal Reserve banks began setting discount rates below market rates of interest and relying on administrative pressure to restrain bank borrowing. Operating under the real bills doctrine, at any given discount rate Federal Reserve banks generally supplied borrowed reserves elastically on all eligible collateral. Thus, the Fed controlled the quantity of borrowed reserves by operating through the demand for borrowed reserves, which it affected by changing the discount rate and the degree of administrative pressure at the discount window.

The administrative measures available to Federal Reserve banks to control bank borrowing came in several forms. One was moral suasion. The Federal Reserve’s oft-stated policy was to single out banks that borrowed unusually large amounts or were frequent or continuous borrowers for special supervisory attention. Examiners reviewed the loan portfolios, deposit behavior, and management quality of problem borrowers, sometimes with bank officers and directors (Anderson, 1971a, 153-154). Federal Reserve banks responding to a December 1930 Senate Banking Committee survey on discounting practices stated that they prevented borrowing abuses by interviewing bank officials, applying moral suasion, and refusing to extend credit (Hearings, pp. 790-792).
Another way for Federal Reserve banks to manage bank borrowing was by altering collateral requirements. Westerfield (1932) provides a detailed contemporary account of Federal Reserve collateral policies. According to his study, Federal Reserve banks required additional collateral to restrain borrowing that was deemed excessive based on “…the welfare of the reserve bank, or of the applicant member, or of the system as a whole.” The link between collateral requirements and the amount borrowed from the discount window, according to Westerfield, p. 47, was straightforward:

The demand for collateral reduced the amount of credit that can be had against a certain amount of paper, and by insisting on a wider margin the reserve bank can repress borrowing without actually refusing to lend or raising the rate. If the loans are already outstanding a demand for additional collateral may force the member to call local loans.

Direct action campaigns.
Although the Federal Reserve maintained it did not direct member banks to call in or reduce particular loans, twice during the 1920s it took extraordinary steps to prevent what it viewed as a misuse of the discount window. The first occasion was in the years immediately following the First World War. Member bank borrowing had expanded rapidly between 1917 and 1920, encouraged by low discount rates that were intended to help reduce the cost of funding war-related deficits. Concerned that the expansion in borrowing was fuelling inflation and speculation, but under pressure from the Treasury to keep interest rates low, the Federal Reserve launched a campaign of moral suasion to reduce discounts. Banks whose borrowing was in excess of their capital and surplus or a credit line computed by their Reserve banks were required to post additional collateral (Anderson 1971a, pp. 146-150). The direct action campaign was opposed by the Federal Reserve Bank of New York, which argued that it was an ineffective substitute for discount rate increases. The campaign continued, however, until the Treasury dropped its opposition to discount rate increases in the second half of 1920.

The second direct action campaign was conducted in 1929 after the stock market boom rekindled the Federal Reserve Board’s concern about speculation. The Federal Reserve System had sold government securities and raised discount rates in an effort to restrain speculation in 1928. But by early 1929 it had come to believe that further tightening would hurt commerce and agriculture and that the best way to curb speculation was to apply direct pressure on banks that were borrowing from the discount window while lending on securities collateral. On February 2, 1929 the Federal Reserve Board sent a letter to all Federal Reserve banks stating:
A member bank is not within its reasonable claims for rediscount facilities at its Federal reserve bank when it borrows either for the purpose of making speculative loans or for the purpose of maintaining speculative loans.

The letter directed the Reserve Banks to report to the Board how they kept informed of the use made by borrowings by member banks, the methods they used to prevent improper use of the discount window, and how effective those methods had been.

Most Federal Reserve banks appear to have taken steps to comply with the Federal Reserve Board’s direct action campaign (Chandler, 1971a, 60-61). The Federal Reserve Bank of New York, while complying at least partially, again opposed the campaign, arguing that lending on securities collateral was not inherently speculative and that Federal Reserve credit was fungible. By the end of May the New York Fed was sufficiently concerned about the effects of the direct action program to warn the Board that banks had become afraid to borrow at all, and that a large increase in Federal Reserve credit would soon be needed (Hearings, p. 164).

Officially, the Board relaxed the direct action program on June 12, 1929 when it sent all Federal Reserve Banks a letter that advised them to temper the campaign to avoid seasonal strains. It is far from clear, however, that Federal Reserve banks perceived the campaign to be over. In a meeting a week earlier with the directors of the New York Fed the Board had declared that any relaxation of its direct action campaign would be “merely a suspension” (Riefler, 1956, 315). In a response to a December 1930 survey by the Senate Banking and Commerce Committee the Federal Reserve Bank of Dallas noted that it had still been applying direct pressure in October 1929 (Hearings, 792). Governor George L. Harrison of the New York Fed stated he believed that the moral suasion effort aimed at borrowing banks in the 1920s made banks less willing to borrow from the discount window in the early 1930s (Chandler, 1971b, p. 18). Congress, meanwhile, remained keenly interested in preventing discount borrowings from being used to finance loans on securities. Hearings on the Federal Reserve’s discount policies held by a subcommittee of the Senate banking and Commerce Committee in January 1931 led to provisions in the Banking Act of 1933 that authorized the Federal Reserve to require the repayment of advances and refuse additional credit to any bank that ignored a wring and increased its lending on securities while borrowing from the discount window.
Concerns about collateral.

As the economic contraction worsened in the early 1930s the Federal Reserve’s concerns shifted from stock market speculation to the quality of the paper that banks were offering as collateral for discount window loans. During the early years of the Great Depression all of the Federal Reserve banks except for San Francisco were requiring substantial amounts of excess collateral (Beckhart, Smith, and Brown, 1932, 29-30). The focus on bank asset quality is evident in the responses of Federal Reserve banks to the Senate Banking and Commerce Committee December 1930 survey. Four Banks reported that they had rejected a substantially higher proportion of paper offered for discounting in 1930 than in 1928 or 1929 (Hearings, p. 705). Several of the Federal Reserve banks indicated that their lending practices varied with the portfolio composition of the borrowing banks, and virtually all replied that they had required additional collateral from banks with weak portfolios. Six of the banks also gave “excessive borrowing” or “impaired liquidity” as a reason for requiring extra collateral. The response of the Federal Reserve Bank of Chicago is typical:

Ordinary banking prudence makes it imperative that in extending credit through the rediscounting process due consideration be given to the condition of the applying bank, and where the condition is unsatisfactory…it is our policy to require excess collateral. Excess collateral is also frequently called for where borrowings of member banks are excessive (Hearings. P. 713).

Although it recognized that the quality of eligible paper had deteriorated, the Federal Reserve Board believed that supplies of eligible assets were adequate and evenly distributed across banks — see the March 1931 Federal Reserve Bulletin (p. 142) and the February 12, 1932 testimony of Governor Eugene Meyer (Hearings, p. 15). Eligible collateral had declined sharply – from 16.6 percent of total member bank loans and investments in June 1925 to 8.9% by June 1932, but it was still greater than the total amount of discount borrowing. Both W. Randolph Burgess (1946, p. 49) and Lester Chandler (1971a, pp. 227-231), however, argue that eligible assets were not evenly distributed among banks in the early 1930s, and that many banks lacked sufficient collateral for discount borrowings. Chandler shows that at year-end 1929 eligible assets amounted to less than 10 percent of loans and investments at in one out of every eight member banks, and that eligible assets at country member had declined by 27 percent between 1929 and 1932. He also cites surveys in which banks indicated that their stocks of eligible assets were inadequate. In a study of the Federal Reserve Bank of Richmond’s credit policy George
McKinney (1960, p. 18) concludes that many banks were forced to close their doors after they exhausted their supplies of eligible collateral and were unable to borrow from the Federal Reserve.²

By 1932 Congress had become persuaded that a collateral shortage existed, and in the Glass-Steagall Act passed year that allowed Federal Reserve banks to make advances, on an emergency basis, on the security of any satisfactory assets to groups of member banks and individual member banks, and in unusual circumstances to discount eligible paper for individuals, partnerships, corporations, and nonmember banks. The broadening of access to the Federal Reserve’s credit facilities, however, resulted in little additional borrowing because loans on the new terms required the advance approval of at least five members of the Federal Reserve Board. During 1932, Federal Reserve banks lent only $33 million on formerly ineligible collateral.

It should be noted that the reduction in Federal Reserve’s provision of liquidity implicit in tighter collateral requirements was not uniform or binding in all periods. The Federal Reserve Bank of Atlanta, for example, responded to a banking panic in Florida in April 1929 by creating special currency funds in Tampa and Miami that allowed banks to obtain cash faster than was possible through discount window loans (Carlson, Mitchener, and Richardson, 2011). The Federal Reserve’s Open Market Committee responded to the banking panics of September-October 1931 and February-March 1933 by buying bills and encouraging banks to borrow, as described by Wicker (1995, p.87-90) and Meltzer (2003, pp. 349-350), though it did not engage in large-scale open market operations. Borrowing increased sharply during the panics, but as a portion of capital never reached the average levels of 1922-28.³

2. The model.

While the historical record shows that the Federal Reserve attempted to use the nonrate terms of access to control discount window borrowing in the 1920s and early 1930s it is not clear the attempts were successful. Assessing whether changes in credit policy had a material effect on bank borrowing requires empirical tests using a model that can measure the administrative pressure applied at the discount window. A useful starting point in developing such a model is in specifying the costs to banks in meeting a reserve need. Cost-minimizing banks would weigh the cost of borrowing from the discount window against the cost of liquidating assets or borrowing from an alternative source. The cost of borrowing from the Federal Reserve is the interest paid at the discount rate, \( R_d \), plus the implicit costs of
supervisory surveillance. These costs are those resulting from the administrative pressure supervisors apply to discourage banks from engaging in arbitrage when discount rates were below market rates of interest, as they were for most of the 1920s and many months in the early 1930s. In this model the implicit costs are represented by a borrowing function in which the marginal surveillance cost of access to the discount window, \( c(B/K) \), rises with the amount borrowed, \( B \), relative to bank capital, \( K \). Capital is the appropriate scale variable given that Federal Reserve banks had from the start focused on borrowing relative to capital when seeking to restrain bank borrowing (Westerfield, 1932, p. 44). The implicit costs may be thought of as the opportunity costs of providing the collateral for the borrowings or the capital adjustments required by supervisors whose attention is drawn to the bank by the borrowing. The cost of liquidating the assets is the foregone interest on the assets, \( R_A \), plus the transactions costs incurred in selling the assets, \( tc \), measured as a portion of the value of the assets. Although a small market for federal funds developed in several cities in the 1920s in which banks could borrow or lend reserves, most banks met reserve drains by liquidating assets — particularly their holdings of call loans and short-term marketable securities (Turner, 1938, 93-97 and Willis, 1964) 3-13). The total cost, \( C \), to banks of meeting their reserve need, \( RN \), can be expressed as:

\[
C = R_d B + c(B/K) + R_a A + tcA
\]

where

- \( R_d \) is the discount rate,
- \( B \) is the level of borrowings from the discount window,
- \( K \) is bank capital,
- \( c(B/K) \) is the implicit or surveillance costs involved in borrowing,
- \( R_a \) is the interest rate on the alternative source of funds,
- \( A \) is the level of funds obtained from an alternative source, and
- \( tc \) are the transactions costs involved in obtaining funds from the alternative source.

For estimation it is necessary to commit to a functional form for the implicit surveillance cost function. One such function in which surveillance costs rise with the level of borrowing relative to capital is:

\[
(2) \quad c(B/K) = (\lambda K/2)(B/K)^2, \quad c'(B/K) = \lambda (B/K)
\]
where \( \lambda > 0 \) measures the degree of administrative or surveillance pressure on the bank. Substituting this explicit cost function into (1), scaling all variables by bank capital and minimizing \( C \) subject to the constraint that \( RN = A + B \), letting \( \text{Spread} = R_a - R_d \), and solving for \( B/K \), gives the bank’s demand for borrowed reserves as:

\[
B/K = \frac{1}{\lambda} (\text{Spread} + tc), \quad B/K > 0.
\]

The demand for borrowed reserves rises with the spread between markets rates and the discount rate, \( \text{Spread} \), rises with the transactions costs incurred in obtaining reserves from an alternative source, \( tc \), and falls with an increase in administrative pressure at the discount window, \( \lambda \).

The model described by equation (3) is a static in that describes only current-period borrowing. The Federal Reserve’s repeated avowal to discourage continuous borrowing during the 1920s suggests the implicit costs should be specified as a function of both current and past borrowing, which would make the demand for borrowed reserves the solution to a dynamic optimization involving current, past, and expected future borrowing as in Goodfriend (1983). Considerable evidence exists, however, that the sanctions against continuous borrowing were not enforced effectively in the interwar period. A study commissioned by the Federal Reserve found that as of August 1925 found more than 588 member banks had been borrowing steadily for a year or more from the Federal Reserve. Of these, 239 had been borrowing since 1920 and 122 had begun borrowing before that; see Shull (1971) pp. 34-35. One Federal Reserve bank was reported to have permitted its members to renew their 15-day loans indefinitely, and as of 1928 had never refused to renew, with some loans running as long as four years (Westerfield, 1932, p. 38). In all likelihood, discount window administrators were reluctant to enforce the policy against continuous borrowing because it conflicted with other Federal Reserve objectives, such as ensuring that ample credit was available in rural areas.\(^4\) It would be desirable, however, to take into account the possibility that banks did not adjust fully their actual borrowing to the desired amount in each period. The model can be made dynamic by specifying that adjustment of actual to desired borrowing occurs through an equilibrium correction mechanism (ECM). See Alogoskoufis and Smith (1991) and Hendry (1995) for a discussion of the specification and interpretation of error and equilibrium correction models. In an equilibrium correction version of the model the bank’s desired or equilibrium demand for borrowed reserves is a function of the interest rate spread and transactions costs as in equation (4). In
each period banks observe current spreads and transactions costs and strive to eliminate a portion $\gamma$ of the discrepancy that has arisen in the previous period between actual and desired borrowing. This can be represented by an equilibrium correction mechanism as:

$$\Delta(B/K) = \alpha \Delta(Spread_t + tc_t) - \gamma [(B/K)_{t-1} - (1/\lambda)(Spread_{t-1} + tc_{t-1})] + \epsilon_t$$

where $\epsilon_t$ is the current-period error term.

The incomplete adjustment of actual to desired borrowing in this case does not arise out of an explicit cost of selling or buying assets — that is captured in the transactions cost variable. Instead, the incomplete adjustment may be thought of as arising from the legal and contractual rigidities that impede immediate asset liquidation, such as the inability to sell securities pledged as collateral for government deposits or the impracticality of demanding early repayment of a customer loan. Alternatively, actual borrowing could depart from its equilibrium value is when it arises out of a temporary precautionary motive. A bank may borrow more than needed to meet current funding needs, for example, out of a concern that its depositors might suddenly increase their demand for cash, only to reduce the borrowing in the next period if the cash drain fails to materialize. For a bank with assets that can be converted into cash promptly $\gamma$ would be 1.0 and adjustment would be instantaneous. For a bank holding assets that cannot be called or sold immediately $\gamma$ would be lower and adjustment slower.

3. Data and variable definitions.

The Federal Reserve Board published data on member bank borrowing during 1914-41 in a variety of ways, including monthly figures on aggregate borrowing by member banks in each of its 12 districts. These district-level figures were chosen as a unit of analysis because they can be combined with Federal Reserve district-level data on bank balance sheet items, discount rates, bank failures, business failures, and debits to checking accounts to create a panel of especially rich data to be used in hypothesis testing. The appendix provides sources for these data.

During the interwar years each Federal Reserve bank was permitted to set its own discount rate, subject to Board approval, and discount rates often varied substantially across districts (Figure 1). The difference
between the highest and lowest discount rates charged among the 12 banks during 1922-33 ranged from as little as zero in some months in the 1920s to as much as 200 basis points for several months in 1931.

**Fig. 1 Federal Reserve Bank Discount Rates, 1922-33**

The rate on the alternative source of funds, $R_a$, should be the rate of return on the assets used to make marginal reserve adjustments. During the interwar period call loans, which were loans to purchase securities payable on demand, were the principal secondary reserve asset of money center banks. Although some banks in smaller cities were active in the call loan market, most relied principally on bankers balances (deposits with correspondent banks), commercial paper, banker acceptances, and time loans in the stock market to make reserve adjustments. Thus, the marginal cost of making reserve adjustments varied with the kind of bank making the adjustment. The Federal Reserve district level data in the panel data consists of banks from cities of all sizes. Ten districts contained Reserve City and Country banks, while two districts — New York and Chicago — included Central Reserve City banks as well. Hence an index of several money market rates would be preferable to a single rate as a measure of the opportunity cost of borrowing by banks aggregated by district. For that reason the Riefler-Turner Index of money market rates — an average of rates on call loans, commercial paper, and time loans — was used to measure $R_a$.

Transactions costs were measured using bid-ask spreads on corporate bonds from a new index of corporate bonds created in the process of preparing this paper. The index was constructed from the bid
and ask prices of a systematic sample of 30 corporate bonds, measured as a percent of the asking price, from January 1914 through December 1941. The data are from the Bank and Quotation Record published by the Commercial and Financial Chronicle. Details on the constriction and properties of this index are available in Gendreau (2017). The bid-ask spread is the cost of buying and immediately selling a security. It is a key component of the cost of transacting in the bond market, and can be viewed as a measure of the price of immediacy. As such, the bid-ask spread provides an observable measure of liquidity shocks in financial markets — a measure that, to this author’s knowledge, has been missing in all previous studies of the discount window. Liquidity in the corporate bond market was important to banks, which had long been advised to hold bonds in their secondary reserves (James, 1978, pp. 48-51), and met unusually large deposit drains in part by selling corporate bonds. Country member banks, for example, sold $226 million in corporate bonds to help meet a $1,172 million net fund outflow between June 30 and December 31 of 1931 — a period that included the September-October banking panic. As a measure of the cost of meeting a liquidity shock through asset sales, the bid-ask spread on corporate bonds overstates the cost of transacting in liquid assets such as call loans or U.S. government securities, but understates the cost of liquidating other assets such as commercial loans made on ineligible collateral.

Fig. 2 Bid-Ask Spreads and Credit Spreads, 1914-41

Bid-ask spreads on corporate bonds tended to be cyclical, though there were exceptions. As can be seen in Figure 2, spreads widened during the 1918-19, 1920-21, 1929-33, and 1937-38 contractions, though not the 1923-24 or 1926-27 downturns. Spikes in bid-ask spreads are also occurred during the war
financing campaigns of the First World War, the banking panics of 1931 and 1933, and the deposit drains of the first half of 1932. Bid-ask spreads were closely correlated with credit spreads as measured by the difference in yields on Moody’s Baa- and Aaa-rated corporate bonds. Like bid-ask spreads, credit spreads also widened during the banking panics of the 1930s as banks shifted out of lower-grade corporate bonds into higher quality bonds such as U.S. Treasuries that were perceived to be better secondary reserve assets and were readily accepted as collateral for borrowings, as discussed in Friedman and Schwartz (1963) and Bernanke (1983).

In the empirical tests the equation describing the demand for borrowed reserves was modified in several ways. First, a statistical intercept was added. Second, dummy variables for each Federal Reserve district were entered into the equilibrium correction term of the regression equations to capture fixed effects — permanent differences in borrowing behavior by banks across districts. In addition, 11 monthly dummy variables were added to capture the variation in borrowing related to seasonal changes in loan demand and deposit withdrawals. The objective in controlling for seasonal effects is to focus on borrowing to meet reserve needs unrelated to expected seasonal variations in loans and deposits. Treating the demand for borrowing as separable from the other bank choices is justifiable if the borrowing is to meet an unexpected reserve need, such as an unanticipated deposit withdrawal. Otherwise, a more comprehensive model of bank optimization across all assets and liabilities is appropriate; see Dutkowsky and McCoskey (2001).

Finally, a reserve need variable was introduced as an additional regressor. The demand for bank reserves as derived in equations (1) through (4) makes no provision for corner solutions, although some banks may have chosen not to borrow from the discount window if surveillance costs were perceived to be prohibitively high, while others may have needed to obtain all of their liquidity from the discount window if they were credit constrained. Borrowing was positive in all Federal Reserve districts throughout 1922-33, but the data aggregated up to the district level may contain observations on banks that were not borrowing from the Fed, on banks that were meeting their reserve needs from the discount widow and other sources, and on banks that were credit constrained and needed to meet all of their reserve need at the discount window. Dutkowsky (1984), however, notes that aggregation may produce smoothing, allowing borrowing by credit-constrained banks to be captured by introducing a reserve need variable into the borrowing regression. In their estimates of the demand for borrowed reserves using
time-series data Goldfeld and Kane (1966) and Wheelock (1993) used unborrowed reserves as a proxy for reserve needs. For estimates with panel data with a cross-section dimension, however, it would be desirable to have a measure of district-specific reserve needs. These were proxied by a monthly fund flow variable, *FundFlow*, measured as the change in deposits minus the change in customer loans in each district, each scaled by bank capital. A positive value for this variable represents a fund inflow, while a negative value represents a fund outflow. This variable is similar to the measure of intrayear bank fund flows proposed by Melichar (1970), except as used here it does not represent predictable seasonal reserve needs — those are captured by the seasonal dummies in the regression equation. Instead, the fund flow variable is intended to capture reserve needs arising from less easily anticipated changes in loan demand and deposit changes, including deposit losses arising out of runs on banks.⁸

The demand curve for borrowed reserves for individual credit-constrained banks, meanwhile, would be perfectly vertical (invariant with respect to interest rate and bid-ask spreads). In aggregated data this would appear as a nonlinearity which could be captured by a nonlinear specification (see Dutkowsky, 1984). Scatter plots of district-level borrowing against interest rate and bid-ask spreads, however, revealed no obvious nonlinearities, so estimates were made using a linear specification. The sample period used in estimation was January 1922 through December 1933 covering 144 months’ of observations on banks in 12 Federal Reserve districts, for a total of 1,728 observations. The sample begins shortly after the Federal Reserve ended its policy of supporting the Treasury bond market and abandoned progressive discount rates for a policy of administrative pressure on borrowing. It ends the month before federal deposit insurance went into effect in January 1934 on a temporary basis as provided for by the Banking Act of 1933 (deposit insurance became permanent on June 30, 1934). Table 1 presents summary statistics for the variables used in estimation. While the data on the money market rate and bid-ask spreads are the same for all districts and vary only over time, the data on bank borrowing relative to capital, discount rates (and therefore interest rate spreads), and fund flows have both cross-section and time-series dimensions. Considerable variation exists in all four variables. The spread between money market rates and the discount rate, which was positive on average in most districts in the 1920s, began to turn negative in some districts in December 1929, and stayed consistently negative in most districts after March or April of 1930. The New York district was an exception: The interest rate spread became consistently negative in that district only after April 1932. Member bank borrowing relative to capital fell by an average of about 45% in the 1930s, though markedly less so in
the Atlanta and Richmond districts than elsewhere. Borrowing, however, rose in nearly all districts
during periods of financial stress, such as in late 1931, early 1932, and early 1933, in part because bid-
ask spreads were unusually high, making bond sales a costly alternative to borrowing despite a negative
interest rate differentials at the discount window.

4. Estimation
The demand for borrowed reserves was estimated as:

\[
\Delta(B/K)_{it} = \alpha_0 + \alpha_1(\Delta\text{Spread}_{i,t} + \Delta\text{Bidask}_{i,t}) + \alpha_2\text{FundFlow}_{i,t} + \gamma[(B/K)_{i,t-1} + \alpha_3(\text{Spread}_{i,t-1} + \text{Bidask}_{i,t-1}) + \text{fixed effects}] + \text{seasonal dummies} + e_{it},
\]

where: \(\text{Spread}_{i,t} = Rm_t - Rd_{i,t}\), \(\text{Bidask}_{i,t}\) is the transactions cost variable measured as bid-ask spreads on a
sample of corporate bonds, \(e_{it}\) is an error term, and the \(i\) subscript identifies variables specific to banks
in the \(i\)th Federal Reserve district. The expected signs on the coefficients were:

\(\alpha_1, > 0, \quad \gamma, \alpha_2, \alpha_3 < 0\)

In this model the “impact coefficient,” \(\alpha_1\), measures the initial or immediate response of borrowing to
changes in interest rate and bid-ask spreads. The \(\alpha_2\) coefficient captures change in borrowing in the
Federal Reserve district aggregate data represented by credit-constrained banks needing to fill all of their
reserve need at the discount window. The \(\gamma\) coefficient, as discussed above, measures the speed at which
the deviation of actual from desired borrowing in the previous period is eliminated. The coefficient of
special interest is the \(\alpha_3\) coefficient on the lagged interest rate and bid-ask spreads which is the key
parameter of the error correction mechanism. The parameter that measures the degree of administrative
pressure on bank borrowing, \(\lambda\), can be recovered from the estimate of \(\alpha_3\) as \(\lambda = 1/\alpha_3\).

A natural starting point in estimating any model using data with a time-series dimension is to see
whether the variables are stationary. As is well known, the use of nonstationary data in regressions can
lead to invalid results. In recent years a vast literature has emerged on testing for unit roots and
cointegration in panel data. Table 2 reports the results of Levin, Lin, and Chu tests for the presence of a
common unit root in the panel data. That test cannot reject the null hypothesis that a unit root exists in
the panel for the ratio of borrowing to capital and the interest rate and bid-ask spread variables measured in levels, but rejects the hypothesis of a unit root when the variables are measured in first differences.  

Engle and Granger (1987) have shown that nonstationary variables — those having a unit root — can be used in estimating an error correction model if they are cointegrated, such that a linear combination of the variables is stationary. Pedroni (1999) has extended Engle and Granger’s test for cointegration to panel data involving multiple regressors, essentially testing in a panel context whether the residuals of a regression in levels among the variables in question are stationary. Results from a Pedroni cointegration test, reported in Table 3, indicate the hypothesis of no cointegration can be rejected at the one percent level whether the autoregressive coefficients are constrained to be the same or allowed to vary across individual districts.

In estimating equation (5) the choice of estimation technique depends on whether the explanatory variables can be considered exogenous. The argument for exogeneity rests, in the language of Koopmans (1950), on the extent to which the explanatory variables can be considered to be “determined outside the system under analysis.” Although borrowing in the aggregate would have affected credit markets, individual member banks were price takers in national money and bond markets. To the extent bank lending and deposit-gathering occurred in the context of long-term customer relationships, meanwhile, short-term fund flows in and out of the banks represented quantity decisions initiated by customers, and hence were exogenous to banks.

If the demand for borrowed reserves cannot, a priori, be considered in isolation, estimation of equation (5) with ordinary least squares is still possible if it’s contemporaneous variables, \( \Delta \text{Spread} \) and \( \Delta \text{Bidask} \), are weakly exogenous. Suppose equation (5) is one of three equations in which \( \Delta B/K, \Delta \text{Spread}, \) and \( \Delta \text{Bidask} \) are the dependent variables, with \( \Delta \text{Spread} \) and \( \Delta \text{Bidask} \) each a function of the change in bank borrowing, the equilibrium correction terms, and structural shocks. In this situation \( \Delta \text{Spread} \) and \( \Delta \text{Bidask} \) are weakly exogenous if no feedback occurs between the equilibrium correction terms and those variables. The argument for weak exogeneity is that it is implausible that the adjustment of actual to desired borrowing at the individual bank or even district level would occur through changes in interest rates in money markets and in prices in corporate bond markets. The assumption of weak endogeneity is also supported by the results of statistical tests. Specifically, in regressions of \( \Delta \text{Spread} \) and \( \Delta \text{Bidask} \) on
the model’s error correction term — measured as the lagged residuals from a regression of the level of bank borrowing, \(B/K\), on the levels of the Spread and Bidask variables (the cointegrating regression) — coefficients on the error correction terms are not statistically significantly different from zero at the five percent confidence levels, suggesting an absence of feedback.

The results of ordinary least squares estimation of the demand for borrowed reserves as specified in equation (5) are presented in Table 4. The estimates indicate that for the full sample, covering January 1922 to December 1933, changes in borrowing as a portion of bank capital were positively related to the model’s impact variables — changes in the interest rate and bid-ask spreads — and also responded to feedback from the difference between the level of past actual and desired borrowing. The coefficient on the fund flow variable is also positive, as expected. All estimated coefficients except the intercept are positive and statistically significantly different from zero at the one percent confidence level.

Table 4 also reports estimates for the sample split at the February 1929 break suggested by the date of the Federal Reserve Board’s letter discouraging member banks from borrowing at the discount window to finance “speculative” loans. A Chow test allows the null that no break occurred in February 1929 to be rejected at the one percent confidence level. The coefficient on changes in the interest rate and bid-ask spreads — the impact coefficient — declines after the break, though only modestly. The estimated coefficient on the fund flow variable (\(FundFlow\)) also declines after February 1929, suggesting a smaller portion of borrowing was accounted for by banks seeking to fill their entire reserve need at the discount window, though the coefficient is not estimated precisely. The coefficient of the most interest is that on the lagged interest rate and bid-ask spreads — the response coefficient in the ECM —because it provides a direct measure of the degree of administrative pressure at the discount window. This coefficient declines markedly after February 1929 consistent with an increase in administrative pressure on discount window borrowers. The feedback effect parameter, \(\gamma\), which measures the speed at which banks adjusted actual to desired borrowing, increases after the break point. This, too, is consistent with a tightening of administrative pressure: Facing increased surveillance banks would have rationally sought to repay their borrowings faster. The estimates suggest that member banks, which took about four months to bring actual into alignment with desired borrowing before February 1929, took only about three months to do so after that date.
The estimated cross-section fixed effect coefficients are reported in Table 5. The dummy variable for the Philadelphia district was omitted from the regressions. Member banks in that district borrowed an amount relative to capital that was close to the system-wide average during 1922-33, so the fixed effects can be interpreted roughly as deviations from average borrowing. The estimates point to enduring heterogeneity in borrowing across Federal Reserve districts. They indicate that once the model’s explanatory variables have been taken into account borrowing relative to capital was notably higher in two districts — Atlanta and Richmond. This suggests discount window officers in those districts were as a matter of course more liberal in extending loans to banks, that member banks in those two districts were chronically less reluctant to borrow at the discount window, or both. The persistently higher level of borrowing in those districts mirrors the well-documented tendency of banks in the South to rely heavily on funds borrowed from city correspondent banks.\textsuperscript{12} The coefficient for the St. Louis district is also larger than that of the average-like Philadelphia district, but substantially smaller than that of the Atlanta and Richmond districts. The only coefficient that is negative and also estimated precisely is that for the New York district, the home of several large money-center banks that were less reliant on borrowing throughout the interwar period than banks located in the rest of the country.

While a strong prior exists for a policy-related structural break in February 1929, it is possible that it occurred at a different date in some Federal Reserve districts, especially those whose banks were not heavily involved in the call loan market. Quant-Andrews tests for unknown breaks using time-series data for each of the 12 Federal Reserve districts showed earlier breaks in some districts and later breaks in others. But the tests pointed to breaks in early 1929 for the Chicago and New York districts, whose member banks as of December 1928 accounted for 58\% of the bills discounted by the Federal Reserve System, and breaks occurring a few months later in 1929 for the Boston, St. Louis, and Kansas City districts, which accounted for another 13\% of bills discounted. In other words, the estimates suggest that by late 1929 the administrative tightening had occurred in districts that accounted for at over 70\% of borrowings.

5. \textbf{Robustness tests}
Confidence in a structural model, such as the one developed here, would be enhanced if the model’s main results can be shown to be robust with respect to specification and variable definitions. The simplest way to do this is to compare it to an alternative model of the demand for borrowed reserves.
The only model that exists of discount window borrowing in the interwar years is the one developed by David Wheelock, reported in his 1991 book and in articles that preceded that book. In that model, which was estimated on time-series data and is based on the well-known model of Goldfeld and Kane (1966), the change in borrowing, \( \Delta B \), is a function of the spread between the commercial paper rate and the discount rate, \( \text{Spread}_{i,t} = R_{CP,t} - R_{d,i,t} \), changes in unborrowed reserves as a proxy for banks’ reserve need, \( \Delta RN \), lagged borrowings, and changes in bank debits, \( \Delta Debits \), to capture the influence of economic activity on the demand for borrowed reserves, and a dummy variable added to capture changes in borrowing during the Great Depression years. To adapt this model for estimation with panel data and facilitate comparisons to the estimates reported in Table 4, borrowing and bank debits were scaled by bank capital, seasonal dummies were added, and the dummy variable for the Great Depression years in the regressions reported by Wheelock was omitted to allow parameter shifts and fixed effects to pick up any change in structure during those years. So modified, the alternative model is:

\[
\begin{align*}
\Delta \left( \frac{B}{K} \right)_{i,t} &= \delta_0 + \delta_1 \text{Spread}_{i,t} + \delta_2 \Delta RN_{t} + \delta_3 \left( \frac{B}{K} \right)_{i,t-1} + \delta_4 \Delta \left( \frac{\text{Debits}}{K} \right)_{i,t} \\
&\quad + \text{seasonal dummies} + u_{i,t}
\end{align*}
\]

where \( u_{i,t} \) is an error term that has both a cross-section and time-series dimension, and the \( i \) subscript identifies variables specific to banks in the \( i \)th Federal Reserve district. The coefficient on the interest rate spread, \( \delta_1 \), is typically interpreted as a measure of the influence of reluctance, surveillance, or both on borrowing (see Goldfeld and Kane, 1966, and Polikoff and Silber, 1967). Table 7 reports estimates of the alternative model using the Federal Reserve district panel data for January 1922 through December 1933, and for the sample split at the hypothesized February 1929 break. The coefficient on the interest rate spread in the alternative model, which implicitly measures the administrative pressure on borrowing, falls after the hypothesized February 1929 break, is consistent with a tightening of the terms of access to the discount window.

7. Did the change in policy matter?

The estimates from the equilibrium correction model can be used as the basis of a counterfactual: Would borrowing have been materially greater had the Fed not tightened the terms of access to the discount window, and if so, did it matter? To provide some evidence on this question the model estimated over the pre-break period was used to predict borrowing during February 1929 – December 1933. Figure 3
shows the results of a dynamic simulation in which fitted values of member bank borrowing relative to capital aggregated up to the national level are plotted against actual borrowings. Predicted borrowing — the dark line in the figure — is consistently higher than actual borrowing, and substantially so in some periods. Based on past relationships with interest rates, bid-ask spreads, and fund flows, borrowing should have averaged 15.8% of bank capital during February 1929-December 1933 — an increase from the average of 13.3% of capital during January 1922-January 1929. Instead, borrowing fell to an average of only 9.6% of capital. Both actual and predicted borrowing rose during the 1931 and 1933 panics, though actual borrowing was still less than predicted by past relationships.

Discount window policy and bank failures.

If, as the simulations indicate, banks borrowed less after February 1929 than predicted by historical relationships it is natural to ask whether the shortfall contributed to the numerous bank failures of the 1930s. Many researchers have found bank failures were important in explaining the severity of the Great Depression, even if they disagree on the transmission mechanism; see the contributions from Anderson and Butkiewicz (1980), Bernanke (1983), Bordo and Lane (2012), Calomiris and Mason (2003), Carlson and Rose (2015), Cohen, Hachem, and Richardson (2017), Friedman and Schwartz (1963), Jalil (2014), Meltzer (2003), Richardson and Troost (2009), Trescott (1992), and Wicker (1996). To the extent that reduced access to the discount window impaired bank liquidity, and thus contributed to bank failures, the decline in borrowed reserves should be associated with higher bank failure rates. It might seem natural...
to test for this by regressing bank failures against the shortfall of actual borrowing from that predicted by the ECM model, controlling for other factors that may have led to bank failures. This approach, however, is unlikely to be persuasive given that factors other than structural change, such as specification errors, may contribute to forecast errors. An alternative approach, which does not use a forecast error as an explanatory variable, is to regress measures of bank failures on the ratio of currency to borrowed reserves and controls. Elmus Wicker (1996) has argued that the quantity of Federal Reserve notes in circulation is a useful proxy for the hoarding of cash that occurs in currency drains. A rise in Federal Reserve notes in circulation in any district unmatched by an increase in borrowing would indicate a decline in liquidity for banks that were credit constrained or had exhausted their liquid assets or eligible collateral. As can be seen in Figure 4, currency-to-borrowings ratio varied considerably over time during the 1920s and 1930s. Ratios rose sharply in late 1929 and hit new peaks during the April-August 1931 banking crisis, only to drop during the September-October 1931 and February-March 1933 crises, reflecting the sudden willingness of the Fed to encourage borrowing in an effort to quell the panics. Nonetheless, after the 1931 and 1933 crises currency-to-deposit ratios remained well above their average levels in non-panic periods.

**Fig. 4  Currency-to-borrowing ratios**

Three measures of bank failures rate at the district level during 1929-33 were used in bank failure regressions. The first, *Banks*, is the real value of deposits in suspended banks in each district, with the
wholesale price index used as the deflator. This is the bank failure measure used by Bernanke (1983) measured at the district level. It is not scaled by bank size or capital, but scaling to avoid spurious size-related correlations is not be necessary in that deposits in failed banks were often larger in some of the smaller districts than in the larger districts. The second, Banksrate, is the ratio of deposits in suspended banks to all bank deposits (excluding interbank deposits). The third, Numbanks, is the ratio of the number of bank suspensions to total number of banks in each district. For both Banksrate and Numbanks the scale factor was lagged one month. All three of these bank failure measures use data from all suspended banks — nonmember as well as member banks — and the figures include temporary as well as terminal suspensions. Measuring bank failures using data on all bank suspensions allows for the possibility that a tightening of the terms of discount window access would have contributed to the failure of banks other than those with direct access to loans from Federal Reserve banks. Commercial banks in smaller communities typically relied on correspondent banks in larger cities, which were nearly always member banks, for interbank credit. A reduction in emergency credit from the discount window for the larger member banks would have impaired their ability to lend to smaller banks, making it difficult in turn for the smaller banks to meet deposit withdrawals.¹⁵,¹⁶

Researchers have long debated the role of solvency versus illiquidity in explaining the bank failures of the Great Depression. One control for solvency is a measure of business failures. Two measures were employed here. One, Fails, is the real value of liabilities of failed businesses per district in 1928 dollars, using the wholesale price index as the deflator. The other, Failsrate, is the value of liabilities of failed businesses scaled by total bank loans (excluding interbank loans), a proxy for the size of total debt in the nonfinancial sector.

Neither the currency-to-borrowing ratio nor business failures can be considered exogenous because they were both affected by bank failures. Boughton and Wicker (1979) and Trescott (1984) provide evidence that the demand for currency during the Great Depression was affected by bank failures as well as interest rates and economic activity. As noted above, bid-ask spreads — which affected the demand for borrowed reserves — widened during the banking panics of the 1930s as banks sought to liquidate bonds to meet deposit withdrawals. Ramirez and Shively (2012), meanwhile, show that business failures were affected by bank failures in the years before the Great Depression. Therefore instrumental variables were used in estimation. The instruments were lagged values of the currency-to-borrowing ratio, bank failures,
and business failures; current and past values of the explanatory variables used in the regressions for the demand for borrowed reserves; and two variables that affect the demand for currency: the spread between the commercial paper rate and the deposit rate, and debits to bank accounts, a common proxy for expenditures. Not all of these instruments, such as interest rates, would be considered exogenous in a broader model of economic and financial activity, but would have been exogenous to those at the district level making short-term decisions about currency holdings and borrowing.  

Table 6 reports the results of the TSLS estimates of the bank failure regressions. To match the scaling of the dependent variables, real liabilities of failed businesses were used in the regression explaining real deposits in failed banks, and the business failures rate was used in the bank failure rate equations. The coefficients on all regressors in the three equations are statistically significant at the one or five percent level except for the coefficient on the currency-to-deposit rate in the Banksrate equation, which is significant only at the ten percent level (two-tailed test. The estimated coefficients are large. For example, the 0.02 coefficient on the currency-to-borrowing ratio in equation (3) in Table 6 implies that a one point decline in that ratio, evaluated at the sample mean, would have reduced the number of failed banks by 4.45 banks per district per month, or 2,670 banks during February 1929-March 1933 — a 41% decline. The coefficient on the currency-to-borrowing ratio in equation (1) in Table 6 implies a smaller effect: a 25% decline in the real value of deposits in failed banks. These are first-order effects only; the long-term effects could be smaller or larger depending on how liquidity as measured by the currency-to-borrowing ratio affected business failures and banks failures with a lag. Still, the size of the effects in Table 6 do not seem unrealistic given that withdrawals were cited by the Federal Reserve’s Division of Bank Operations as either a principal or contributing cause in 48% of bank suspensions during January 1929-March 1933 (see Richardson, 2007).

7. Conclusions.
The founders of the Federal Reserve System envisaged that the discount window would be the new central bank’s principal operating instrument. Although it was superseded in the 1920s by open market operations as the Fed’s principal tool for affecting credit conditions, the discount window continued to be a source of seasonal and emergency liquidity for individual banks. The failure of thousands of banks during the Great Depression, many of which occurred during banking panics or runs on individual banks, suggests the Federal Reserve had tightened the terms of access to the discount window. Banks
eligible to borrow should have been able to use the discount window to obtain emergency liquidity assistance.

This paper presents evidence, based on a model estimated on a panel of Federal Reserve district-level data, that the demand for borrowed reserves fell sharply after February 1929. That was the date the Federal Reserve Board, concerned about speculation in the stock market, began a campaign to discourage banks from borrowing to finance loans to buyers of stocks. It was followed by a tightening of the collateral requirement as concerns rose about bank asset quality. Borrowing at the discount window after February 1929 was substantially less than past relationships between borrowing, interest rates, and transactions costs predicts. A rise in the currency-to-borrowing ratio, which would have been affected by an administrative tightening of the terms of access to the discount window, is positively related to measures of bank failures after controlling for business failures.

The picture of Federal Reserve discount window policy that emerges is one of an institution that struggled with multiple and sometimes conflicting goals. The Fed’s desire to accommodate borrowing on real bills conflicted with its efforts to steer credit away from the stock market, which eventually discouraged all borrowing. The Federal Reserve’s efforts in the 1930s to avoid lending to weakened banks conflicted with its desire to promote financial stability. The end result of these conflicts were policies that tightened the terms of access to the discount window. The estimates presented here indicate that borrowing fell far short of what it would have been had the Fed not tightened the terms of access to the discount window, resulting in a substantial increase in bank failures.
Footnotes

1 See Hackley (1973) for a legislative history of the discount mechanism.

2 The issue of what collateral is appropriate for central bank credit facilities arose again in the 2008-09 global financial crisis; see Cheun, von Koppen-Mertes, and Weller (2009).

3 In the 1931 crisis member bank borrowing jumped from $333 million at the end of August to an average of $723 million in during September-October as banks scrambled to meet the massive gold drain following Great Britain’s departure from the gold standard. The consensus at the October 26 meeting of the Fed’s Open Market Policy Committee was that “everything should be done to persuade the (city) banks to adopt a liberal policy” of lending to banks in difficulty and rediscouting at the Federal Reserve banks, though the Committee failed to approve a bold program of open market purchases of government securities (Meltzer, 2003, pp. 349-350). Similarly, in the 1933 crisis borrowing more than doubled to $582 million in February when deposit drains induced six states to declare banking holidays or authorize restrictions on the withdrawal of deposits. Twenty two other states went on to declare bank holidays in the first few days of March 1933, and on March 6 President Roosevelt declared a nation-wide holiday. The System responded to the onset of the 1933 crisis much as it had in 1931, discounting “freely” but declining to purchase securities in quantity in the open market. Total borrowing at member banks relative to capital reached a peak of 11.7% in the 1931 panic and 11.1% in the 1933 panic, but remained below the 12.3% average of the during the 1922-28 years in which no national banking panics occurred.

4 Hackley (1973) presents evidence that the provision of credit for agricultural purposes was one of the primary objectives of the Federal Reserve Act, and that sponsors of the Act envisaged that the discount mechanism would permit banks to expand in normal times (pp. 10 and 43). Redenius and Weiman (2006) argue that reformers hoped the creation of the Federal Reserve would reduce high agricultural credit costs, especially in the South.

5 The $1,172 million outflow is the change in deposits minus the change in customer loans at country member banks during the second half of 1931. In addition to selling corporate bonds, the banks met this fund outflow by liquidating $289 million in loans on securities collateral, withdrawing $332 million in bankers balances from correspondent banks, selling $46 million in open-market paper, and borrowing $279 million from the Federal Reserve and other sources.

6 Note that call loans, the main secondary reserve asset of money center banks of the era, were not as liquid as they might have appeared. Even though they were callable on demand they were settled in clearing house funds and did not provide immediate availability of funds (Board of Governors, 1959, 28).

7 Dutkowsky (1984) derives the demand for borrowed reserves in the context of a nonlinear optimization that takes these two corner solutions explicitly into account, resulting in three possible regimes: (i) one in which there is no borrowing from the discount window, (ii) one in which banks meeting reserve needs in part from the discount window and in part from other sources, and (iii) by meeting all reserve needs by borrowing. Estimates of the demand for borrowed reserves using individual bank data could take switching among these three regimes into account.
With seasonal dummy variables in a regression equation, introducing a variable is equivalent to seasonal adjustment using those dummies before entering it into the regression. (Equation 27)

Augmented Dickey-Fuller (ADF) tests were conducted for the existence of individual unit root processes in the variables. These tests lead to acceptance at the five percent level of the null hypothesis that an individual unit root exists in the interest rate spread data, but reject this hypothesis for the level of borrowings as a portion of bank capital. When the test was repeated for borrowing at each individual district, however, the tests rejected the presence of a unit root for four districts at the five percent confidence level, but allowed acceptance of the null of a unit root for the other eight districts. The ADF tests, meanwhile, reject the hypothesis of individual unit roots in all of the variables when measured in first differences. On balance, I interpret this as evidence of a unit root in bank borrowing in the panel. (Equation 28)

The exogeneity of customer loans is apparent in Winfield Riefler’s description of them as “…well secured but indeterminate loans by banks to customers who cannot tell the period for which they will need accommodation, and desire to repay their obligations at will. It is not expected that they will be called at the option of the bank…If banks desire to keep customers they must be prepared to meet their legitimate credit demands” (Riefler, 1930, 87-88). Customer loans, however, would not necessarily have been endogenous over longer periods of time or unaffected by the amount of credit available to banks through the discount window. Research by Cohen, Hachem, and Richardson (2016) indicates such loans were affected by a reduction in liquidity to banks. (Equation 29)

The estimates reported in Table 4 incorporate the restriction that the coefficients on the interest rate spread and bid-ask spread variables are equal. A Wald test cannot reject that restriction that the impact coefficients on $\Delta\text{Spread}$ and $\Delta\text{Bidask}$ are equal, but rejects the equality restriction on the coefficients on lagged levels of the interest rate and bid-ask spreads at the one percent level. The results are reported with the restrictions in place because (i) they are derived explicitly from cost minimization as modeled above, and (ii) they should result in more efficient estimates. Relaxing the coefficient restrictions does not alter the conclusions drawn from the estimates. (Equation 30)

On December 31, 1928 interbank borrowings amounted to 15% of capital in the Atlanta and Richmond districts vs. 4% in the other ten districts. James (1978, pp 159-164) and Redenius and Weimer (2006) argue the greater reliance on interbank borrowing in the South reflects the underdevelopment of the banking sector and large swings in loan demand related to seasonal variation in the crop cycle for cotton. Borrowings from Federal Reserve Banks were also higher in the Atlanta and Richmond districts, amounting to 25% of capital vs. an average of 16% of capital in the other districts. (Equation 31)

Dynamic forecasts allow forecast errors to accumulate by using simulated values for lagged dependent variables. The average predicted and actual borrowing ratios shown in Figure 3 are figures for individual districts weighted by each district’s share of total member bank borrowing. (Equation 32)

These are averages across districts weighted by member bank capital. The averages shown in Table 1 are unweighted averages. (Equation 33)

Member banks were prohibited by the Federal Reserve Act from acting as agents for nonmember banks in applying or receiving Federal Reserve credit except by permission of the Federal Reserve Board. This provision was not binding upon member banks, because borrowed funds are fungible and
because the Fed interpreted the statutory prohibition liberally. Member banks were making interbank loans while in debt to the Federal Reserve throughout the 1920s and 1930s, and most interbank loans were to nonmember banks. The September 29, 1931 call reports, for example, show that member banks had $598 million outstanding in interbank loans, of which 75% were to nonmember banks, while they were in debt by $330 million to Federal Reserve banks. See Hackley (1973, p. 119) for a discussion of the Fed’s liberal interpretation of the prohibition on member bank borrowing on behalf of nonmember banks.

16 Flannery (1996) provides a model of how lenders may rationally withdraw from the interbank market during a financial panic.

17 Tests of whether the bank failure and business failure measures contain a unit root were generally inconclusive. Tests could not reject the null of a common panel unit root for two of the bank failure and all of the business failure variables, but indicated in each case that some cross-sections did not have a unit root. The real value of deposits in failed banks, in which no common unit root was evident, was an exception. Differencing the data to eliminate common unit roots, however, introduced negative serial correlation. Quasi-differencing the data eliminated the first-order serial correlation in the panel, but Wald tests rejected the presence of a common factor that would justify such a restriction. The coefficient estimates using data in levels, first differences, or quasi-differences, however, were all remarkably similar, and only the results of the TSLS regressions in levels are reported in Table 6.
References


Carlson, Mark. and Rose, Jonathan D., “Credit Availability and the Collapse of the Banking Sector in the 1930s,” *Journal of Money, Credit, and Banking*, vol. 47, no. 7 (October 2015), 1239-1271.


Jalil, Andrew J., “Monetary Intervention Really Did Mitigate Banking Panics during the Great Depression: Evidence Along the Atlanta Federal Reserve District Border,” *Journal of Economic History*, vol. 74, no. 1 (March 2014).


Table 1
Summary Statistics

Panel data for member banks in 12 Federal Reserve districts
in percent

1922.01 - 1933.12
1,728 observations

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowing/capital (B/K)</td>
<td>11.76</td>
<td>10.50</td>
<td>7.55</td>
</tr>
<tr>
<td>Spread</td>
<td>-0.29</td>
<td>0.14</td>
<td>1.16</td>
</tr>
<tr>
<td>Bidask</td>
<td>1.52</td>
<td>1.15</td>
<td>1.09</td>
</tr>
<tr>
<td>FundFlow</td>
<td>-1.56</td>
<td>-0.71</td>
<td>11.23</td>
</tr>
</tbody>
</table>

*B/K:* Borrowing as a portion of book capital.

*Spread:* Difference between money market rate (Reifler-Turner index) and the discount rate in each district.

*Bidask:* Spread between ask and bid prices on corporate bonds, % of ask price.

*FundFlow:* Change in deposits minus change in customer loans, scaled by bank capital.
Table 2
Panel Unit Root Tests

Levin, Lin, and Chu t-tests
Null hypothesis: A common unit root

1. Levels

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowing (B/K)</td>
<td>1.79</td>
<td>0.96</td>
</tr>
<tr>
<td>Spread</td>
<td>1.50</td>
<td>0.94</td>
</tr>
<tr>
<td>Bidask</td>
<td>0.34</td>
<td>0.63</td>
</tr>
</tbody>
</table>

2. First differences

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowing (B/K)</td>
<td>-35.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Spread</td>
<td>-20.10</td>
<td>0.00</td>
</tr>
<tr>
<td>Bidask</td>
<td>-70.74</td>
<td>0.00</td>
</tr>
<tr>
<td>FundFlow</td>
<td>-21.96</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Lags in all of the tests were chosen using the modified Aikike criterion given the presence of a significant negative MA terms in the time series of all three variables.

No test for a unit root in the levels of the fund flow variable, FundFlow, is reported because that variable is measured in first differences. No test for an individual unit root process for the bid-ask spread was conducted because there is no cross-section variation in this variable.
Table 3  
Panel Tests for Cointegration  

Series: Borrowing (B/K), Spread, and Bidask  
1922.01 - 1933.12 (12 cross sections, 1728 observations)  

Null hypothesis: No cointegration  

1. Common autoregressive coefficients  

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel ADF-statistic</td>
<td>-3.19</td>
</tr>
</tbody>
</table>

2. Individual autoregressive coefficients  

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group ADF-statistic</td>
<td>-2.69</td>
</tr>
</tbody>
</table>

ADF: Augmented Dickey-Fuller test. The lag length was selected using the modified Akaike criterion. The tests included an intercept but no deterministic trend. The conclusions for the tests do not change if a trend is included.
### Table 4
Estimated Demand for Borrowed Reserves
**ECM model**

Dependent variable: Change in borrowing relative to capital, $\Delta(B/K)_{i,t}$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full sample 1922.01-1933.12</td>
<td>Pre-break 1922.01-1929.01</td>
<td>Post-break 1929.02-1933.12</td>
</tr>
<tr>
<td><strong>Coefficient</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.16</td>
<td>-0.82</td>
<td>-1.62</td>
</tr>
<tr>
<td></td>
<td>(-2.84)**</td>
<td>(-1.47)</td>
<td>(-2.80)**</td>
</tr>
<tr>
<td>$\Delta$Spread$<em>{i,t}$ + $\Delta$Bidask$</em>{t}$</td>
<td>0.78</td>
<td>0.86</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(7.22)**</td>
<td>(3.79)**</td>
<td>(6.89)**</td>
</tr>
<tr>
<td>FundFlow$_{i,t}$</td>
<td>-0.02</td>
<td>-0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(-2.98)**</td>
<td>(2.36)**</td>
<td>(-1.10)</td>
</tr>
<tr>
<td>Feedback effect, $\gamma$</td>
<td>-0.21</td>
<td>-0.26</td>
<td>-0.32</td>
</tr>
<tr>
<td></td>
<td>(-16.09)**</td>
<td>(-14.81)**</td>
<td>(-13.04)**</td>
</tr>
<tr>
<td>Spread$<em>{i,t-1}$ + Bidask$</em>{t-1}$</td>
<td>-3.51</td>
<td>-5.34</td>
<td>-3.47</td>
</tr>
<tr>
<td></td>
<td>(-11.54)**</td>
<td>(-10.24)**</td>
<td>(-15.28)**</td>
</tr>
<tr>
<td><strong>Fixed effects</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Seasonal dummies</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.20</td>
<td>0.25</td>
<td>0.34</td>
</tr>
<tr>
<td>Obs.</td>
<td>1716</td>
<td>1008</td>
<td>708</td>
</tr>
</tbody>
</table>

OLS estimates; t-statistics in parentheses; *** indicates statistical significance at the one percent level, and ** at the 5% level (two-tailed tests).

$\Delta(B/K)_{i,t}$: Change in borrowing/capital, $(B/K)_{i,t} - (B/K)_{i,t-1}$.

Spread$_{i,t}$: Difference between money market rate (Riefler index) and the discount rate.

Bidask$_{t}$: Spread between ask and bid prices on corporate bonds, % of ask price.

FundFlow$_{i,t}$: Change in deposits minus change in customer loans, both scaled by capital.
Table 5  
Estimated Fixed Effects

<table>
<thead>
<tr>
<th>Federal Reserve District</th>
<th>Coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>-2.58</td>
<td>-6.83 ***</td>
</tr>
<tr>
<td>New York</td>
<td>-4.59</td>
<td>-2.43 **</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>-1.12</td>
<td>-0.59</td>
</tr>
<tr>
<td>Cleveland</td>
<td>-2.79</td>
<td>-1.48</td>
</tr>
<tr>
<td>Richmond</td>
<td>4.75</td>
<td>2.52 **</td>
</tr>
<tr>
<td>Atlanta</td>
<td>7.06</td>
<td>3.73 ***</td>
</tr>
<tr>
<td>Chicago</td>
<td>-2.18</td>
<td>-1.16</td>
</tr>
<tr>
<td>St. Louis</td>
<td>1.95</td>
<td>1.03</td>
</tr>
<tr>
<td>Minnnesota</td>
<td>-2.43</td>
<td>-1.28</td>
</tr>
<tr>
<td>Kansas City</td>
<td>0.95</td>
<td>0.50</td>
</tr>
<tr>
<td>Dallas</td>
<td>-2.82</td>
<td>-1.49</td>
</tr>
<tr>
<td>San Francisco</td>
<td>0.77</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Joint probability (F-test) 0.000

The estimates are of coefficients for Federal Reserve district (cross-section) dummy variables, multiplied by -1. *** denotes statistical significance at the one percent level, and **statistical significance at the five percent level on a two-tailed test.
Table 4
Estimated Demand for Borrowed Reserves
Alternative model

Dependent variable: Change in borrowings relative to capital, $\Delta(B/K)$

<table>
<thead>
<tr>
<th></th>
<th>(1) 1922.01-1933.12</th>
<th>(2) 1922.01-1929.01</th>
<th>(3) 1929.02-1933.12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.65</td>
<td>0.89</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(2.03)**</td>
<td>(2.12)**</td>
<td>(0.30)</td>
</tr>
<tr>
<td>Spread_{i,t}</td>
<td>1.14</td>
<td>2.05</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>(9.72)**</td>
<td>(7.93)**</td>
<td>(7.64)**</td>
</tr>
<tr>
<td>$\Delta RN_t$</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(-6.71)**</td>
<td>(-6.69)**</td>
<td>(2.16)**</td>
</tr>
<tr>
<td>$(B/K)_{i,t-1}$</td>
<td>-0.21</td>
<td>-0.21</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>(-15.79)**</td>
<td>(-12.56)**</td>
<td>(-10.02)**</td>
</tr>
<tr>
<td>$\Delta(Debits/K)_{i,t}$</td>
<td>0.20*</td>
<td>-0.09</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>(1.73)*</td>
<td>(-0.59)</td>
<td>(2.84)</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Seasonal dummies</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.22</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>Observations</td>
<td>1716</td>
<td>1008</td>
<td>708</td>
</tr>
</tbody>
</table>

OLS estimates; t-statistics in parentheses; *** indicates statistical significance at the one percent level, ** at the 5% level, and * at the 10% level in two-tailed tests.

$(B/K)_{i,t}$: Member bank borrowing/capital.
$Spread_{i,t}$: Commercial paper rate, $RCP_{i,t}$, minus the discount rate $Rd_{i,t}$.
$\Delta RN_t$: Change in the Federal Reserve’s holdings of government securities, a proxy for reserve need.
$\Delta(Debits/K)_{i,t}$: Change in debits to bank accounts, scaled by bank capital.
Table 7
Bank Failure Regressions

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Banks_{i,t}</th>
<th>Banksrate_{i,t}</th>
<th>Numbanks_{i,t}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.49</td>
<td>-0.13**</td>
<td>-0.24***</td>
</tr>
<tr>
<td></td>
<td>(-0.29)</td>
<td>(-2.26)</td>
<td>(-2.80)</td>
</tr>
<tr>
<td>C/B_{i,t}</td>
<td>0.82***</td>
<td>0.01*</td>
<td>0.02***</td>
</tr>
<tr>
<td></td>
<td>(4.36)</td>
<td>(1.82)</td>
<td>(3.05)</td>
</tr>
<tr>
<td>Fails_{i,t}</td>
<td></td>
<td></td>
<td>0.59***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3.07)</td>
</tr>
<tr>
<td>Failsrate_{i,t}</td>
<td></td>
<td>1.54**</td>
<td>3.06***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6.34)</td>
<td>(8.60)</td>
</tr>
<tr>
<td>R^2</td>
<td>0.09</td>
<td>0.04</td>
<td>0.09</td>
</tr>
<tr>
<td>Obs.</td>
<td>516</td>
<td>516</td>
<td>516</td>
</tr>
</tbody>
</table>

t-statistics in parentheses. * indicates statistical significance at the ten percent confidence level, ** at the five percent level, and *** at the one percent level in two-tailed tests.

* Banks_{i,t} = Real value of deposits in suspended banks, millions of 1928 dollars.
* Banksrate_{i,t} = Deposits in suspended banks divided by total deposits lagged one month.
* Numbanks_{i,t} = Number of suspended banks divided by total number of banks lagged one month.
* Fails_{i,t} = Real value of liabilities of failed businesses, millions of 1928 dollars.
* Failsrate_{i,t} = Liabilities of failed businesses divided by total bank loans.
Data Appendix

All bank deposits: Deposits (excluding interbank deposits) in all banks member and nonmember, by Federal Reserve district. Figures for June and December for 1922-33 are from All-Bank Statistics (ABS); figures for the intervening months are fitted values from a regression of all bank deposits against member bank deposits with an R-square of .996.

Banks: Real value of deposits in all suspended banks, member and nonmember, by Federal Reserve district, deflated by the wholesale price index. The Federal Reserve published preliminary figures on deposits in suspended banks in each district each month in the FRBulletin but published revised aggregate figures only for the country as a whole. The ratio of preliminary estimates to final figures on deposits in suspended banks on a national level, however, was remarkably stable. Accordingly, the preliminary deposit estimates were adjusted by an amount equal to the aggregate ratio of final to preliminary deposit estimates. The wholesale price index is from the NBER Macrohistory Database. For March 1933 deposits in suspended banks were adjusted using the method proposed by Bernanke (1983).

Banksrate: Deposits in all suspended banks, by district, as reported in the FRBulletin, expressed as a ratio to all bank deposits lagged one month.

Bid-ask spread, Bidask: A monthly index constructed from the bid and ask prices of a systematic sample of 30 corporate bonds, measured as a percent of the asking price, from January 1914 through December 1941. The data are from the Bank and Quotation Record published by the Commercial and Financial Chronicle. Details on the construction and properties of this index are available in Gendreau (2017).

Borrowing: Member bank borrowing, end-of-month figures, by district, from FRB.

Fails: Liabilities of failed businesses, monthly, by district, $ millions. These are R. G. Dun and Company’s figures as reported in the FRB. For use in estimation they are scaled by total loans at all banks (ex. interbank loans), a proxy for total corporate debt.

Currency-to-borrowing ratio: Federal Reserve notes outstanding, by district, last Wednesday of the month figures, from the Annual Reports (AR) of the Board of Governors of the Federal Reserve Board, divided by member bank borrowing in each district.

Commercial paper rate, RCP: The prevailing rate on 4-6 month prime commercial paper, end-of-month figures from the New York Times.

Debits: Bank debits to deposit accounts, except interbank accounts, $ millions, monthly, by district. Source: 1922-24, AR; 1925-33, FRBulletin.

Deposit rate: The demand deposit rate fixed for participating banks by the New York Clearing House Association on demand deposits, announced as published in the New York Times and Commercial and Financial Chronicle. Boughton and Wicker (1979) maintain that rates in Boston and Chicago moved in tandem with New York rates, and cite American Banking Association surveys showing that more than half of responding banks reported paying interest on demand deposits.

**FundFlow**: Monthly fund flows measured as the change in member bank deposits minus the change in member bank customer loans in each district, each scaled by member bank capital.

**Member bank capital**: Book capital at member banks, by Federal Reserve district. Figures for call dates are from the *FRBulletin* and *AR*; figures for the intervening months are linear interpolations.

**Member bank deposits**: Total deposits of member banks. Figures on call dates from December 1921–December 1933 are from *BMS, Part II*; figures in the intervening months are linear interpolations, with the exception of May 1933 figures, which are deposits in licensed member banks reported in the 1933 *AR*.

**Member bank customer loans**: Figures for December 1921 and for call dates from September 1928-December 1933 are “other loans” reported for each district in the *FRBulletin*. “Other loans” are loans other than open market paper, loans on securities, real estate loans, or interbank loans. Monthly figures for February 1921-August 1928 are estimates from a regression of member bank other loans on member bank debits and member bank total loans in each district.

**Member bank loans**: Total loans of member banks. Figures on call dates for 1921-32 by district are from the *AR* and *BMS Part II*; figures for the intervening months are linear interpolations. Figures for 1933 are estimated by Federal Reserve district level data as the ratio of member to national bank loans as of December 1931 times national bank loans for each call date in 1933, with linear interpolations used for the intervening months. This procedure forecasts 1932 loans for member banks with an R-square of .99.

**Numbanks**: The bank suspension rate, measured as the number of all bank suspensions by Federal Reserve district from the *FRBulletin* divided by the estimated total number of all banks lagged one month. Figures on call dates are the number of all banks in each district reported in the *FRB* and *AR*; figures for the intervening months are linear interpolations. The number of all banks as of June 1933 was estimated from state figures reported in *ABS*, with figures for states lying within two Federal Reserve districts pro-rated according to the portion of that state’s population residing in each district. The number of suspended banks for March 1933 is the number of banks still unlicensed as of June 28, 1933, scaled to the failure rate of December 1931, per Bernanke (1983).

**Reserve need, $\Delta RN$**: Monthly change in holdings of U.S. government securities by Federal Reserve banks, $\$ millions$, based on end-of-month figures. Source: *BMS*.

**Riefler-Turner Index, $R_A$**: A measure of the interest rate on money market instruments that could have been used to make reserve adjustments as alternatives to the discount window. (Riefler, 1930, and Turner, 1938). The index is a weighted average of the call loan renewal rate (weight: 3), the rate on 4-6 month prime commercial paper (weight: 3), and the rate on 90-day Stock Exchange time loans (weight: 2); see Riefler (1930), 223-225, and Turner (1938), 104. The interest rates are end-of-month figures from the *New York Times*. 
