Volume Title: Essays on Interest Rates, Volume 1

Volume Author/Editor: Jack M. Guttentag and Phillip Cagan, eds.

Volume Publisher: NBER

Volume ISBN: 0-87014-201-1

Volume URL: http://www.nber.org/books/gutt69-1

Publication Date: 1969

Chapter Title: Interest Rates and Bank Reserves—A Reinterpretation of the Statistical Association

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Chapter URL: http://www.nber.org/chapters/c1212

Chapter pages in book: (p. 223 - 271)

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Interest Rates and Bank Reserves—A Reinterpretation of the Statistical Association

Phillip Cagan

I. Introduction

Many studies of banking have found that reserve ratios are correlated with interest rates; the relationship has become the centerpiece of theoretical and econometric models of the financial sector linking the supply of money to market developments. A currently popular interpretation of the association is that banks equate the marginal advantages of additional free reserves and earning assets; the two substitute for each other in bank portfolios depending upon the cost of borrowing reserves and the rate of return on assets. Given the quantity of unborrowed reserves provided by the monetary authorities, a relation between free reserves and interest rates helps determine the supply of bank deposits.

That an association exists between reserves and interest rates has long been noted in U.S. data. While the interest-rate data need no special comment, the data on reserves do. Before 1914, the association pertained to excess reserves (vault cash and balances with reserve

NOTE: Circulation of an earlier version of this study in 1966 elicited many comments which were most useful in preparing this revision. I wish to thank in particular Karl Brunner, Richard Davis, Peter Frost, Jack Guttentag, George Morrison, Anna Jacobson Schwartz, Robert Shay and William L. Silber. The conclusions are entirely mine, of course.

I am also indebted for supervision of the computations to Josephine Trubek and Jae Won Lee, research assistants, and to Martha T. Jones in the data processing department, at the National Bureau.

agents minus required reserves); at that time there was no central bank to create and lend reserves. Since 1914, when Federal Reserve Banks began providing a discount window for member banks, it has pertained to excess reserves and member-bank borrowing from Reserve Banks, or to free reserves (excess reserves minus borrowing). The association for both periods—before and after 1914—is similar, as will be shown later. The explanation given for the phenomenon, however, has turned completely around. Until the late 1930's, most studies (such as the well-known work of Riefler [39] and Tinbergen [45] [1]) assumed that the association reflected an effect of the reserve ratio on interest rates. Then, following Turner's 1938 criticism [46] of Riefler's study, the direction of influence was reversed—interest rates were thought to affect reserve ratios. The new explanation was expressed in terms of the marginal advantages to banks of free reserves and other assets. This later view has come to monopolize opinion. The Appendix to this chapter briefly surveys empirical studies on this subject, documenting the shift in interpretation.

Evidence on the association is examined in Section II. Section III tests the earlier explanation and Section IV the later explanation. Both are found to be inadequate. Finally, Section V discusses and tests another interpretation of the association. The conclusion is that the pursuit of short-run profits motivated bank borrowing much more strongly in the 1920's than it did in the 1950's, but such behavior accounts for little, if any, of the association in either period. The explanation offered here is that bank borrowing from the Federal Reserve increases as monetary conditions tighten, because the banks are striving to accommodate their regular loan customers. Interest rates appear to play a small role in the variations of deposit growth due to changes in free reserves.

II. Interest Rates and Reserve Ratios: The Statistical Association

The association referred to above pertains mainly to short-run cyclical movements. There have been long-run movements in the excess reserve (or free reserve) ratio of banks, but they reflect institutional developments or special circumstances.[2] We may focus on short-run

[1] Bracketed numbers refer to works cited in the references following the Appendix to this chapter.

[2] Long-run movements are discussed in my *Determinants and Effects of Changes in the Money Stock* [7].

movements by grouping the data according to the stages of business cycles. Chart 6-1 presents National Bureau reference cycle patterns of the free reserve ratio of member banks[3] and the commercial paper rate, which behaves similarly to the Treasury bill rate typically used in this comparison. The patterns for the two series tend to move inversely. Although far from perfect, the association is fairly strong for most periods. The amplitude of cyclical movements in the reserve ratio has varied, however. They were large in the 1920's and even larger in the 1930's, but were quite small in the 1950's. Short-term interest rates fluctuated with roughly the same amplitude in the 1950's as they did in the 1920's, but with a much smaller amplitude in the intervening period. A sharp decline in the early 1930's brought short-term rates to very low levels, where they remained with only minor changes during that decade and most of the next.

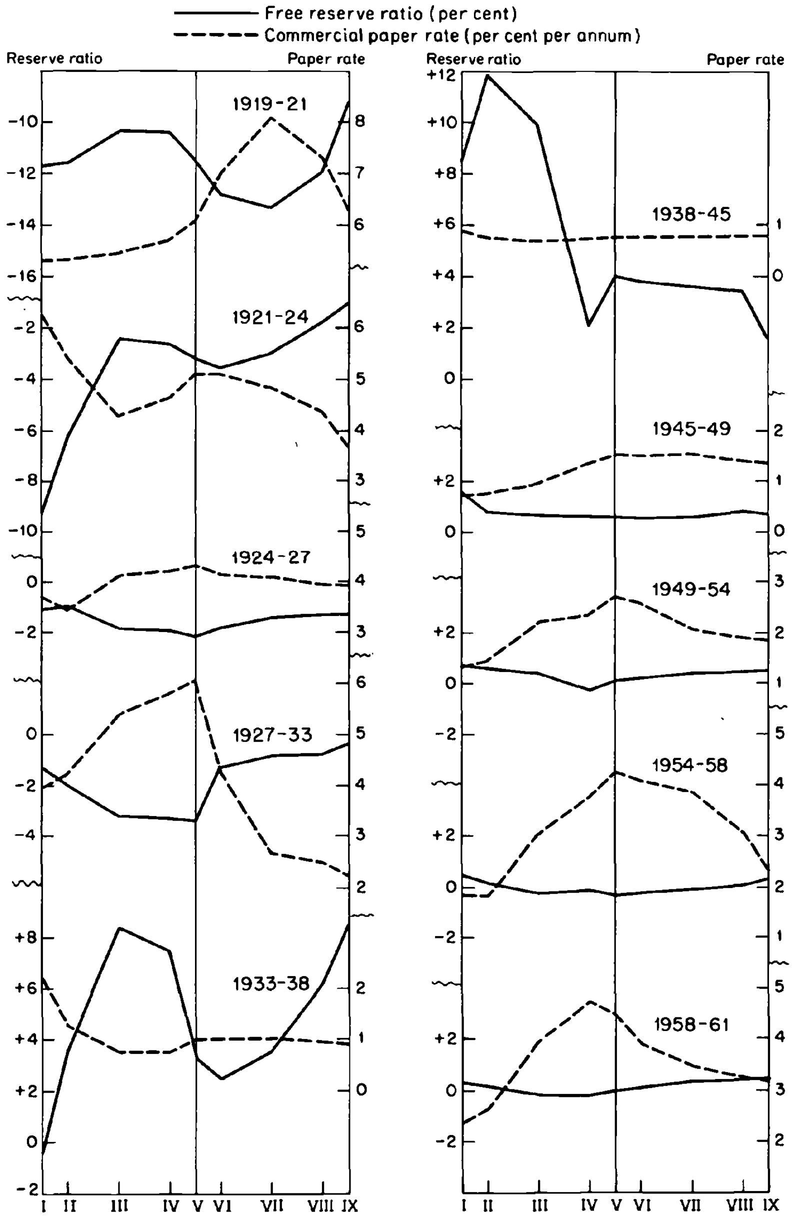
The strongest evidence of an inverse association is provided by the data for the 1920's, the period studied by Riefler. The period since World War II, to which most recent studies are confined, has produced a smaller variety of cyclical patterns and, so far, less revealing evidence. The difference in the relation over time can be seen in Chart 6-2, which presents a scatter diagram of changes from stage to stage of the reference cycle patterns 1919–61. The chart distinguishes the three periods discussed. The points for the middle period 1933–38 show no correlation. Those for 1919–33 show the strongest correlation, though four observations in particular for that period (dated on the chart) stand out as extremes. The points for the latest period also show a negative correlation, but with a much flatter slope than that for the 1920's. The flatter slope reflects the smaller amplitude of fluctuation in the free reserve ratio after World War II compared with the 1920's, given the roughly unchanged amplitude of fluctuation in short-term interest rates.

Although Charts 6-1 and 6-2 show little association for the 1930's and early 1940's, that period is often cited as dramatic proof of such an association. After 1933, banks stopped borrowing from Federal Reserve Banks and accumulated excess reserves at a rapid pace, while short-term interest rates fell sharply, creating a nice inverse association between the two series for the period as a whole. The changes

[3] Although many studies of the association do not divide reserves by deposits, it is desirable to do so, particularly when examining data for long time periods.

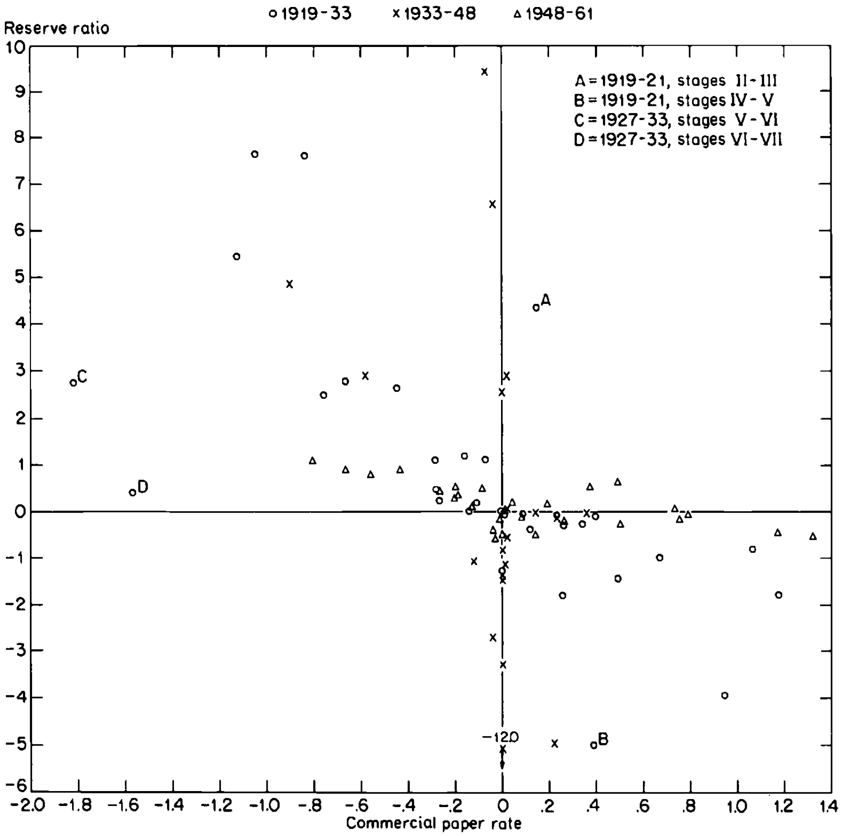
Data on member-bank free reserves have been published by the Board of Governors of the Federal Reserve System since 1929; earlier figures used here are estimates of the National Bureau.

CHART 6-1. Reference Cycle Patterns of Member-Bank Free Reserve Ratio and Commercial Paper Rate, 1919–61



SOURCE: Same as Table 6-1.

CHART 6-2. Member-Bank Free Reserve Ratio and Commercial Paper Rate, Changes Between Reference Stages in Percentage Points



SOURCE: Same as Table 6-1.

from stage to stage in Chart 6-2 hide this longer-run association during those years.

The continuing increase in excess reserves after 1933 can be attributed to a combination of two quite different influences, both of a special nature and both difficult to quantify. The first influence reflects the cost of investing in short-term securities, supplemented during that decade by the lack of demand for loans and the risk of investing in long-term securities. Banks normally profit by investing funds which, for the time being, exceed needed working balances. To take care of fluctuations in reserves, banks buy short-term securities for short holding periods, as excess funds permit. At very low yields on those securities, however, the transaction costs (broadly interpreted) of buying and selling may equal or exceed the return; excess funds will then be held idle. If the break-even point for most banks were as high as 1 per cent on Treasury bills and commercial paper, it would help explain the sharp rise in the excess reserve ratio after 1933 when those short-term rates fell below that level,[4] even though the changes from stage to stage in Chart 6-2 reveal no relation.

Transaction costs undoubtedly did not exceed the return on loans and bonds, however. Beyond some moderate amount, depending upon the circumstances of each individual bank, excess reserves are not needed to meet expected drains. If the preceding argument were to explain an accumulation beyond that amount in the 1930's, it would have to be that the demand for bank loans was limited, and that bonds appeared unattractive to banks at the low yields then available because of the danger of capital losses if yields later increased. (The situation changed in 1942 when the Federal Reserve began to support U.S. bond prices, preventing any increase in yields while the policy continued.) This danger does not seem to have been sufficient to explain why banks did not purchase bonds during the 1930's. After all, yields continued to fall throughout the decade and there was little prospect of a major rise. It cannot, however, be ruled out as a minor reason for the accumulation of excess reserves.

A second influence on excess reserves during that period was the shattering experience of the financial crisis which culminated in the complete suspension of bank operations for one week in March 1933. For many years thereafter, banks remained extremely reluctant to acquire any but the highest-grade assets, which were limited in supply. There is considerable evidence to support this interpretation.[5] Banks shifted their portfolios after 1933 toward cash and short-term earning assets which were highly liquid and low in risk, and continued to do so until the wartime support policy of the Reserve Banks made long-term bonds substantially more liquid. This shift produced an unusually large accumulation of excess reserves.

[4] This argument is presented and tested by Peter A. Frost [17]. This period has also been interpreted as providing unique evidence for the existence of a "liquidity trap" for banks (that is, a flattening of their demand curve for reserves at very low rates), on the argument that the large increases in the ratio after the mid-1930's were accompanied by very low, virtually constant short-term interest rates (see Horwich [24], and the references cited therein).

[5] It is discussed by Friedman and Schwartz [16], Chapter 9, and was stressed by me [7]. Also see the supporting evidence presented by George R. Morrison [31], Chapters 3–5.

The 1930's and 1940's wove together some very special circumstances, making interpretation difficult. They do not provide clear evidence on the behavior of banks in ordinary times. Moreover, in the 1920's and 1950's the amount of excess reserves and the amplitude of their fluctuation were usually too small to warrant our attention; most of the fluctuation in free reserves ratios reflected borrowing from Reserve Banks. The subsequent analysis concentrates on the borrowing during those two decades, though for comparison 1929–38 is included in some regressions for the full period (with the two world wars excluded).

Many of the patterns in Chart 6-1 portray a standard response to cycles in business activity—interest rates conforming positively and the reserve ratio inversely—which raises a question of spurious association. These two variables may appear to be related solely because they both conform to business cycles. Corresponding cyclical movements in two variables tempt us to infer that they are directly related, but such evidence by itself is weak: Since many variables conform to business cycles, cyclical movements in each of them can be attributed to a wide variety of possible relationships. This is true of reserve ratios and interest rates, which may display associated cyclical fluctuations for many reasons. Changes between successive stages, as shown in Chart 6-2, suppress the serial correlation existing in the monthly series and make trends less prominent, but common cyclical influences of a possibly spurious nature may still remain. One way to remove such influences is to hold the average cyclical pattern constant by means of dummy variables. Since reference cycles have nine stages, we need seven dummy variables, one for each of seven of the eight stage-to-stage changes (one less than the total number to avoid overdetermining the regression). The dummy variables represent separate constant terms for each stage change and absorb any covariation in the other variables which would result from a common cyclical pattern. This is equivalent to fitting eight separate regressions with the requirement that all of them have the same regression coefficient for the nondummy variables.

Table 6-1 reports the correlations of stage-to-stage changes, with and without dummy variables, for various periods. The interest series are the main short-term rates available which appear relevant to the management of bank reserves. The atypical 1938–48 period of bond pegging is excluded, and the very different decades following the two world wars are shown separately. The table reveals a high negative association, confirming earlier studies. For the much cited 1948–61

TABLE 6-1. Correlation Between Free Reserve Ratio and Interest Rates, Changes Between Reference Cycle Stages

Period, Banks, and Interest Rate	Simple Correlation Coefficient (and *t* value)	Partial Correlation Coefficient (and *t* value), Holding Common Cyclical Movements Constant [a]
1874–1914 [b]		
New York City Clearing House Banks		
Commercial paper rate	−.49(4.9)	−.36(3.3)
Call money rate	−.47(4.7)	−.32(2.8)
Log of call money rate [c]	−.53(5.3)	
Reserve City National Banks		
Commercial paper rate	−.16(1.4)	−.06(0.5)
Call money rate	−.09(0.8)	−.03(0.3)
Country National Banks		
Commercial paper rate	−.30(2.8)	−.21(1.8)
Call money rate	−.16(1.5)	−.06(0.5)
1919–61, Member Banks [d]		
1919–61 excluding 1938–48		
Commercial paper rate	−.58(5.8)	−.64(6.3)
Treasury bill rate	−.52(4.7)	−.60(5.6)
Bank loan rate	−.58(5.7)	−.57(5.3)
1919–29		
Commercial paper rate	−.86(8.7)	−.90(8.8)
Treasury bill rate	−.82(6.6)	−.87(6.9)
Bank loan rate	−.82(7.4)	−.80(5.9)
1948–61		
Commercial paper rate	−.60(3.8)	−.13(0.6)
Treasury bill rate	−.70(5.0)	−.34(1.6)
Bank loan rate	−.53(3.2)	−.09(0.4)

SOURCE: Excess reserve ratio. New York City Clearing House Banks (excess lawful money reserves to net deposits): 1874–1908, A. P. Andrew, *Statistics for the United States, 1867–1909,* National Monetary Commission, 1910, Table 28; 1909–14, *Commercial and Financial Chronicle* seasonally adjusted monthly data kindly supplied by George R. Morrison from data cards for his *Liquidity Preference of Commercial Banks* [31]. Noncentral Reserve city and country national banks (lawful money plus deposits with reserve agents to net deposits, minus required reserve ratio): *Annual Report of the Comptroller of the Currency,* various years, seasonally adjusted call-date data.

Free reserve ratio of member banks (excess reserves minus Federal Reserve discounts and advances as ratio to demand deposits adjusted plus time deposits): NBER estimates from data in *Banking and Monetary Statistics* and *Federal Reserve Bulletin* period, however, the dummy variables reduce the correlation to insignificance, indicating that the association then cannot be distinguished from a common response of the variables to business cycles. Yet, for the 1920's the correlation remains highly significant despite the inclusion of dummy variables, suggesting that the 1948–61 correlation probably is, after all, genuine though weak. As can be seen from Chart 6-2, the observations for the 1920's dominate the correlation for the post-World War I period as a whole.

Before World War I, the association is strong only for banks in New York City. One reason for its weak appearance elsewhere is that the two interest-rate series, both compiled from New York City quota-

NOTES TO TABLE (CONTINUED)

(member bank deposits 1948–61 supplied by Board of Governors of Federal Reserve System), seasonally adjusted monthly data.

Call money rate: January 1948–December 1961, *Survey of Current Business;* February 1936–December 1947, FRB; January 1878–January 1936, Frederick R. Macaulay, *Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856,* NBER, New York, 1938.

Commercial paper rate: February 1936–December 1961, computed from weekly data in *Commercial and Financial Chronicle;* January 1878–January 1936, Macaulay.

Treasury bill rate: FRB. (Treasury notes and certificates to 1929, three-month bills thereafter.)

Bank loan rate: IQ 1939–IVQ 1961, FRB; January 1928–December 1938, unpublished data supplied by Board of Governors of the Federal Reserve System; January 1919–December 1927, *B&MS.*

Regression observations are changes between nine successive NBER reference stage averages of monthly seasonally adjusted data.

[a] Multiple regression equation (col. 2) is

$$\Delta r_0 = \alpha\Delta\left(\frac{R_f}{D}\right) + \sum_{1}^{7} \delta_s U_s + \text{constant}$$

where r_0 is the interest rate, R_f/D the reserve ratio, and U_s the seven dummy variables, one for each successive pair of reference stages except the last. The operator Δ denotes changes between reference-stage averages. U_s is unity if the observation pertains to that pair of stages, otherwise zero; α and δ_s are regression coefficients. Signs of the t values, which pertain to the associated regression coefficients, have been dropped.

[b] Period begins with stage change VI–VII of 1870–79 reference cycle for New York banks and with VIII–IX of that cycle for the other banks, and ends with VIII–IX of 1912–14 cycle.

[c] Excludes seven extreme observations: 1879–85 VII–VIII; 1885–88 II–III; 1891–94 VI–VII and VI–VIII; 1894–97 II–III; and 1904–08 VI–VII and VII–VIII.

[d] Period begins with initial trough of 1919–21 cycle or peak of 1945–49 cycle and ends with peak of 1927–33 cycle or terminal trough of 1958–61 cycle, except that the Treasury series begins with 1920 peak. Exclusion refers to period from 1938 trough to 1948 peak.

tions, were less relevant to other Reserve city and country banks. Excess reserves of interior banks depended primarily on the local demand for loans. When the demand was high, excess reserves were low; and conversely. Only if the interior demand for loans and the commercial paper or call loan rates had the same movements are the correlations in Table 6-1 likely to be as high for the interior banks as for those in New York City.

Although the various interest rates give similar results, the regression using call money rates in logarithmic form produces a better fit for the earlier period (despite the exclusion of seven extreme observations which, if included, would make the correlation even higher). The logarithmic form is justified for the earlier period by nonlinearity at both ends of the relation: The excess reserve ratio had a lower limit imposed by national bank reserve requirements (the banking system could not acquire more reserves through domestic borrowing, since there was no central bank to provide them). And, when short-term rates were below 1 per cent, very large increases in the ratio may have been associated with small declines in rates because, as suggested earlier, costs of temporarily investing excess reserves may have exceeded the low return available. There is less reason for nonlinearity in the later period. The free reserve ratio of member banks has no practical limits (the ratio can be and usually is negative, and an upper theoretical limit of unity or so is never approached). Also, the only period with very low interest rates—1933–48—has been excluded. Since excess reserves have been quite small except for the 1930's, any important nonlinearity would have to pertain to borrowing. A tendency of the Federal Reserve to constrain borrowing, just when banks want to increase it, might produce a nonlinear relationship. Chart 6-2 gives but a slight suggestion of nonlinearity for the 1920's, however, and none for the 1950's. To keep the analysis of the two periods comparable, linear regressions have been used throughout.

In general, the evidence demonstrates an association between reserve ratios and interest rates which has a long history and cannot be dismissed as a product of common cyclical patterns. It appears to reflect a direct relationship between the two variables.

III. Critique of the Earlier Interpretation

Many writers have pointed to the association summarized by Table 6-1, and most of those before Turner attributed it to monetary effects on interest rates. Although never spelled out, the basic hypothesis was that a tight reserve position forces banks to restrict credit, and a position of ease allows them to expand. Hence, low reserves in relation to deposits lead to high interest rates, and conversely. How the effect on rates occurs, however, was never clarified, and suggestions of various mechanisms can be found in the literature.

In some early writings on the association it was implied that low reserve ratios lead the public to expect tight credit, and conversely for high ratios. The public then takes steps which somehow produce the expected behavior of interest rates. We may be skeptical, however, that such expectations would be held with much regularity unless banks did affect interest rates directly.

Tinbergen's view was that banks simply post a loan rate reflecting their reserve position. As reserves tighten, banks post higher rates, and conversely as reserves loosen. But this view oversimplifies banking practice in the United States and elsewhere. Such insularity from the demand side is true in part for only a few U.S. rates (such as consumer loan rates and the prime loan rate) and to only a limited extent for the average bank loan rate, used here. "Administrative pricing" of bank rates cannot explain the association for commercial paper and Treasury bill rates, which are determined on the open market.

If reserve ratios affect market interest rates, the connection presumably occurs through the supply of loanable funds. A high growth rate of the money stock increases the supply of loanable funds in relation to the demand, thus lowering interest rates, and conversely. The association will carry over to the free reserve ratio, however, only insofar as the ratio is a determinant of monetary growth, as was implied by Riefler's formulation. He contended that undesired changes in reserves resulting from open-market operations and currency or gold flows are largely offset in the first instance by member-bank borrowing —an increase if banks initially lose reserves or a decrease if they gain. By tradition as well as by Federal Reserve insistence, borrowing should be infrequent and, when justified, temporary; member banks in debt therefore take immediate steps to build up reserves by restricting credit. When total borrowing rises, the banking system restricts credit and the money market tightens. Thus, when the volume of borrowing is high (free reserve ratio low), interest rates are high, and conversely— reflecting an inverse effect of the growth rate of the money stock on interest rates.

On a theoretical level such an explanation seems plausible. On an empirical level, it also has merit—up to a point. An earlier study of mine found a significant inverse effect by the rate of growth of the money stock on interest rates [8]. And the free reserve ratio is positively correlated with the rate of deposit growth. But are these relationships strong enough to account for the high association between the reserve ratio and interest rates in Table 6-1? In the Riefler interpretation, that association is an indirect reflection of separate relations between each of the two variables and the growth rate of deposits. Therefore, it should disappear when deposit growth is held constant. A test of this hypothesis is reported in Table 6-2. The partial correlations with deposit growth held constant (col. 4) are only slightly smaller than the simple correlations of Table 6-1 (reproduced here in col. 1), indicating that the direct association between the free reserve ratio and interest rates far outweighs any indirect association via deposit growth. The hypothesis fails. The statistical reason for the small difference between columns 1 and 4 is that the postulated correlations with deposit growth (cols. 2 and 3) are much weaker than the correlations in column 1 which they are supposed to explain.

There is an alternative formulation of the Riefler theory. The association between the free reserve ratio and interest rates might reflect a relation between interest rates and the public's demand to hold money. Earlier writers sometimes seem to have had such an explanation in mind. The demand to hold money depends upon interest rates, and a change in the money stock affects market rates as the public buys or sells financial assets to remain on its demand curve. If the reserve ratio were a good proxy for the total money stock, the association between the ratio and interest rates would reflect those portfolio adjustments. But this formulation has serious drawbacks. First of all, the correlations of Table 6-1 do not hold wealth or income constant, as is required to measure the demand for money balances properly. Secondly, the reserve ratio is not consistently a good proxy for the level of deposits, which depends mainly upon the level of reserves made available to the banking system. Moreover, when we use the level of deposits in Table 6-2 in place of their growth rate, the correlations (not shown) are very similar to those presented there and also fail to support the Riefler theory.

Of course, some effect of the kind Riefler and other earlier writers proposed may be at work, since changes in reserve ratios affect deposit growth to some extent and thus affect interest rates through the supply of loanable funds. We may conclude, however, that such effects are not the main explanation of the high correlations in Table 6-1. We

TABLE 6-2. Correlations Between Free Reserve Ratio, Interest Rate, and Growth Rate of Deposits, Changes Between Reference Cycle Stages

Period and Interest Rate	Simple Correlation Coefficient			Partial Correlation Coefficient
		Deposit Growth and		
	Free Reserve Ratio and Interest Rate (1)	Interest Rate (2)	Free Reserve Ratio (3)	Free Reserve Ratio and Interest Rate, Holding Deposit Growth Constant (4)
1919–29				
Commercial paper rate	–.86	–.31	.49	–.85
Treasury bill rate	–.82	–.65	.64	–.69
1946–61				
Commercial paper rate	–.60	–.60	.39	–.50
Treasury bill rate	–.70	–.65	.39	–.64

SOURCE: Same as Table 6-1. Deposit growth is monthly percentage change in member-bank demand and time deposits.

NOTE: Coverage and data are the same as corresponding correlations of Table 6-1. Observations are changes between successive reference stage averages of monthly data.

The two correlations in column 3 for the earlier period are different only because the expansion phase of the 1919–21 cycle is omitted for Treasury bills.

are led to examine the main current interpretation, discussed in the next section.

IV. Examination of the Recent Interpretation

Since the 1930's most writers have completely reversed the Riefler interpretation. Instead of the free reserve ratio somehow influencing interest rates, the effect is now viewed as running from rates to the ratio. This new view, as argued above, seems justified by the evidence. The rationale for the effect has, however, taken a particular form. Banks are thought to adjust their reserve positions by borrowing from Reserve Banks, primarily to maximize short-run profits. When market rates rise, so does the income foregone by holding excess reserves idle, intensifying the inducement to keep reserves low and to borrow (assuming the borrowing rate does not rise commensurately). Since borrowing accounted for most of the fluctuation in free reserves in the 1920's and 1950's, the new view as applied to those periods is mainly a theory of borrowing. It denies Riefler's thesis that banks eschew indebtedness and borrow only to meet temporary reserve deficiencies. As Turner contended, banks may honor the tradition against unnecessary borrowing, but always with half an eye on the foregone profits. Consequently, when market rates rise, banks make do with smaller reserves, taking greater chances of being caught short, and so find it necessary to borrow more often.

A DIRECT TEST OF THE PROFIT THEORY. This theory implies that after 1914 the free reserve ratio was more closely correlated with the difference between the market and the discount rate than with the market rate by itself, since the profit depends upon the return from lending minus the cost of borrowing. Table 6-3 presents the partial correlation coefficients of the free reserve or borrowing ratio with both the interest rate and its differential over the discount rate, each as a separate variable. For all periods, the market rates themselves account for virtually all the association observed in the previous tables. This is true when sectors of member banks are treated separately (also shown), and when the period of the excess profits tax (June 30, 1950, to December 30, 1953) is given a separate constant term by means of a dummy variable (not shown). The results are also the same when the 1919–21 cycle, which had unusually high levels of borrowing and two extreme observations (see Chart 6-2), is excluded (not shown). The short-run profit motive as represented by the differential rate either is not significant or, when significant, has the wrong sign (in theory the differential should affect free reserves inversely and borrowing positively).

The regressions using the ratio of borrowing to deposits take account of the objection that the banks which hold most of the excess reserves seldom borrow and may behave differently. Treating borrowing by itself, however, gives the same results (with opposite sign), because its cyclical variations dominate those in excess reserves (except during the 1930's and 1940's, omitted here). The combination of time and demand deposits in the denominator of the ratio may also raise objections, because time deposits are less subject to unexpected withdrawals and seldom give banks cause for borrowing. Using demand deposits instead of total deposits in the denominator of the ratio, however, gives similar results (not shown). Finally, substitution of the federal funds rate for the discount rate in the regressions also gives similar results (not shown).[6]

Many studies have reported weak, though significant, negative coefficients for the differential rate, which simply reflects the correlation of the differential with the market rate (the discount rate has less amplitude of fluctuation). The correlation coefficient between the commercial paper or Treasury bill rate and the corresponding differential rate was about +.5 for stage changes in the 1920's and 1950's. The bank-loan-rate differential, on the other hand, has a positive correlation with the free reserve ratio, because the loan rate moves sluggishly and its differential is dominated by the discount rate. Since it gives the wrong sign, the loan differential has understandably not been reported in published studies.

The differential rate is clearly the relevant one for bank profits, rather than the level of the market rate; yet the correlation is all with the rate level. It may be argued that the differential rate is not entirely appropriate for the profit theory on the grounds that informal pressures by Federal Reserve officials to discourage banks from borrowing have not been taken into account here. Undoubtedly such pressures on banks vary over the cycle, and, conceivably, they reduce the correlation shown by the differential rate. Yet, such pressures probably intensify just when the profit incentive to borrow is

[6] The federal funds rate is relevant here only if the reserve position of banks lending federal funds, unlike that of borrowers, is not influenced by the funds rate. This is not likely, but it is a possibility. Otherwise, the behavior of lenders and borrowers of federal funds cancels out in the aggregate reserves of member banks.

TABLE 6-3. Regression of Free Reserve or Borrowing Ratio on Interest Rates and Their Differential Over the Discount Rate, Changes Between Reference Cycle Stages (*partial correlation coefficient and* t *value*)

	Free Reserve Ratio and		Borrowing Ratio and	
	Rate	Differential	Rate	Differential
	All Member Banks			
1919–61 excl. 1938–48				
Commercial paper rate	−.56(5.5)	+.07(0.6)		
Treasury bill rate	−.55(5.1)	+.24(2.0)		
Bank loan rate	−.47(4.3)	+.13(1.0)		
1919–29				
Commercial paper rate	−.85(8.0)	+.19(1.0)	+.85(8.0)	−.17(0.9)
Treasury bill rate	−.86(7.6)	+.48(2.5)	+.85(7.5)	−.49(2.6)
Bank loan rate	−.74(5.6)	+.38(2.0)	+.74(5.5)	−.37(2.0)
1948–61				
Commercial paper rate	−.48(2.7)	−.02(0.1)	+.48(2.7)	+.08(0.4)
Treasury bill rate	−.53(3.2)	−.10(0.5)	+.55(3.3)	+.18(0.9)
Bank loan rate	−.42(2.3)	+.16(0.8)	+.50(2.9)	−.07(0.3)
	Member Banks by Sector, 1948–61			
New York City				
Commercial paper rate	−.36(2.0)	+.08(0.4)		
Treasury bill rate	−.37(2.0)	−.02(0.1)		
Bank loan rate	−.22(1.1)	+.20(1.0)		
Chicago				
Commercial paper rate	−.47(2.7)	+.13(0.7)		
Treasury bill rate	−.49(2.8)	+.07(0.3)		
Bank loan rate	−.40(2.2)	+.15(0.8)		
Reserve cities				
Commercial paper rate	−.43(2.4)	−.05(0.2)		
Treasury bill rate	−.49(2.8)	−.17(0.9)		
Bank loan rate	−.39(2.1)	+.14(0.7)		
Country				
Commercial paper rate	−.51(2.9)	−.12(0.6)		
Treasury bill rate	−.57(3.5)	−.11(0.5)		
Bank loan rate	−.50(2.9)	+.11(0.6)		

SOURCE: Discount rate is that of Federal Reserve Bank of New York: January 1922–December 1961, Board of Governors of the Federal Reserve System, *Annual Report*, various years, and *Federal Reserve Bulletin;* November 1914–December 1921, simple averages of weighted rates on commercial, agricultural and livestock paper from FRB, *Discount Rates of the Federal Reserve Banks, 1914–21*. Reserve ratios by sectors, *Federal Reserve Bulletin*, monthly data seasonally adjusted by NBER. Other data are the same as for Table 6-1.

highest. When the discount rate is high enough to discourage borrowing, persuasion is superfluous. If the pressures partially offset borrowing for profit without eliminating it, the differential rate would still be the appropriate variable. The absence of correlation in Table 6-3 suggests that official persuasion effectively stifles the desire to borrow for short-run profit. That indeed was Riefler's contention, though his explanation relied on the traditional belief that borrowing was incompatible with sound banking, rather than on the Federal Reserve's restraint of banks' desire to borrow when it was profitable.

There is no simple way to quantify variations in official pressures against borrowing. We may conjecture that the pressure steps up, both when the differential rate rises (which increases the incentive to borrow) and when market rates rise and the credit market tightens (for reasons to be discussed in Section V). If so, the absence in Table 6-3 of a variable representing such pressure weakens the partial correlation of both independent variables; which of them is more greatly affected is hard to judge. Nevertheless, it seems unlikely that this omission can explain away the insignificance of the differential rate. Certainly none of the many studies attributing an important effect to the differential rate on borrowing contend that its importance is evident only after taking the degree of pressure into account.[7]

Another objection to Table 6-3 might be that the short-run profit incentive is represented in the regressions by the difference between the market and discount rates, thus assuming that their regression

NOTES TO TABLE (CONTINUED)

NOTE: Regression equations have the form:

$$\frac{B}{D_m} \text{ or } \frac{R_f}{D_m} = \alpha r_0 + \beta(r_0 - r_b) + \text{constant}$$

where r_0 and r_b are the open market and borrowing (discount) rates, B and R_f are member-bank borrowed and free reserves, and D_m member-bank deposits. α and β are regression coefficients. The regressions were run as first differences between reference stages, that is, each observation is the change between successive stage averages of monthly data.

Periods are the same as for previous tables (for Treasury bills, excluding 1919–20 expansion stages).

Signs of the t values, which pertain to the associated regression coefficients, have been dropped.

[7] A partial exception is a series of articles by Murray Polakoff, who has argued that borrowing is constrained beyond a certain point during periods of monetary tightness. He suggests that the relation between the free reserve ratio and the differential rate at such times is curvilinear. See [35], [36], and especially [37].

coefficients have opposite signs equal in magnitude. Because of official pressures against borrowing or a variety of other reasons, the two rates may conceivably affect the free reserve ratio by different amounts. If the profit theory is to be supported, however, the market rate should have a negative effect and the discount rate a positive effect on the ratio, since in theory they affect short-run profits in opposite directions. Table 6-4 shows that the data also fail to support this more general formulation of the profit theory. The market rate has a negative coefficient as required, but the discount rate tends to have a negative

TABLE 6-4. Regression of Free Reserve Ratio on Market and Discount Rates, Changes Between Reference Cycle Stages

Market Rate and Period	Partial Correlation Coefficient (and t value)	
	Market Rate	Discount Rate
1919–29		
Commercial paper rate	−.51(3.0)	−.19(1.0)
Treasury bill rate	−.48(2 5)	−.48(2.5)
Bank loan rate	−.40(2.2)	−.38(2.0)
1948–61		
Commercial paper rate	−.34(1.8)	.02(0.1)
Treasury bill rate	−.54(3.2)	.10(0.5)
Bank loan rate	−.18(0.9)	−.16(0.8)

SOURCE: Same as for Table 6-3, all member banks.

coefficient as well (reflecting its covariation with market rates). Two of the coefficients are positive, but the very low level of significance indicates that they do not differ statistically from zero. An increase in the discount rate simply does not have a perceptible depressing influence on bank borrowing from Reserve Banks as is implied by the profit theory.

The high (negative) correlation between the free reserve ratio and market interest rates in Tables 6-3 and 6-4, and the apparent absence of any influence by the discount rate, can be more simply explained by *long-* rather than short-run profit incentives. Banks rightly concern themselves with their position in the market over the long run and at all times wish to accommodate the loan demand of their regular customers; to do so when credit tightens requires selling securities, running down excess reserves, and borrowing. (A variable to take account of loan demand will be used in Section V.) That effect amply accounts for the observed association in Table 6-1, and borrowing motivated by changes in the differential rate (Table 6-3) does not contribute to the explanation. The often cited correlation of the free reserve ratio with the differential rate alone reflects the correlation between the ratio and the market rate, and cannot be offered as evidence for a short-run profit theory of bank borrowing.

If the differential rate has a measurable effect on bank behavior, it must be found in some other way. The subsequent analysis examines the data for such an effect.

TESTS BASED ON A DISCREPANCY BETWEEN ACTUAL AND DESIRED RESERVES. *The Effect on Deposit Growth.* The preceding analysis assumes that desired and actual free reserves are always equal, whereas in fact they may not be. A sophisticated version of the borrowing-for-profit theory, first presented by Meigs [30], distinguishes between actual and desired levels of the free reserve ratio (denoted by $\frac{R_f^a}{D_m}$ and $\frac{R_f^d}{D_m}$, where D_m is member-bank deposits). The desired ratio depends inversely on the difference between the open-market rate (r_0) and the borrowing (discount) rate (r_b):

$$\frac{R_f^d}{D_m} = -\phi(r_0 - r_b), \tag{1}$$

where ϕ is positive. The rate of change of member-bank deposits is made proportional to the existing discrepancy between the actual and the desired ratio:

$$\frac{d\log_e D_m}{dT} = \gamma\left(\frac{R_f^a}{D_m} - \frac{R_f^d}{D_m}\right). \tag{2}$$

Substituting (1) into (2), we have

$$\frac{d\log_e D_m}{dT} = \gamma\left(\frac{R_f^a}{D_m} + \phi\,[r_0 - r_b]\right), \tag{3}$$

where γ and ϕ are positive. Hence deposit expansion is related positively to the rate differential and the free reserve ratio. Put into this terminology, Riefler's theory would be equivalent to assuming that the desired free reserve ratio is a constant.

Regressions based on this equation and two others, discussed subsequently, are presented in Table 6-5. For purposes of measurement,

TABLE 6-5. Regression of Deposit Growth on the Rate Differential and Other Variables, Changes Between Reference Cycle Stages

Period and Interest Rate	Equation Number	Partial Regression Coefficient (and t value) $\frac{R_f}{D_m}$ (1)	$r_{CP} - r_b$ or $r_{TB} - r_b$ (2)	$\frac{d\log_e R_u}{dT}$ (3)	$\frac{D_m}{R_u}\left(\frac{-d\frac{R_q}{D_m}}{dT}\right)$ (4)
1919–29					
Commercial paper rate	3	4.8(3.0)	6.5(0.8)		
	4	4.6(2.8)	4.8(0.6)	−.02(1.0)	
	5	4.7(3.3)	−5.8(0.7)	−.01(0.7)	.12(2.9)
Treasury bill rate	3	3.1(3.5)	−4.0(1.4)	−.03(2.9)	
	4	2.2(2.7)	−7.0(2.6)	−.03(2.9)	
	5	2.5(2.7)	−6.8(2.5)	−.03(2.3)	.02(0.6)
1922–29					
Commercial paper rate	3	4.2(2.1)	−6.4(1.2)		
	4	4.8(3.0)	−0.3(0.1)	.09(3.3)	
	5	5.2(2.9)	0.4(0.1)	.10(3.0)	.08(0.5)
Treasury bill rate	3	2.8(1.6)	−7.2(2.8)		
	4	3.8(2.3)	−3.5(1.3)	.07(2.5)	
	5	3.9(2.0)	−3.4(1.2)	.07(2.0)	.01(0.1)
1948–61					
Commercial paper rate	3	4.7(1.7)	−3.4(1.2)		
	4	4.4(1.5)	−4.0(1.3)	−.06(0.9)	
	5	2.7(1.1)	−2.7(1.1)	.27(2.6)	.35(3.6)
Treasury bill rate	3	1.7(0.6)	−5.6(2.4)		
	4	1.5(0.5)	−5.7(2.4)	−.05(0.9)	
	5	2.5(0.9)	−1.9(0.7)	.25(2.0)	.32(2.7)

SOURCE: Reserve ratio and interest rates, same as for Tables 6-1 to 6-4; deposit growth, same as Table 6-3; required reserves, based on same sources as free reserves; unborrowed reserves, for 1919–29, high-powered money from Friedman and Schwartz [16, Table B3], revised and extended, *minus* member-bank borrowing and currency outside banks (equals unborrowed reserves at Federal Reserve Bank *plus* vault cash of all banks), and for 1948–61, member-bank reserves at Federal Reserve Banks *minus* borrowing.

NOTE: Regressions are based on text equations 3, 4, and 5, plus a constant term, not shown. Dependent variable is monthly percentage change in member-bank demand and time deposits, annual percentage rate. Independent variables are defined by column:

(1) free reserve ratio (ratio of member-bank free reserves to demand and time deposits), per cent;

(2) differential rate (commercial paper or Treasury bill rate *minus* discount rate), per cent per annum;

banks are assumed to begin to respond immediately to any discrepancy between the actual and desired ratio, so that the average rate of deposit growth during a given month reflects the average discrepancy in that month. The assumption seems appropriate for monthly data, since banks are more likely to act on the basis of their current reserve position than on that of the previous month or quarter. Yet, while the response begins immediately, it may not be completed within one month, but only with time approximates a full adjustment. The regressions therefore measure a continuing process of adjustment. Because the variables are averaged for reference stages, however, and then put into first-difference form as in previous tables to avoid spurious correlation, the data reflect the average effect on deposit growth of the discrepancy during reference stages (usually several months or more in duration).

In regressions based on equation (3), the regression coefficients estimate the effect of a 1-percentage point change in the ratio or the rate differential on the annual percentage rate of deposit growth. The free reserve ratio has the correct sign (and for commercial paper is highly significant with t well above 2.0 in the earlier period), but the rate differential is not significant and mostly has the wrong sign (it should be positive). The regressions appear to pick up the negative effect of monetary growth on interest rates, which hides whatever positive effect the differential rate would have on the desired free reserve ratio and, thence, on deposit growth.

One suggested way of isolating the latter effect is to take account of some of the other factors determining deposit growth, since the reserve ratio is not the only factor or even the most important one. Accordingly, we may, following Meigs, add the growth rate of unborrowed reserves,

NOTES TO TABLE (CONTINUED)

(3) growth rate of unborrowed reserves (monthly percentage change in bank reserves *minus* borrowed reserves), annual percentage rate;

(4) contribution of required reserves to growth rate of deposits—see footnote 8 (monthly change in ratio of member-bank required reserves to total deposits, with sign reversed, *times* the ratio of deposits to unborrowed reserves), annual percentage rate.

The regressions were run as first differences between reference stages, that is, each observation is the change between successive stage averages of monthly values of the variables shown in table heading.

The first and last periods are the same as for previous tables (for Treasury bills 1919–29, excluding 1919–20 expansion stages). The 1922–29 period begins March 1922 with the change between stages III and IV of the 1921–24 cycle.

Signs of t value have been dropped.

R_u, to the equation:

$$\frac{d\log_e D_m}{dT} = \gamma\left(\frac{R_f^a}{D_m} + \phi[r_0 - r_b]\right) + \Theta\,\frac{d\log_e R_u}{dT}, \tag{4}$$

and, following Davis [11],[8] also the contribution to deposit growth of changes in the required reserve ratio:

$$\frac{d\log_e D_m}{dT} = \gamma\left(\frac{R_f^a}{D_m} + \phi[r_0 - r_b]\right) + \Theta\,\frac{d\log_e R_u}{dT} + \eta\,\frac{D_m}{R_u}\left(\frac{-d\,\dfrac{R_q}{D_m}}{dT}\right), \tag{5}$$

where Θ and η are positive. These two variables are added to the regressions in Table 6-5. For the later period, unborrowed reserves are

[8] The contribution of changes in requirements may be derived as follows. By definition, total reserves of member banks comprise required R_q and excess reserves R_e:

$$R_u + B \equiv R_q + R_e,$$

or

$$R_u \equiv R_q + R_f,$$

where $R_f \equiv R_e - B$.

Dividing by member-bank deposits and rearranging the terms gives

$$D_m \equiv \frac{R_u}{\dfrac{R_q}{D_m} + \dfrac{R_f}{D_m}}.$$

To derive rates of change, we may take natural logarithms and differentiate with respect to time:

$$\frac{d\log_e D_m}{dT} \equiv \frac{d\log_e R_u}{dT} + \frac{D_m}{R_u}\left(\frac{-d\,\dfrac{R_q}{D_m}}{dT}\right) + \frac{D_m}{R_u}\left(\frac{-d\,\dfrac{R_f}{D_m}}{dT}\right).$$

In this form the growth rate of deposits is the sum of three parts, the contribution of the growth rate of unborrowed reserves and that of changes in the required and free reserve ratios. The factor D_m/R_u converts changes in the reserve ratios into units that represent their contribution to the growth rate of deposits. (The factor can be omitted if we deal with changes in the dollar amount of reserves rather than in ratios.)

This formulation disregards currency flows on the assumption that the Reserve Banks supply whatever quantity of currency the public desires, offsetting entirely the effect of currency flows on bank reserves. Otherwise, changes in the ratio of currency held by the public to deposits affect reserves and deposit growth. The Reserve Banks have often, though by no means always, offset changes in the currency ratio; they certainly did not at certain crucial times like 1929–33. And a currency offset could not be expected at all in the period before 1914. (In that earlier period, too, B was zero.)

While the analysis here follows current practice in ignoring currency flows, the appropriateness of doing so requires further study, particularly for the earlier period.

defined as member-bank deposits at Federal Reserve Banks less borrowing. For the early 1920's, however, that definition makes no sense. Such reserves were then negative: borrowing exceeded bank deposits at Federal Reserve Banks, which was possible because vault cash was an important component of bank reserves. The series used for the 1920's therefore includes the vault cash of all banks (nonmember-bank vault cash cannot be readily excluded). This series has always been positive but, in 1920 and 1921, it was quite small. By 1922 reserves held at Federal Reserve Banks had increased appreciably, and vault cash was relatively less important. Table 6-5 therefore also reports regressions for 1922–29, to exclude the first two years of the decade when borrowing was nearly as large as total reserves; the unborrowed residual was small then, and its monthly percentage changes were volatile.

The two added variables show significant effects on deposit growth, though for the earlier period changes in the required reserve ratio [9] are only important in 1919 (this year covered only by the commercial paper regressions). The volatile changes in unborrowed reserves during the early 1920's produce an apparent negative effect in the regressions which turns positive when those years are omitted. In terms of long-run effects, the coefficients of these last two variables should, by the above formulation, be positive and approximately unity. They estimate pure numbers, since the dependent variable is measured in the same units. A continual increase in unborrowed reserves or decrease in required reserves will add to the growth rate of deposits unless continually offset by increases in the free reserve ratio.

The estimated effects of these variables in the table are all well below unity, presumably because of lags. In the short run, changes in unborrowed reserves are partly or largely unforeseen. They would affect deposit growth gradually and only after a period of adjustment, whereas banks can be expected to expand deposits right along with anticipated, regular increases in unborrowed reserves. A regression coefficient below unity for this variable therefore indicates that the changes were not fully anticipated. (Meigs [30] suggests that the rate of change of unborrowed reserves may also affect the desired level of free reserves. Banks may be comfortable with a lower ratio during periods of rapid growth in unborrowed reserves. Consequently, besides the direct effect on deposit growth, a higher growth rate of re-

[9] In the earlier period changes in the required ratio reflected shifts in deposits between reserve classes and between time and demand deposits. In the later period, changes in legal requirements also occurred.

serves would gradually lead to a once-and-for-all reduction in the free reserve ratio and to a higher rate of deposit growth while the reduction was taking place. This effect would tend to make the regression coefficient of changes in unborrowed reserves higher, however, not lower.) The coefficient may also be less than unity insofar as the Federal Reserve partly offsets member-bank borrowing through deliberate changes in unborrowed reserves; this will be discussed later.

However we interpret these regressions, the interest-rate differential gives no evidence of a positive effect on deposit growth. Regressions of the form (4) and (5) or close variants are often used in studies of banking behavior.[10] The differential rate sometimes turns out to be significant with the correct sign, though usually the association is weak. The only major differences between this and other studies are the omission of data after the 1961 trough and the allowance for common cyclical patterns in the variables. Significant correlations using data in monthly or quarterly form need not reflect a genuine relationship but simply a tendency of the variables to move similarly over business cycles in response to a variety of cyclical influences. In Table 6-5 the common cyclical pattern in the variables has practically been eliminated by taking changes between reference-stage averages (dummy variables to remove any remaining common cyclical pattern were not used), and the differential rate is either insignificant or has the wrong sign.

These results indicate that responses of the desired free reserve ratio to the differential rate are not strong enough to register clearly on deposit growth. The next two subsections show why such responses may not affect deposit growth and explore an alternative way of measuring them.

The Problem of Interdependence Between Open-Market Operations and Borrowing. Many econometric models of the monetary system do not allow for a dependence of Federal Reserve open-market operations on member-bank borrowing. To be sure, unborrowed reserves are usually included in equations like (4) and (5), but only to take account of a dependence running in the other direction: Open-market operations make reserves temporarily flush or tight, which leads some banks to reduce or step up borrowing, as the case may be, until they can accommodate their portfolios to the new conditions. Later, when banks have had time to adjust to the change in reserves, the free

[10] See for example Meigs [30]; Brunner and Meltzer [4], especially Table 5; Davis [10] and [11]; and Teigen [44]. See also Rangarajan and Severn [38], who use the market (not the differential) rate, and conclude that it has no discernible effect on deposit growth.

reserve ratio returns to the desired level determined by other considerations. Those adjustments are consistent with the explanation of borrowing given by Riefler. It is appropriate to allow for them in measuring the effect of the differential rate. But there is no reason to ignore a mutual dependence. The privilege of borrowing helps individual banks avoid temporary stringencies, but it is not supposed to compromise the over-all objectives of monetary policy. The Federal Reserve may also engage in open-market sales—as well as persuasion—to offset borrowing which interferes with the desired monetary policy. To the extent that borrowing is thereby offset, it, as well as the corresponding reduction in unborrowed reserves, will have no observable effect on deposit growth. If we measure the effect of the differential rate on desired free reserves by means of their induced contribution to deposit growth, we in effect assume that the Federal Reserve does not offset the contribution. This assumption underlies much recent econometric research on the determinants of the money supply and deserves attention.[11]

The fact of the matter is that changes in unborrowed reserves and the free reserve ratio are highly correlated inversely (as shown by Table 6-6) especially when changes in the required reserve ratio are held constant. Since the variables are all measured in the same units, the negative coefficients of about unity indicate that the contributions to deposit growth of unborrowed and free reserves offset each other and also that unborrowed reserves offset changes in requirements. (Since the data pertain to concurrent monthly changes, there is no implication that the offsets are permanent.) It is true that the two independent variables, as measured, contain unborrowed reserves in the denominator. That might tend to increase the negative correlation with the dependent variable, but probably not a great deal. The dependent variable is monthly changes in unborrowed reserves which, except perhaps for the early 1920's, behave quite differently than the ratio D_m/R_u contained in the two independent variables. Nor do the high correlations reflect similar cyclical patterns in the variables. When dummy variables are used to absorb the common cyclical fluctuations, the results (not shown) are virtually the same.

[11] Whether valid or not, the assumption does not affect the argument made by Meigs [30] that free reserves are a misleading indicator of bank behavior; their level does not predict how rapidly banks are going to expand loans or deposits. When the growth of unborrowed reserves is high, banks might keep the actual free reserve ratio low, and by that indicator monetary policy might appear to be tight; while in fact the desired ratio may be even lower, leading to rapid monetary growth. Nothing said here denies this point.

TABLE 6-6. Regression of the Growth Rate of Unborrowed Reserves on the Contribution to Deposit Growth of the Free and Required Reserve Ratios, Changes Between Reference Cycle Stages

Period	Simple or Partial Regression Coefficient (and t value): $\frac{D_m}{R_u}\left(\frac{-d\frac{R_f}{D_m}}{dT}\right)$	Simple or Partial Regression Coefficient (and t value): $\frac{D_m}{R_u}\left(\frac{-d\frac{R_q}{D_m}}{dT}\right)$	Adj. R^2
1919–29	−.80(6.7)		.62
	−.88(8.9)	−.86(3.8)	.75
1922–29	−1.17(8.4)		.80
	−1.10(12.8)	−1.70(5.3)	.93
1948–61	.35(0.7)		.00
	−1.00(6.1)	−.89(14.5)	.89

SOURCE: Same as for Table 6-5.

NOTE: Dependent variable of regressions is growth rate of unborrowed reserves (monthly percentage change in bank reserves at Reserve Banks *minus* borrowed reserves), annual percentage rate. Constant term is not shown. Independent variables, by column, are:

(1) Contribution of free reserves to growth rate of deposits—see footnote 8 (monthly change in ratio of member-bank free reserves to total deposits, with sign reversed, *times* the ratio of deposits to unborrowed reserves), annual percentage rate.

(2) Contribution of required reserves to growth rate of deposits—see footnote 8 (same as col. 1 except with required instead of free reserves), annual percentage rate.

The regressions were run as first differences between reference stages, that is, each observation is the change between successive stage averages of monthly values of the variables shown in the table heading.

Periods are the same as for Table 6-1.

Signs of t values have been dropped.

These results are indeed to be expected. Open-market operations are used to offset sudden and undesired changes in bank reserves. For example, they help counteract the immediate effects of changes in legal requirements, allowing banks time to make adjustments. Banks borrow when open-market sales disturb reserves, but that response alone seems insufficient to explain the high correlation. In addition, the Federal Reserve counteracts the effect on deposits of any borrowing which does not agree with monetary objectives. It is true that the Reserve Banks have never announced an explicit policy of offsetting bank borrowing, but they nevertheless pursue such a policy indirectly in the normal course of countering undesired expansions or lapses in deposit growth. The correlation between free and unborrowed reserves therefore reflects an influence running in both directions.

For the short-run profit theory of borrowing, however, it is irrelevant that induced changes in desired free reserves, as found in Table 6-5, do not affect deposit growth. Because of open-market operations and other factors affecting deposit growth, it is better to test the theory directly, as is done below.

The Effect on Free Reserves. Another difficulty with equations (3)–(5), mentioned earlier, is that they ignore the inverse effect of monetary growth on interest rates. That effect would tend to counteract the positive relation assumed in those equations and helps to explain why the coefficients of the differential rate in Table 6-5 are sometimes negative. Because of that difficulty and the interdependence just discussed, we may examine the effects of the differential rate on the contribution of the free reserve ratio to deposit growth, rather than on the total growth itself. We may retain the general hypothesis that banks respond to the discrepancy between the desired and the actual free reserve ratio. The equation then is

$$\frac{D_m}{R_u}\left(\frac{-d\,\dfrac{R_f^a}{D_m}}{dT}\right) = \gamma\left(\frac{R_f^a}{D_m} + \phi[r_0 - r_b]\right). \tag{6}$$

Table 6-7 reports regressions of this form,[12] as well as with the addition of changes in unborrowed and required reserves. The contribution of the free reserve ratio to deposit growth is practically the same as the change in the ratio with the sign reversed. The difference is the factor D_m/R_u, which as pointed out in footnote 8 converts changes in the ratio into their effect on deposit growth. The assumption behind this formulation is that a given discrepancy between the actual and desired ratios leads banks to produce – other things remaining the same – a commensurate change in the growth rate of deposits rather than in the reserve ratio *per se*. The two effects will usually be roughly equivalent, however, thus rendering the distinction of little importance. Large

[12] See footnote 8 for derivation of dependent variable. Variants of (6) were also used by Meigs [30]; as well as by de Leeuw [12]; Goldfeld [18]; and Goldfeld and Kane [19].

TABLE 6-7. Regression of the Contribution to Deposit Growth of Free Reserves on the Differential Rate and Other Variables, Changes Between Reference Cycle Stages

Period and Interest Rate	Partial Regression Coefficient (and t value)				
	$\frac{R_f}{D_m}$ (1)	$r_{CP} - r_b$ or $r_{TB} - r_b$ (2)	$\frac{d\log_e R_u}{dT}$ (3)	$\frac{D_m}{R_u}\left(\frac{-d\frac{R_q}{D_m}}{dT}\right)$ (4)	Adj. R^2 (5)
1922–29					
Commercial paper rate	8.3(0.7)	55.3(1.9)	–		.08
	11.2(0.9)	55.9(1.9)	–	0.7(0.8)	.06
	4.2(0.8)	9.8(0.6)	–.68(7.1)	–	.79
	–3.0(0.7)	–3.4(0.3)	–.85(10.7)	–1.5(4.0)	.90
Treasury bill rate	15.6(1.5)	46.8(3.2)	–	–	.34
	18.1(1.7)	46.7(3.2)	–	0.6(0.8)	.32
	7.3(1.3)	14.6(1.6)	–.61(6.3)	–	.81
	–0.6(0.1)	5.0(0.7)	–.80(9.1)	–1.3(3.6)	.90
1948–61					
Commercial paper rate	–0.3(0.1)	–1.7(0.4)	–	–	.00
	0.7(0.2)	–1.2(0.3)	–	–.10(1.4)	.00
	–0.7(0.2)	–2.2(0.6)	–.07(0.8)	–	.00
	2.4(1.2)	–4.6(2.2)	–.69(7.6)	–.65(7.9)	.69
Treasury bill rate	4.6(1.1)	5.5(1.8)	–	–	.04
	4.6(1.2)	4.7(1.5)	–	–.08(1.1)	.05
	4.4(1.1)	5.4(1.7)	–.05(0.6)	–	.02
	2.2(0.9)	–3.1(1.4)	–.72(6.6)	–.71(6.7)	.66

SOURCE: Same as for Table 6-5.

NOTE: Regressions are based on text equation (6) and variants, plus a constant term, not shown. For derivation of monetary variables, see footnote 8. Dependent variable is contribution of free reserves to growth rate of deposits (same as Table 6-6), annual percentage rate. Independent variables (see Table 6-5) are, by column:

(1) free reserve ratio, per cent;

(2) differential rates, per cent per annum;

(3) growth rate of unborrowed reserves, annual percentage rate;

(4) contribution of required reserves to growth rate of deposits, annual percentage rate.

The regressions were run as first-differences between reference stages, that is, each observation is the change between successive stage averages of monthly values of the variables shown in table heading.

Periods are the same as for previous tables.

Signs of t values have been dropped.

differences did occur in 1920 and 1921 when unborrowed reserves were very small and, as before, those years have been excluded for that reason.

The regressions with the highest multiple correlations are those including changes in unborrowed reserves and legal requirements. As explained in the preceding subsection, however, the former can be expected to overstate the response of banks to open-market operations and hide the true effects of the other variables. It should perhaps be omitted.[13] There is no parallel reason for omitting changes in the required reserve ratio, since those changes induce temporary borrowing and presumably reflect distributional shifts in deposits or policy actions with long-run objectives in mind, rather than provide a short-run offset to borrowing. With changes in unborrowed reserves excluded, the differential rate is positive and significant ($t \geqslant 2.0$) for Treasury bills 1922–29, and on the borderline of significance for bills 1948–61 and commercial paper 1922–29. If we test the profit theory by adding the market rate to these regressions (not shown), the coefficient of the differential rate remains about the same in size and significance, unlike the version of the theory in Table 6-3 which failed that test. The addition of dummy variables also makes little difference here, unlike the correlations in Table 6-1 for the 1948–61 period. These results therefore provide some evidence of a short-run profit theory of borrowing.

Based on the Table 6-7 estimates, however, the lure of such profits has been sharply constrained since the 1920's. If we compare the earlier and later periods for the first two Treasury bill regressions (which exclude changes in unborrowed reserves), we see that the coefficient of the differential rate was nine times larger in the 1920's (47 compared with 5). The coefficient measures the effect on deposit growth: the change produced in the annual percentage rate of deposit growth for a 1-percentage point change in the differential. Column 2 divided by column 1 gives an estimate of ϕ in equation (6): the effect on the desired free reserve ratio (in percentage points). By the same comparison, that effect was two and a half times larger in the 1920's. The decline in magnitude is not surprising, considering how much larger were the fluctuations in borrowing during the 1920's for similar variations in the differential rate. Ironically, economists began to

[13] One could, of course, set up a more complicated equation that allowed for mutual interaction between bank borrowing and open-market operations, but that seems unnecessary for present purposes.

attach importance to borrowing by banks for short-run profit well after the heyday of such activity had passed.

The estimate of ϕ for Treasury bills 1948–61 is slightly above unity (5.5/4.6), indicating that a 1-percentage point rise in the bill-discount differential—the typical change from cyclical trough to peak in the 1950's (see Chart 6-3, below)—increased the desired free reserve ratio about 1 percentage point, not a large amount. To be sure, because of the delayed adjustment, this induced an increase in the contribution to deposit growth of 5.5 per cent per year (the estimate of $\gamma\phi$ in col. 2), but open-market operations apparently offset most or all of it, as indicated by the negative estimate when changes in both unborrowed and required reserves are included.

The partial correlations of the differential rate in Table 6-7 (not shown) range from +.66, for the first two Treasury bill regressions in the earlier period, to below zero (for the negative coefficients). On the whole they are much smaller than the corresponding correlations relating the free reserve ratio to the level of interest rates in Table 6-1, which are also much more significant and therefore more reliable. While that association originally attracted the attention of economists and eventually led to the short-run profit theory, it cannot be adequately explained as a reflection of equation (6) or its variants. Indeed, the statistical relations measured by Tables 6-1 and 6-7 appear to be practically independent of each other.

V. Reinterpretation

The preceding results seem paradoxical at first. The strong association observed between the free reserve ratio and interest rates appears to reflect neither the contribution of the ratio to deposit growth nor the effect of differential rates on the desired ratio. Those two interpretations, however, do not exhaust the possibilities. In particular, they disregard an important characteristic of bank behavior: the effort to retain the loyalty of regular customers by accommodating requests for loans so far as possible even when funds are scarce. Such behavior has been noted.[14]

Experience generally shows that tightness in the availability of credit to bank customers is related to a large volume of member bank discounts outstanding,

[14] The first quotation is from [2], p. 46, the second by George W. McKinney, Jr. [29], p. 27. For similar statements see Robinson [40], Hodgman [23], Kane and Malkiel [25], and Goldfeld [18], pp. 15–16.

and easy credit conditions to a small volume of borrowing from Reserve Banks.

> . . . the typical banker is acutely aware of his responsibilities to his customers and to his community, and is far more interested in establishing and maintaining long-term customer relations and providing his community with funds to meet its legitimate credit needs than he is in short-run profit considerations.

In striving to satisfy the demand of regular customers for loans, banks will, when necessary, lend whatever funds they can obtain by reducing excess reserves, selling securities, and borrowing. When loan demand expands, therefore, it is met by reducing the free reserve ratio, regardless of the discount rate and the effect on short-run profits. When, at some later time, loan demand weakens and funds become plentiful, banks settle into a more relaxed and easy reserve position. The costs of accommodating customers at "acceptable" loan rates frequently requires giving up maximum current profits, which banks willingly subordinate to the more important purpose of retaining the loyalty of their regular clientele over the long run.

To be sure, when banks need funds, they undoubtedly seek to acquire them in the cheapest way. That they try to maximize profits or minimize losses at all times is not at issue here. The question is how to explain the high correlation between borrowing and interest rates. Probably no one would deny the importance to banks of accommodating customers, yet most time-series studies have overlooked this simple explanation of the correlation. Short-term interest rates serve as a proxy for the intensity of pressure put on bank officials by regular borrowers, since market rates reflect changes in the demand for short-term funds, part of which represents a demand for bank loans.[15]

The pressure to make loans varies over time, not only because the demand for loans fluctuates, but also because banks do not charge a rate that clears the market. Loan officers could let high rates drive away the excess demand when reserves become tight, but by all accounts they prefer instead to ration credit. Bank loan rates do move with the market to a considerable extent, but usually not enough to clear it. Credit rationing leaves an unsatisfied demand in excess of supply and creates a group of disgruntled customers pressing to borrow more. The intensity of over-all pressure will depend upon a variety of factors, an important one being the level of market rates. In view of the widely acknowledged concern of banks to retain customer

[15] The first writer to attribute the association to loan demand, so far as I know, is Irving Fisher [15]. See the quotation of his in the Appendix.

loyalty, the high correlation of short-term interest rates with the reserve ratio (Table 6-1) in itself supports this interpretation.

Market rates may be an imperfect indicator of the intensity of customer pressure on banks. Consequently, the test of Table 6-3 may be biased against the short-run profit theory of borrowing, since the market rate is also correlated with the market-discount rate differential (a result of infrequent changes in the discount rate). The market rate might, as an imperfect proxy for the degree of credit rationing, spuriously reduce the partial correlation between the differential rate and the reserve ratio. Perhaps, if we took account in another way of the pressure on banks to accommodate customers, an effect of the market-discount rate differential might come to light.

Unfortunately, there are no ready measures of shifts in the demand curve for bank loans. We must improvise. Besides the level of market rates, two makeshift indicators of the pressure on banks to expand credit suggest themselves. The prevalence of credit rationing suggests one: the difference between the market rate and the average bank loan rate. The first rate reflects what banks could charge (for a given supply), and the second what they do charge, at least directly. To be sure, loan rates usually exceed the rate on commercial paper or Treasury bills, because these instruments entail less risk than the average bank loan does. Nevertheless, since market rates fluctuate with shifts in the demand curve for loans, the differential between the market and the loan rate measures variations both in excess demand and in the pressure on banks to expand loans. Thus the market-discount rate differential may be reinterpreted: In the partition of $r_0 - r_b$,

$$(r_0 - r_l) + (r_l - r_b),$$

the first term (the market-loan rate differential) measures the excess demand for bank loans, and the second term (the loan-discount rate differential) measures the gross profit to banks in borrowing from Reserve Banks.

Another indicator is the volume of loans as a proportion of earning assets. Banks devote an increasing portion of their total resources to loans as the pressure mounts, even though they satisfy only part of the total demand. The assumption underlying this indicator is that rejected applications for loans increase approximately as fast as do approvals.

Admittedly, these two indicators are rough. We cannot expect them to remain nicely proportional to the pressure on banks to expand loans. They nevertheless provide an alternative to market rates as measures of that pressure, and so allow a partly independent test of the relative importance of the two interpretations of bank borrowing.

Table 6-8 presents the results of such a test. One set of regressions makes use of the foregoing partition, in which the loan-discount rate differential represents the incentive to borrow for short-run profits. That variable does poorly (its coefficient is not even negative for the

TABLE 6-8. Regression of Free Reserve Ratio on Rate Differential and Two Proxies for Intensity of Loan Demand, Changes Between Reference Cycle Stages

Period and Market Rate (r_0)	Partial Regression Coefficient (and t value): Loan Demand: $r_0 - r_l$ (1)	Loan Demand: $\frac{L}{L+I}$ (2)	Differential Rate: $r_l - r_b$ (3)	Differential Rate: $r_0 - r_b$ (4)	Total Correlation Coefficient
1919–29					
Commercial paper rate	−2.2(3.5)	–	+0.6(0.8)	–	.76
	–	−.42(3.3)	–	−0.9(1.1)	.62
Treasury bill rate	−1.3(2.5)	–	+1.5(2.1)	–	.71
	–	−.71(5.9)	–	−0.8(1.8)	.80
1948–61					
Commercial paper rate	−0.4(2.3)	–	−0.0(0.0)	–	.55
	–	−.04(2.3)	–	−0.2(1.0)	.56
Treasury bill rate	−0.4(3.1)	–	−0.0(0.2)	–	.63
	–	−.04(2.9)	–	−0.4(2.9)	.69

SOURCE: Ratio of loans to total earning assets: for later period all commercial banks, for earlier period reporting member banks, *Federal Reserve Bulletin,* monthly data seasonally adjusted by NBER. Other data are the same as for Tables 6-1 and 6-3.

NOTE: Dependent variable is ratio of member-bank free reserves to demand and time deposits, per cent. Constant term is not shown. Independent variables are, by column:

(1) Commercial paper or Treasury bill rate *minus* average bank loan rate, per cent per annum.

(2) Ratio of loans to total loans and investments, per cent.

(3) Average bank loan rate *minus* discount rate, per cent per annum.

(4) Commercial paper or Treasury bill rate *minus* discount rate, per cent per annum.

The regressions were run as first-differences between reference stages, that is, each observation is the change between successive stage averages of monthly values of the variables shown in table heading.

Periods are the same as for previous tables (for Treasury bills 1919–29, excluding 1919–20 expansion stages).

Signs of t values have been dropped.

earlier period, although it should be), and it appears to have no relation to borrowing. Consequently, the market-discount rate differential was used to represent the profit incentive in the other set of regressions, in which the loan ratio represents the intensity of loan demand. The two independent variables in that set are related (their simple correlation coefficient is +.30 for the earlier period and +.51 for the later period), but not so closely as to preclude measuring their separate effects.

The loan-demand variables are highly significant. Their regression coefficients imply that customer pressure affected the reserve ratio much less in the 1950's than in the 1920's, consistent with the much freer borrowing allowed in the earlier period. The total correlation coefficients are nearly as high as the simple correlations between the ratio and the corresponding market rates in Table 6-1. The Table 6-8 regressions appear to capture most of that association, which the short-run profit theory attributes to the effect of differential rates alone. Judged by the levels of significance, however, the loan-demand variables are more important, with one exception: the later regression for bills in which the two variables have equal significance. The differential rates mostly have the correct negative coefficient, but only for the exception is it significant ($t \geq 2.0$), though it is on the borderline in in the second Treasury bill regression for the earlier period. The results are similar to Table 6-7 in that the coefficient for the differential rate is larger for the earlier period.

The evidence of Table 6-8 on the short-run profit incentive is only tentative. A better proxy for loan demand might well reduce the coefficient of the differential rate. The results of using the market rate as the proxy (Tables 6-3 and 6-4) suggest such a possibility. Yet those results may underestimate the profit effect, as was suggested, because the market rate might, if Reserve Banks put restrictions on borrowing, sometimes indicate the true return in borrowing for short-run profit better than the differential rate does. Since the market rate may thus represent both reasons for borrowing and the other proxies for loan demand may be inadequate, the importance of the profit effect is hard to assess. Presumably it lies part way between the effects shown by Tables 6-3 and 6-8.

The relative importance of loan demand and the differential rate can be assessed from their regression coefficients and amplitudes of fluctuation. In the later period, for example, the ratio of loans to total assets usually rose about 10 percentage points from trough to peak of reference expansions, and the bill-discount rate differential about 1 percentage point. The regression coefficient of the differential rate is ten times that of the loan ratio (bottom line, Table 6-8). Therefore, their effects on the free reserve ratio over reference expansions were about equal, each producing a total change in the reserve ratio of roughly 0.4 percentage points. For the earlier period, the effects were larger and the loan ratio was absolutely and relatively much more important. For commercial paper rates in both periods, the loan ratio was relatively more important than the differential rate.

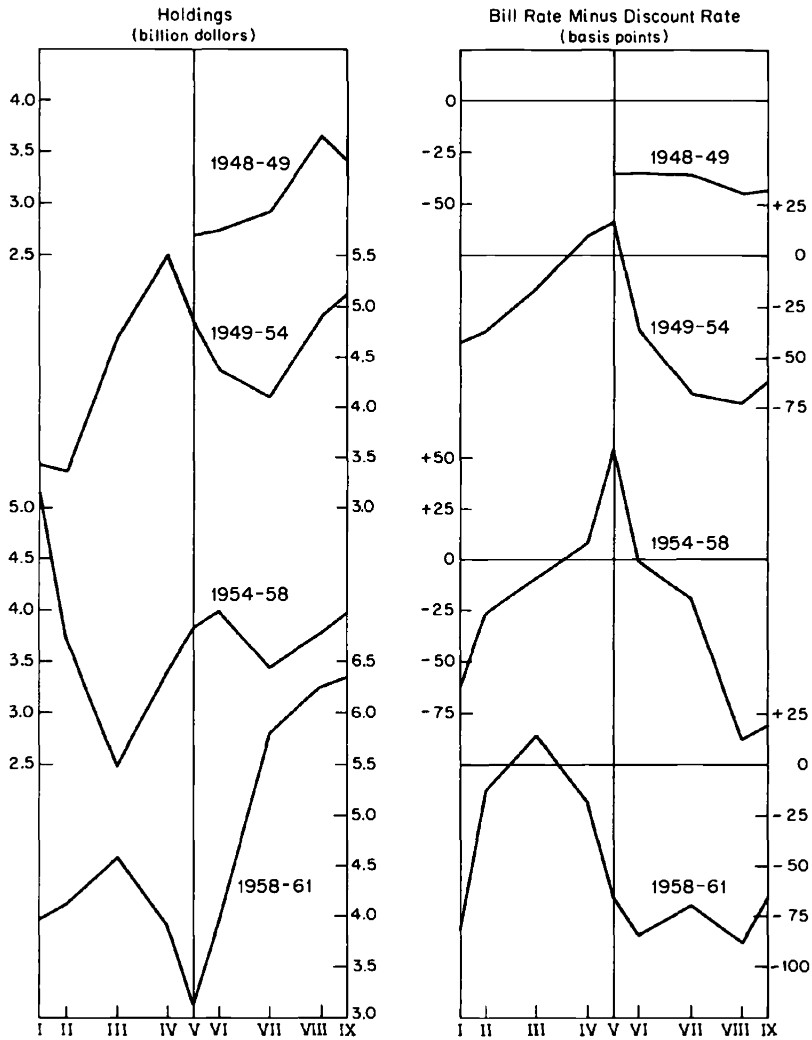
Since we find that borrowing depends in part upon the bill-discount rate differential, at least for the later period, does that mean that the funds are used to acquire Treasury bills? Clearly not. Chart 6-3 shows that bank holdings of Treasury bills did not follow movements in the bill-discount rate differential during the 1950's. Bill holdings tended to rise in the last half of reference contractions, when the profit incentive to borrow—and borrowing itself (see Chart 6-1)—actually reached a cyclical low point. The bill-discount rate differential was seldom positive in the post-World War II period; when it was, bank holdings of bills were not at their cyclical peaks (the 1950–53 expansionary years, when the excess profits tax was in effect, are a partial exception). A comparison of cyclical movements therefore denies that the differential rate influenced the purchase of Treasury bills. By all indications, bills serve as a dispensable reservoir of lending power to meet cyclical variations in loan demand.[16] What is true of bills is generally true of other security holdings. Banks both run off securities and borrow from Reserve Banks to finance an expansion of loans.

The bill-discount rate differential nevertheless does better than the other series in reflecting the short-run profit from loans. The *loan*-discount rate differential itself shows no relation to borrowing from Reserve Banks, largely because banks prefer to ration credit rather than to charge what the market will bear at the moment. But the average loan rate may not, when funds are tight, fully register changes in the *short-run* return produced by higher compensating balances and the selection of loans with lower risk. As a result, the bill rate may more accurately represent changes in the total return from loans. The ques-

[16] Since pressure for loans leads banks to reduce bill holdings as well as the free reserve ratio, it is also tempting to argue that loan demand is the source, via changes in the nonbank supply of bills, of the corresponding movements in the bill rate. Hence the bill rate and the free reserve ratio would be inversely correlated, though not directly as cause and effect. One difficulty with this interpretation, however, is that the bill holdings of banks do not have a regular (inverse) cyclical pattern (Chart 6-3), while the bill rate has a regular positive pattern (see [8]). The argument therefore appears weak.

tion here is not what banks do with borrowed funds – mainly they expand loans, but whether they borrow only when the desired accommodation of long-standing customers strains resources or also, as the evidence in part suggests, when the rate differential makes it particularly attractive.

CHART 6-3. Reference Cycle Patterns of Treasury Bill Holdings of All Commercial Banks and Bill-Discount Rate Differential, 1948–61



SOURCE: Differential, same as Table 6-3; holdings, *Monthly Treasury Bulletin.*

Whether we interpret the effect of the differential rate in these regressions to be large or small, it seems clear that the major part of bank borrowing reflects simply a desire to accommodate customers, without regard to short-run profits. That is shown by the high correlation (Table 6-8) between the free reserve ratio and the loan-demand variable, holding the differential rate constant. Such borrowing appears to be the main explanation for the long-noted association between interest rates and bank reserves. While loan demand may well explain most of the association before World War I, the evidence developed here does not directly apply to that period. The discount window did not exist and we cannot readily distinguish between the two roles of interest rates at that time: as proxy for loan demand and as the foregone return on excess reserves.[17] For the 1920's and since World War II, when borrowing from Reserve Banks has provided most of the fluctuation in free reserves, the distinction can be made because the second role is played by the market-discount rate differential, not by the market rate itself. For these later periods at least, loan demand should be accorded primary emphasis in a theory of bank borrowing and the free reserve ratio. The effect of interest rates on free reserves has, on the whole, been less important. Their effect appears to be very important only because the rates happen to be good proxies for customer pressures on banks to expand loans.

VI. Summary

Statistical studies of the behavior of bank reserves have had an unusually long history relative to other empirical work in economics. During the past half-century economists have become increasingly aware of a high correlation between reserve ratios and short-term interest rates. An earlier interpretation, expounded most fully by Riefler, attributed the association to the influence of bank reserves on financial markets. Though never adequately spelled out, this view may be formulated as saying that easy or tight reserves produce a high or low contribution, respectively, by banks to the growth rate of deposits, which shifts the supply curve of loanable funds and affects market interest rates accordingly. The rates are thus inversely related to the reserve

[17] The pre-1914 period is further complicated by the fact that many reserve agents paid interest on deposit reserves held with them by other banks. The rate paid, however, was a standard 2 per cent and, as far as I can determine, changed little. A rise in market rates, therefore, still increased the incentive to reduce excess reserves.

ratio of the banking system. Beginning with Turner's 1938 criticism of Riefler's study, opinion reversed the direction of influence and, since then, has attributed the association to the effect of market rates on the free reserve ratio. This interpretation regards bankers as equating the marginal contribution to profits of holding excess reserves and earning assets or of borrowing from Reserve Banks. When market rates rise, banks are thought to convert excess reserves into earning assets, and also, if the discount rate does not rise as high, to borrow more. Hence, the free reserve ratio falls as the market-discount rate differential increases.

There is some merit in both explanations of the association, but neither one comes near accounting for it fully: (1) Monetary growth does affect interest rates inversely, but that has nothing to do with the observed association between rates and the reserve ratio. The association is not affected by holding the growth of deposits constant, contrary to the earlier interpretation in which the reserve ratio affects interest rates through the induced changes in bank credit and deposits (Section III). (2) The later interpretation implies that, with the advent of discounting under the Federal Reserve System, the free reserve ratio should be inversely related to the difference between the rate which banks can earn on assets and the discount rate. Yet the free reserve ratio is not correlated with the market-discount rate differential when the market rate itself is held constant (Section IV, first part). The ratio continues to be highly correlated with the level of short-term interest rates.

The alternative interpretation offered here (Section V) puts emphasis on the long-run goals of successful bank management. Personal and business loans provide the most profitable use of bank funds. Studies of banking also stress the overriding concern of management with meeting the credit needs of regular customers. Banks make every effort to accommodate them by selling securities, reducing excess reserves to the minimum, and borrowing from Reserve Banks with only a side glance at the discount rate. Hence, when the demand for loans expands, we observe a rise in interest rates and a decline in the free reserve ratio; and the converse when loan demand slackens. To be sure, banks are constrained to borrow for only short periods at a time. Yet, when the money market tightens and the accommodation of customers strains available funds, banks are forced to borrow more often, and the total borrowing of the system will be greater. That accounts for the major part of the association between the free reserve ratio and interest rates.

Of course, modern bank management seeks to maximize current profits by equating the marginal returns of borrowing and allocating resources among various alternatives, insofar as other considerations permit. But portfolio adjustments are not made in a vacuum. Important long-run and institutional considerations come in—such as preserving the goodwill of long-time customers and official constraints on the purposes and duration of borrowing from the Federal Reserve. Since banks nowadays hold negligible excess reserves, borrowing is one recourse when the demand for loans reaches a cyclical high point.

The data do show an effect on the free reserve ratio of the differential between the Treasury bill rate and the discount rate, holding constant certain other variables (Sections IV, second part, and V). The effect appears to have been much stronger in the 1920's than in the 1950's, as could be inferred from the much larger fluctuations in borrowing in the earlier period (Chart 6-1). Statistical studies of the effect, however, have overstated its strength and importance by making no allowance for common cyclical patterns in the variables and ignoring the varying pressures by bank customers for loans. The differential rate is a rough proxy for those pressures and, when used in regressions as the only interest-rate variable, exhibits a spuriously high correlation with the free reserve ratio.

Banks do not ordinarily borrow to acquire Treasury bills or other securities, as the frequent emphasis in statistical studies on the bill-discount rate differential may suggest. Holdings of such securities, if anything, fall as borrowing increases because both are used to provide funds for meeting an expansion of loans. Moreover, the bill rate usually stood below the discount rate in the 1950's, so the negative differential discouraged using borrowed funds to acquire bills. The bill rate here is apparently a proxy for the total return on loans, and the funds borrowed help banks to fulfill loan commitments. The average loan-discount rate differential shows no such effect, presumably because of credit rationing and the unrecorded returns to banks from compensating balances and other devices for altering charges indirectly.

The statistical association between the reserve ratio and interest rates provides little justification for assuming that changes in the money supply are sensitive to interest rates, as is standard in many current models of the financial system. Although the market-discount rate differential affects the free reserve ratio, changes in the ratio since World War II have accounted for a small part of the variations in deposit growth. To a large extent changes in the ratio are offset by Federal Reserve open-market operations (Section IV, second part). The Federal Reserve itself, of course, might occasionally take steps to limit interest-rate movements by its monetary measures, thus imparting an interest sensitivity to the supply, but it has never systematically pursued such a policy. The cornerstone of the evidence to support allegations of such sensitivity has been the statistical association between interest rates and the reserve ratio, and that association does not carry over to deposit growth (Section IV, second part). Properly interpreted, the data give no indication of an important interest sensitivity in the money supply.

Appendix

HISTORICAL REVIEW OF EARLIER EMPIRICAL STUDIES OF INTEREST RATES AND BANK RESERVES [18]

STUDIES OF THE PRE-1914 MONEY MARKET. A close association between bank reserves and short-term interest rates in New York City has apparently been known to financial observers for some time. "In the pre-war [World War I] days, fluctuations in the surplus reserves of clearing banks were observed with interest by all those who were interested in the state of the money market, for the approach of an exhaustion of the surplus was an announcement of impending restriction" [21, p. 264]. To my knowledge the first published study of the phenomenon was by John P. Norton in 1902 [32]. He examined call money rates and the lawful reserve ratio of New York City Clearing House Banks weekly from 1885 to 1900. The simple correlation between the two was −.52.

Norton assumed that the banks' reserve position largely determines call rates, not the other way around, which agreed with the generally accepted view at the time. Kinley, in the course of his famous study of the independent Treasury [27], attributed to banks' reserve position various short-run effects on the money market, but did not delve into the evidence to support his statements. The only exception I have found is Irving Fisher [15], who expressed a view similar to the findings of this study:

> When business is optimistic, . . . the immediate effect is to increase bank loans. These results tend to lessen the ratio of bank reserves to liabilities. Thus the banker is led to raise his rate. It *seems* that the rise merely reflects his reserve situation. But back of this situation is the demand for loans. [Italics his.]

[18] Also see Meigs [30], who reviews the theoretical analysis of this literature.

Writers who subscribed to the other, prevailing view did not elaborate.

In his statistical findings, Norton also showed a three-week lag of call rates behind the reserve ratio, which indicates that changes in the ratio affect interest rates rather than the converse. But this test of timing covered only a two-year period (unspecified), which is too short to provide reliable evidence.

For his study of seasonal variations, Kemmerer [26, table facing p. 40], derived evidence of a negative correlation between the fifty-two weekly seasonal factors in the call money rate and the reserve ratio of New York City Clearing House Banks. The correlation coefficient computed from his data is −.61.

Apparently unaware of Norton's work, Persons [33] published a study in 1924 of the same material but covering a longer period. Persons used the ratio of loans and investments to deposits (which approximates the complement of the reserve ratio) of New York City Clearing House Banks, monthly, 1867–1924. He adjusted the data to remove seasonal variations and a linear trend, which Norton did not do. This series graphically shows a close association (no correlations were computed) with seasonally adjusted commercial paper rates, except for a few periods, attributed by Persons to wars and panics. Comparable call-date data for national banks outside New York City during the same period also correspond to commercial paper rates fairly well over cycles, though not nearly as well month to month. Related comparisons for the pre-1914 period in Table 6-1 of the present study suggest that the correlation is not statistically significant.

The ratio of loans and investments to individual deposits (adjusted for float) of national banks in six geographic regions on call dates, 1901–04, were compared with commercial paper rates. The comparison shows the closest correspondence for New York City banks and the least for the Western and Southern banks. Indeed, there is a clear-cut association only for the New York City banks. (Our results in Table 6-1 confirm this.) This result is consistent with the influence running in either direction. On the one hand, one might argue that New York City banks have the most influence on this interest rate because they dominate the market for commercial paper. On the other hand, one might argue that this rate applies chiefly to the New York money market and so mainly affects the desired reserve levels of banks in that city.

Ayres [1] showed, after smoothing the data by moving averages, that there is a close association between commercial paper rates and the fraction of Treasury currency held outside of banks. The data are monthly figures for the period 1896–1914. Smoothing suppresses changes of a very short-run nature and reveals an association between the cyclical movements. The fraction of currency outside banks, which for the pre-1914 period is the complement of the ratio of reserves to high-powered money, has a close association with commercial paper rates—presumably because it is a fair approximation to the reserve ratio of national banks, at least for cyclical movements. This seems the most plausible way to interpret Ayres' results, as he offers no clear explanation.

In terms of theoretical interpretation, the best of the earlier works is a little-known 1922 article by Seltzer and Horner [42]. They extended the weekly series that Norton used for the period 1885–1900 to the succeeding nine years, 1900–09. For these nine years, they obtained the same correlation coefficient (–.52) that Norton did for the preceding fifteen years.

This is the only earlier work of all I have seen that explicitly interprets the correlation as reflecting a two-way dependence of the reserve ratio on rates *and* of rates on the reserve ratio.[19] For Seltzer and Horner, the reserve ratio measures changes in the "supply factors" affecting the loan market, as it does for Norton, but they also insist that the interest rate acts back upon the reserve ratio to produce a mutual dependence. Since "demand factors" are not represented in their correlation, Seltzer and Horner attribute to these factors the variations in the interest rate not explained by the reserve ratio. When they correlated the weekly data for individual years, the correlation coefficients varied from –.30 to –.68, which the authors explain by the varying strength of "demand factors" in different years.

The interpretation cannot be so simple, however, even in terms of their theoretical framework, as they themselves recognized.[20] In effect, they postulate a supply curve of loanable funds, for which the amount supplied depends upon interest rates (the foregoing studies implicitly assume that this curve is inelastic to changes in interest rates); the whole curve shifts with changes in the reserve ratio (when the ratio is low, loans are curtailed and conversely). Demand is also dependent on interest rates, and shifts in the supply curve

[19] Roos and Szeliski [41] did take account of both influences by adding various and sundry variables to their regression equation, but their analysis is so loosely formulated, and their regression variables so shot through with multicollinearity, that an interpretation of their results appears impossible. I seriously doubt that the high correlation coefficients they obtained, covering quite a short period, carry any economic significance.

Their work was inspired by Skinner's results [43], which allegedly show a strong relation between monetary factors and interest rates. He presented his data in graphs without sources or full explanation, so that the results can be neither verified nor interpreted.

[20] Seltzer and Horner argue (pp. 111–112) that "there is an effective limit . . . below which bankers cannot safely reduce their reserves. But as the reserve ratio rises above this limit, bankers have an increasing incentive to lend. . . . The higher the reserve ratios, the lower the rates at which bankers will be willing to lend; the lower the reserve ratios, the higher the rates which must be offered to tempt bankers further to diminish their reserve ratios.

"But, in fact, the situation is really more complex. Demand factors not only operate upon the call rate directly; but the call rate which results from partial or predominant demand influence affects in turn the reserve ratios. The great speculative boom will tend to force call rates upward without a prior decline in the reserve ratio; but the high rates in turn will tempt bankers to diminish their reserves to the minimum ratio compatible with safety or legal requirements. The high rates, in other words, will be partly *cause*, not altogether the effect, of a diminishing reserve ratio." [Italics theirs.]

We should probably interpret them as referring to the *stock* of funds supplied by banks rather than to a *flow* per period of time.

generate observations along the demand curve. But the demand curve may also shift, producing a movement along the supply curve in which loans expand by reducing the reserve ratio and vice versa. The trouble here is that the reserve ratio is serving as proxy for two separate sets of factors: Shifts in the supply curve affect the ratio in the same direction; movements along the curve (due to shifts in the demand curve) affect the ratio inversely. This raises the well-known problem of statistical identification, which they left unresolved.

Seltzer and Horner thought that their study had only historical interest because they believed the association between bank reserves and interest rates disappeared with the advent of Federal Reserve control over bank reserves and ability to stabilize the money market. Yet in the late 1920's, studies of the post-World War I period again found an association, though in a slightly different form.

A later study by Morrison [31] extends the evidence for the pre-1914 period.

STUDIES OF THE POST-1914 MONEY MARKET. Persons' study [33], already cited, covered the early 1920's, for which he also found a good association between the (complement of the) reserve ratio of New York banks and commercial paper rates. This would not be true of the late 1920's nor, especially, since World War II when banks have kept reserves much closer to the minimum required. Burgess [5] was the first to point to the post-1914 association, although in a new form. He showed that there was a close, positive, monthly association during 1923–26 between commercial paper rates and the borrowings (discounts and advances) of member banks from Federal Reserve Banks. In his book [6] published later, he extended the series to the 1922–33 period, for which the conformity is good though far from perfect. Burgess attributed the association to the influence of banks' indebtedness on interest rates. Because of the tradition against borrowing, banks allegedly borrow only temporarily when a reserve drain forces them to, and their ensuing efforts to terminate the debt by contracting loans tighten the money market. Burgess noted that, although borrowing is normally heavy in the closing months of each year, interest rates are not unusually high at that time, which he explained as banks' willingness to loan freely when they know the heavy demand for loans is temporary. A simple theory stating that banks borrow solely for profit does not account for this lapse in the association.

The evidence was discussed at some length in the celebrated book by Riefler [39] in 1930. Riefler's strong insistence that most banks do not borrow for profit appeared to represent the view of most top Federal Reserve officials.[21] His analysis started from a simple graph showing a close association between the borrowings of member banks and three short-term interest rates (for time and call loans, and commercial paper), monthly during 1917–28, with no apparent lag either way. The absence of lags led him to the view that, when

[21] See Harris [21, p. 262] and the references cited by him. For more recent views held by the Federal Reserve, however, see [13], [14], and [3].

banks are forced to borrow because of a loss of reserves, they immediately tighten up loans, and short-term rates rise. He noted that banks accounted for two-thirds of short-term loans in 1922 and one-half in 1928. If borrowing depended on profitability, it might lag behind changes in rates.

Borrowing for profit also implies that, without any restrictions on banks, the profit spread would disappear and open-market rates would then approach the discount rate. Although the two rates do exhibit similar movements, this similarity reflects a tendency of the Federal Reserve to adjust the discount rate to the market. Their movements are usually not so close as to prevent banks from making profits. The only rate that stays close to the discount rate is that on acceptances, for which Federal Reserve policy does control the market. The acceptance rate reveals the effect of such control, which other rates do not show.

This argument against the profit theory holds only in the extreme case. If we combine a profit theory with some limited aversion of banks to indebtedness, there is no implication that market rates have to equal the discount rate.

Riefler's argument, which received considerable attention, elicited a mixed reaction. The main issue was whether banks borrow for profit and hence whether the association between borrowings and interest rates reflects the effect of rates (or, better, the differential rate over the discount rate) on borrowing or the effect of borrowing on rates. It is not clear from his evidence which way the direction of influence runs.

Among those writing on the subject before World War II, Currie, Hardy, and Tinbergen supported Riefler's conclusions, while Harris and Turner disputed them.

To determine the response of banks to the level of their indebtedness, Currie [9] examined the association between the borrowings and deposits of different classes of member banks monthly during 1922–31. He found that New York City banks contracted deposits most strongly (by reducing loans and investments) when borrowing was heavy, and the connection between borrowing and deposit contraction was weakest for country banks. In other words, when banks were forced to borrow because of a drain of reserves, they contracted earning assets. The strength of the response varied between country and city banks, as might be expected. His results are marred by the ambiguity of his evidence. It is based on a visual examination of the series, and he made no allowance for common business cycle patterns.

Hardy [20] compared borrowings with the discount rate 1922–31 and found a positive association, whereas the profit theory of borrowing implies a negative one. He explains the positive association by Federal Reserve actions, in which open-market operations and changes in the discount rate occur together. The Reserve Banks sell bonds and raise the discount rate to tighten credit, thus forcing member banks to offset reserve losses by temporarily borrowing at the same time that the discount rate is increased. On the profit theory of borrowing, banks reduce their indebtedness when the discount rate is raised, which would produce an inverse association. This evidence is far from conclusive, however, because Hardy should have used not the level of the discount rate but the differential market rate over the discount rate. Short-term rates are positively correlated with the discount rate.

Tinbergen [45] introduced the concept of "free reserves" (excess reserves minus borrowings). In a scatter diagram he showed that free reserves and a short-term rate of interest—not specified but probably commercial paper rates—have a close linear relation monthly during 1917–37. The relation is negative, since borrowings are subtracted from excess reserves. Actually, the relation for the late 1930's is not linear, but Polak and White [34] demonstrated later that all the points lie along a linear regression function if the interest rate is measured logarithmically. (Logarithms are really only necessary to handle the very low rates of the late 1930's and early 1940's.) As a rationale for the relationship, Tinbergen cited Riefler's study.

Harris [21, Chap. XV] discussed particular episodes (mainly in the late 1920's) when member banks appear to have borrowed for purposes of profit. He drew attention to the lack of a close association between borrowings and short-term rates at various times. Harris contended that the data for certain years can only be explained on the presumption that banks often do borrow or remain in debt for profit.

While Harris questioned the application of Riefler's position to certain periods and in an extreme form to all periods, he did not reject it completely. A major study by Turner [46], however, concluded that the association can be entirely explained by banks' response to changes in the spread between short-term rates and the discount rate. Turner attacked Riefler's argument that borrowing for profit would always keep market rates at the level of the discount rate. This was contrary to fact and was used by Riefler to argue that the profit theory was invalid. Turner rightly countered that this would only happen if banks could and did borrow without limit and if demand factors played no role in determining market rates. Neither of these conditions is likely to hold, nor does the profit theory of borrowing require it to. Riefler's argument therefore rests basically on the assertion, derived from his familiarity with banking practice, that banks do not usually borrow for profit, which Turner disputed. Turner rightly pointed out that interpreting the motivation for borrowing is hazardous. When banks lose reserves, they may rely more on borrowing and less on selling investments, given a favorable profit spread, without breaking the injunction to borrow only for "need."[22]

To determine the direction of influence, Turner examined the relation between borrowings and the profit spread for each of the twelve Federal Reserve districts, monthly during 1922–36. For each district he computed a profit

[22] Turner also argued that banks have often held large amounts of bonds at times of sizable indebtedness as proof against Riefler's position that they eschew borrowing except when necessary. This argument is no more convincing than Riefler's. After all, banks might prefer to borrow temporarily for "need" rather than sell bonds if bond prices are at the moment sinking, and not because or only when the profit spread on borrowing is favorable.

spread on borrowing by subtracting the discount rate in the district from the same weighted average of short-term rates used by Riefler. There is no separate short-term rate published for each district. Consequently, since discount rates seldom differ among districts, the profit spread varies very little among districts and disaggregating the twelve districts provides less additional information than one might hope for. Undaunted, Turner compared this spread with the borrowings of banks in each district. The association was closest in the New York, Chicago, Boston and Philadelphia districts; for these he found no lag either way. In the other districts, where the association was lower, he found (based on correlation coefficients) that borrowings lag behind the profit spread by one to five months, suggesting that borrowing depends on profit.

This statistical evidence is really quite weak. The lag occurs only for the weakest correlations, not the highest, and therefore may be spurious. In addition, the correlation for all districts together, which has no lag, is higher than any of the correlations for the districts individually, suggesting that the breakdown by districts provides less information on the relationship than do the aggregate figures. This is inconsistent with the profit theory of borrowing but not with Riefler's position.

Turner's study therefore did not establish that the data favor the profit theory of borrowing over Riefler's interpretation (though Turner thought so), but it did cast a shadow over Riefler's interpretation.

In recent years the empirical study of liquidity preference inspired by Keynes has led to a search for such preferences in all sectors of the economy, including banking. Current studies now assume that the influence runs primarily from interest rates to free reserves and not the other way.[23] The supposition of the earlier work is thus implicitly rejected, though mainly by neglect rather than explicit evidence.

Polak and White's work [34] in 1955 improved on the technical quality of earlier studies and extended the coverage to later years. They presented a scatter diagram, with annual data for 1922–53, of the Treasury bill rate and the ratio of free reserves to total deposits of member banks. The bill rate is measured logarithmically, which appears to make the relationship linear even when the low rates of the late 1930's are included. The observations fit a straight line fairly well—no correlation is computed—indicating that the as-

[23] For a recent throwback to the Riefler interpretation, which has been practically extinct since World War II, see [22].

In 1955 Klein and Goldberger [28] presented a scatter diagram using annual data, 1929–52, of percentage changes in the commercial paper rate and the excess reserve ratio of member banks. The relationship is negative but not significant. They view banks as heavily influencing short-term rates through their lending, which creates an inverse dependence of interest rates on banks' ability to lend, as in the older view. However, they regard excess reserves (above average levels) as indicative of a disequilibrium, and depart from the older view by assuming that rates will change in inverse proportion to the degree of disequilibrium. Thus large excess reserves cause banks to lend freely and produce falling rather than low rates.

sociation first noticed by Norton has continued to prevail. Polak and White assumed, however, that they were measuring a simple liquidity preference relation: When market rates are high, banks are encouraged to keep low cash reserves and to borrow, while the incentive progressively weakens as market rates decline. They claimed that they were merely extending Tinbergen's earlier empirical work, but this statement failed to indicate that their rationale for the association is the opposite of Tinbergen's. Hence they should have used the rate differential instead of the level of the rate.

Except for Polakoff [35], who introduced the possibility of a reluctance of member banks to increase borrowing beyond certain limits, the next important development in the profit theory was due to Meigs [30]. He formulated the profit theory in terms of desired and actual reserves, with the desired level depending upon the differential between market rates and discount rate. Since Meigs, this formulation has been applied widely in econometric studies, some of which are cited in the main text.

SUMMARY. These various studies document a close association between free reserves and short-term interest rates. The association is too close and covers too long a period to be accidental. Most of these studies use the same basic data and so do not offer independent evidence, despite the variety of periods covered and the different ways the basic relationship is presented. The underlying association is strong enough to come through no matter how the data are handled and has therefore lent support to a variety of hypotheses. Before the 1930's, the association was generally attributed to the effect of reserves on rates, and since then to the opposite influence.

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