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Volume Author/Editor: Philip Cagan

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Chapter Author: Philip Cagan

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But this cannot explain the increased amplitude of corporate (and taxable U.S.) bond yields from the 1920's to the 1950's, because municipal bond yields display roughly the same increase (Table 5).

Although the evidence is based on a group of series which are not entirely comparable from period to period, the consensus of the measures is that, along with timing, the amplitude of cycles in most interest rates has responded more and more sharply to fluctuations in business activity of a given severity. The main qualifications involve the timing and amplitude of the two short rates before World War I, which cannot be appropriately compared with the series for the later period. Effects of financial disturbances in the 1930's and of interest-rate pegs in the 1940's and early 1950's are wholly excluded from the comparisons. Amplitudes have been larger in the 1950's than the 1940's, of course, because the Federal Reserve pegged interest rates during and after World War II. Amplitudes would not be larger in the 1950's than the 1920's, however, unless monetary policy or other relevant factors differed between the two periods.

III Monetary Influences on Interest Rates

From a formal point of view, changes in interest rates can be interpreted as stemming from either the demand to borrow funds or the supply of new funds. While numerous developments have no doubt affected the timing and amplitude of particular interest rates, the changes discussed appear broadly based, so that the factors responsible seem to encompass the entire market for funds. Moreover, since we took account of the amplitude of business activity (Table 6), a satisfactory explanation must account for an increased amplitude in business cycles of given severity. The analysis here is confined to monetary influences on the supply of funds. Money is defined as currency outside banks plus demand and time deposits at commercial banks. The emphasis on money is not meant to imply that it is the most important factor affecting interest rates. Others are probably more important. But money plays a key role in monetary theory and policy, and the evidence to be presented indicates that it helps to account for the cyclical behavior of interest rates.

New money first enters the economy mainly through the banking system and hence becomes part of the supply of loanable funds. An increased rate of monetary growth might therefore be expected to depress interest rates and a reduced growth rate to increase them. This has long been a tenet of monetary theory and became a famous thesis of the Swedish economist Knut Wicksell, writing over half a century ago. It implies an inverse association between the rate of change of the money stock and interest rates, which the evidence to be presented substantiates. Previous studies of the financial system have largely ignored this tenet of monetary theory and the implied effects on interest rates.[6]

Bank lending produces the first-round effect on interest rates of an injection of new money. Subsequent effects could be of equal or greater importance. A change in monetary growth may produce temporary discrepancies between the public's actual and desired money holdings. In response to such a discrepancy, the public can be expected to alter its expenditures on goods as well as financial assets, with repercussions on interest rates, though the direction and duration of these subsequent effects are complicated because they depend upon how the public adjusts its desired money holdings as changes occur in income, wealth, and commodity prices. (The demand schedule mentioned in footnote 6 implies an equilibrium relation between the actual stock of money and interest rates, for given income and wealth. The relation can help to identify discrepancies, but does not itself indicate how adjustments take place and at what speed.) Price changes can affect market interest rates insofar as the public takes into account the expected rate of depreciation in the real value of fixed-dollar loans and securities, though that adjustment is likely to occur slowly. An examination of the way in which monetary growth affects interest rates is left to a later

[6] Numerous studies have documented an inverse association between the *stock* of money and interest rates, holding national income or wealth constant. This allegedly reflects a dependence of the demand to hold money on interest rates, in which an increase in the stock induces a fall in rates to equate the demand and the supply. Such a relation is different from (though not inconsistent with) that discussed in the text, which postulates an effect of the *rate of change* of the money stock on the supply of loanable funds and thence on interest rates, which equilibrates the supply and demand for loanable funds. Both effects could of course occur at the same time. Some evidence on the stock demand to hold money is presented below.

study. The analysis here is concerned only with demonstrating the existence of such effects in the short run and with examining their contribution to changes in the cyclical behavior of interest rates.

There are statistical difficulties in relating interest rates to monetary growth. Long-run movements in interest rates are large and important, yet they appear to be determined by a different set of influences than short-run cycles are, which complicates the analysis. And in the short-run, shifts in the demand schedule for loanable funds play a conspicuous role, which the analysis must somehow distinguish from monetary effects. As it turns out, these difficulties are not insurmountable. By confining the analysis to changes within cycles, we reduce the importance of long-run movements over decades (not examined here). Furthermore, most demand shifts probably exhibit quite different cyclical movements than the rate of change in the money stock does, making statistical identification of its effects feasible.

Institutional developments over time have materially altered the structure and behavior of the monetary system. One far-reaching change was the establishment of the Federal Reserve System in 1914. Its influence on interest rates through control of the money stock has been noted for seasonal movements[7] and some aspects of cyclical movements.[8] Federal Reserve policy operates mainly through purchases and sales of U.S. securities and through discount actions, including changes in the rate. Reserve policies, apart from their immediate impact, largely affect bank reserves and thence lending, which is reflected in the stock of money supplied. Such policies are not, however, the only determinants of the monetary growth rate. Analysis of monetary growth therefore takes in a variety of factors (including, for example, international capital movements) that produce changes in the money stock and in the supply of loanable funds from that source. The point of view taken here, which is tentatively supported by the evidence examined, is that cycles in monetary growth are an important and, unlike most other credit supplies, largely independent source of fluctuation in interest rates.

[7] See, for example, Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States 1867–1960*, Princeton for NBER, 1963, pp. 292–296.

[8] See Arthur F. Burns and Wesley C. Mitchell, *Measuring Business Cycles*, New York, NBER, 1946, pp. 332–3, 393.

A *Cycles in Monetary Growth: Timing*

One way to test for an association between monetary growth and interest rates is to compare turning points. An inverse association implies that upturns in monetary cycles coincide with downturns in interest rates, and conversely. Chart 3 is designed for such a comparison. Nonwar specific cycle turns in the rate of growth of the money stock from 1879 to 1960 have been related to opposite turns in a variety of interest-rate series. The chart shows the leads or lags of these turns from the nearest reference turn that corresponds in direction to the interest-rate turns. The money series is related to reference cycles here on an inverted basis. The monetary growth rate has a cycle corresponding to every reference cycle, but the timing differs considerably.

The chart reveals a general tendency for interest rates to have a long or short lag behind reference cycles, and occasionally a lead, depending on the location of the opposite turn in monetary growth. Table 7 presents correlation coefficients of the association, indicating that it is highly significant for all except call-money rates. To be sure, because Chart 3 omits skipped turns in the interest rates and ignores extra turns not corresponding to monetary cycles, the coefficients may overstate the association, though in a way difficult to quantify. The long lags at the 1879, 1929, and 1933 reference turns result from ignoring earlier extra cycles in the rates, though the correlation coefficients excluding these turns (in column 2) are only slightly lower.

Ordinarily, an association between two series that exhibit cyclical fluctuations carries little economic significance because of the strong possibility of spurious correlation. But measuring the turning points as deviations from reference peaks and troughs, as done here, removes any spurious association due to common responses of the two series to business activity. Measured this way, the observations are also likely to be serially independent, making the statistical significance of the coefficients meaningful. Despite the exclusion of skipped and extra turns, the association appears strong.

Does the pattern of monetary cycles explain the changed timing of interest rates? It explains

CHART 3. — TIMING OF SPECIFIC CYCLES IN MONETARY GROWTH RATE (INVERTED) AND INTEREST RATES, LEAD OR LAG IN RELATION TO REFERENCE TURNS

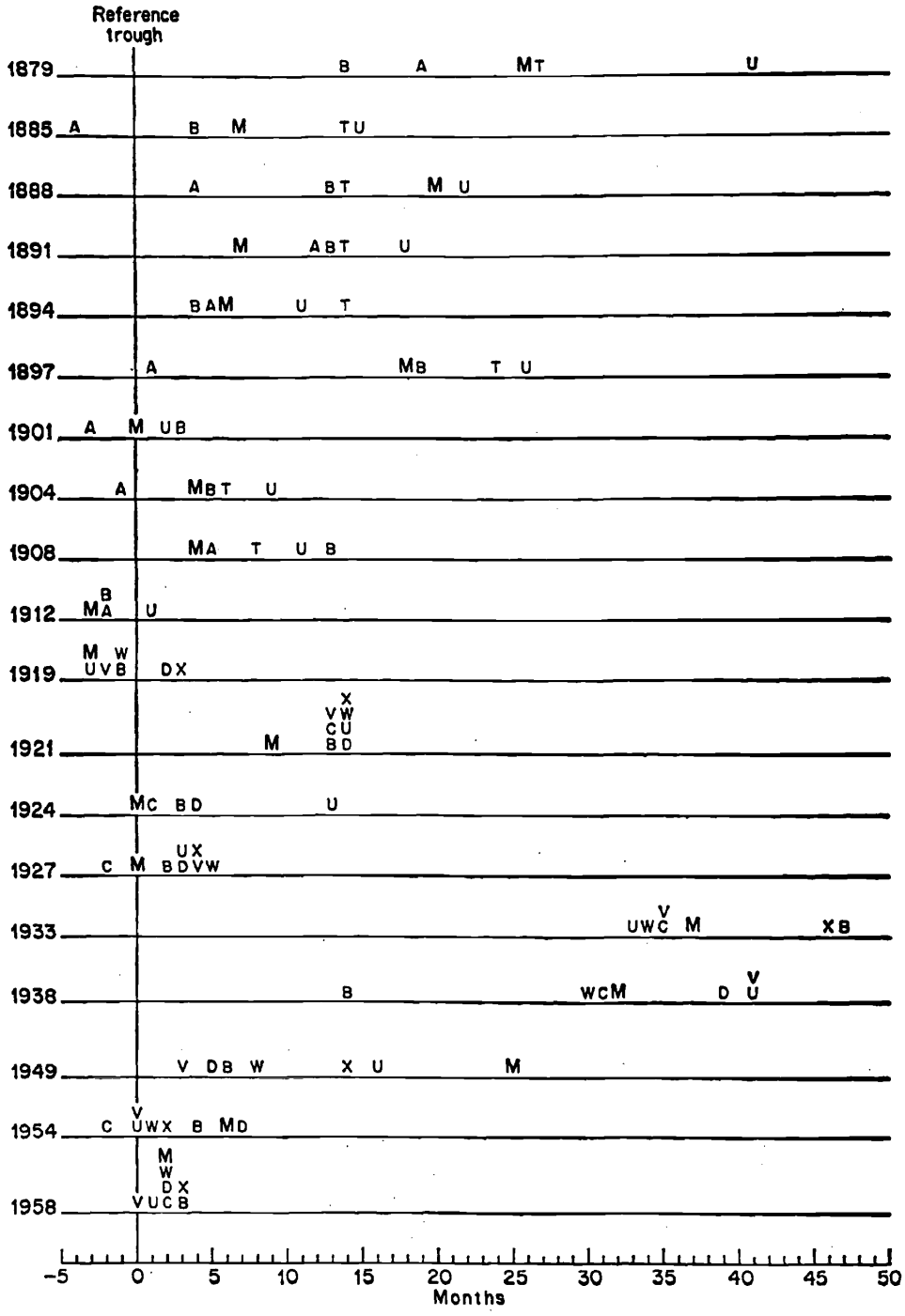
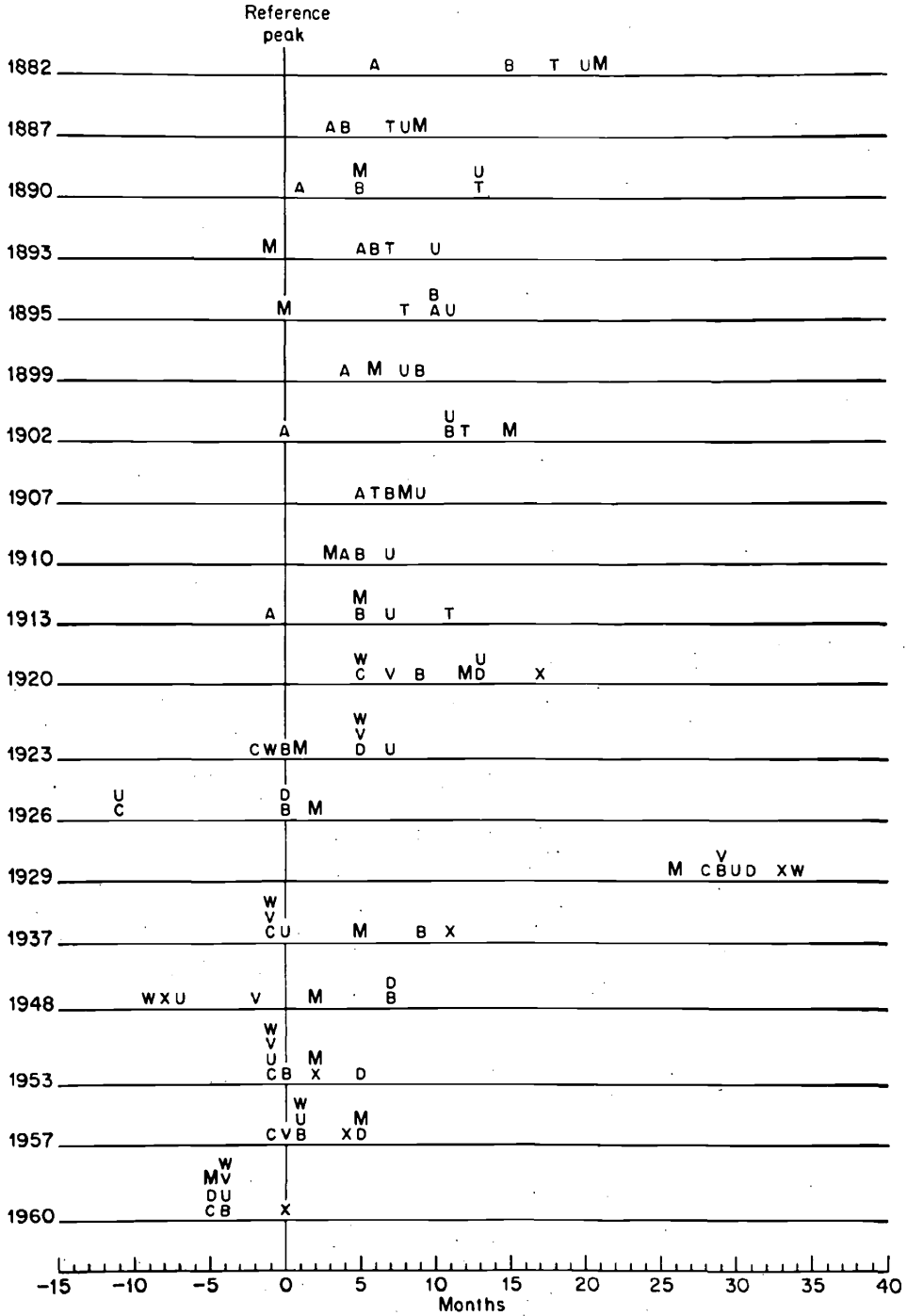


CHART 3 (continued)

SOURCE: Appendix Table A and Friedman and Schwartz, "Money and Business Cycles," *Review of Economics and Statistics* (February 1963), Table 1, p. 39. Interest-rate turns are those for specific cycles nearest the corresponding turn for monetary growth.

Note: Every interest rate is not included in all turns because of skipped cycles (see Chart 1).

CHART 3 (concl.)



Key

M = rate of monetary growth (inverted), A = call money, B = commercial paper, C = Treasury bills, D = bank loans, T = railroad bonds, U = municipal bonds, V = U.S. bonds, W = corporate bonds Aaa, X = corporate bonds Baa.

TABLE 7. — TIMING RELATION BETWEEN MONETARY GROWTH RATE (INVERTED) AND INTEREST RATES, CORRELATION BETWEEN LEAD OR LAG FROM CORRESPONDING REFERENCE TURNS

Interest Rates and Period	Correlation Coefficients		Regression Coefficients for All Turns[c]	
	All Nonwar Turning Points[a] (1)	Excluding 3 Extreme Observations[ab] (2)	Slope (3)	Intercept (months) (4)
Pre-World War I				
Call money, 1885–1913	.29	.09		
Commercial paper, 1882–1913	.76	.75	.47(±.20)	4.4(±2.2)
Railroad bonds, 1879–1913	.79	.68	.61(±.27)	6.8(±3.4)
Municipal bonds, 1879–1913	.85	.79	.96[u]	5.3(±3.3)
Post-World War I, 1919–60				
Commercial paper	.83	.72	.82[u]	0.7[s]
Treasury bills	.95	.92	1.07[u]	−3.5(±3.1)
Bank loans	.85	.80	.87[u]	2.4[s]
U.S. bonds	.87	.78	.96[u]	−1.4[s]
Corporate bonds, Aaa	.89	.83	.93[u]	−1.8[s]
Corporate bonds, Baa	.90	.68	1.04[u]	1.4[s]
Municipal bonds	.89	.83	1.02[u]	−0.8[s]

SOURCE: Same as Chart 3.

Note: The regression equation is $I = bM + a$, where I is the lead (−) or lag (+) in months of specific cycle turns in the interest rate relative to matched reference turns, M is the corresponding lead or lag for the monetary growth rate, and b and a are regression coefficients shown in cols. 3 and 4, respectively.

[a] Excluding turns skipped by the interest rate (see Chart 1).
[b] 1879 trough from the earlier period, and 1929 peak and 1933 trough from the later period.
[c] Parentheses contain ranges of error for significant coefficients at .05 level of significance.
[u] Not significantly different from unity at .05 level.
[s] Not significantly different from zero at .05 level.

much of their variability in timing from cycle to cycle, particularly the very long lags which occurred sporadically. If we put aside the long lags as atypical, which means excluding the 1929 peak and the 1933 and 1949 troughs, the remaining turns in Chart 3 show some decline over time in the lag of the monetary growth rate. The decline is most pronounced between the periods before and after World War I, though this may partly reflect the use of annual data for money before 1907. Some decline appears to have occurred also from the 1920's to the 1950's if, as in Table 1, we include the 1921 and 1929 turns and exclude the period of Federal Reserve bond pegging from World War II through the 1949 trough.

Monetary cycles do not, however, fully account for the changed timing of interest rates. As Table 7 suggests, those cycles had similar effects on short and long rates and so do not explain the difference in timing of the two groups. Also, Chart 3 indicates a gradual shift in timing of interest rates relative to monetary cycles. More so recently than formerly, the rates turn ahead of the monetary growth rate (inverted). This is brought out by column 3 of Table 7, which gives the constant term of the regressions. This term can be viewed as an estimate of the average timing difference between the interest rate and monetary growth. Constant terms of approximately zero imply roughly coincident turns in the two series. Except for Treasury bills, the constants are approximately zero for the later period (allowing for statistical error), but are positive for the earlier period, indicating a lag of the rates behind monetary cycles. Monetary growth accounts only in part, therefore, for the changed timing of interest rates from the earlier to the later period,

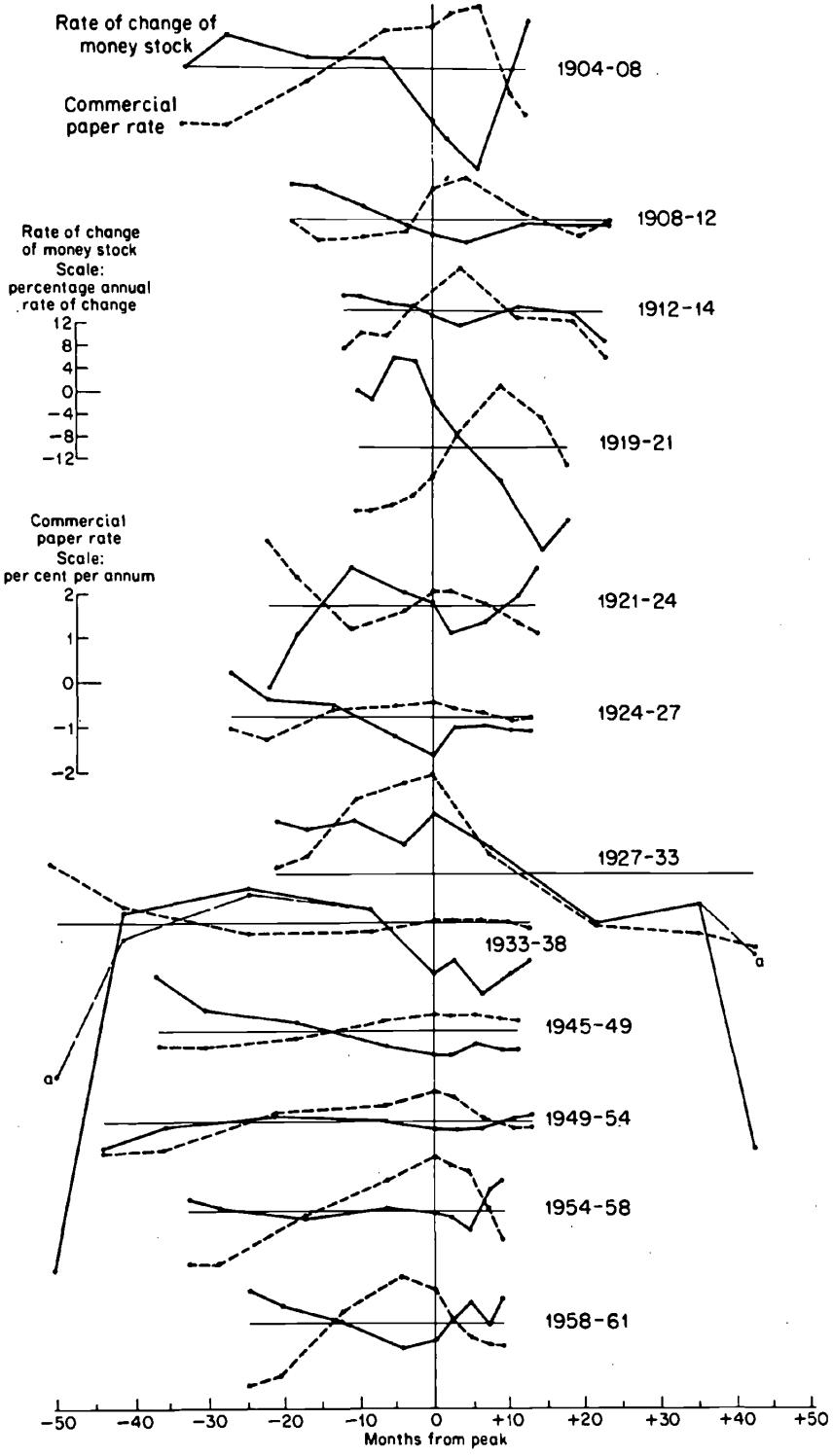
B *Cycles in Monetary Growth: Amplitude*

Chart 4 shows reference cycle patterns for the rate of monetary growth and commercial paper rates. There is a marked inverse relation in the amplitude as well as the timing of most fluctuations, the major exception being 1929–33, when banks rearranged portfolios to become more liquid,[9] and the demand for loans fell sharply in response to the business contraction.

These patterns abstract from intercyclical trend in the series and smooth over erratic month-to-month fluctuations, particularly in monetary growth, which is volatile on a monthly basis,

[9] For a detailed discussion, see Friedman and Schwartz, *Monetary History*, p. 312.

CHART 4. — NONWAR CYCLICAL PATTERNS OF COMMERCIAL PAPER RATE AND MONETARY GROWTH RATE, NINE REFERENCE CYCLE STAGES (numerical deviations from cycle averages)



SOURCE: Same as Table 8.

[a] Including unlicensed banks, 1933–34.

and in that way highlight the intermediate-run relation between the two series. The appearance of association, however, may reflect the common responses of the series to business cycles. Interest rates respond positively to changes in the demand for loanable funds, and the monetary growth rate responds more or less negatively to changes in business activity. Also, the patterns do not remove *intra*-cyclical trend in the series. These sources of spurious correlation are largely eliminated by taking stage-to-stage changes in the patterns. In that form the data retain virtually no trend and, for the money series, very little regular conformity to reference cycles. The correlation coefficients between these changes for the money series and each of five interest rates are shown in Table 8. The correlations begin with 1904 or the first date of the interest-rate series, whichever is later. (The 1904–8 cycle is the earliest for which the money data permit an independent computation of all nine reference stages.) The 1929–33 reference contraction, the major exception noted earlier to an inverted association, and the atypical war cycles are excluded.

Although first differences usually retain little of the correlation in the original series, we still find evidence of an important negative relation. All the coefficients in Table 8 are significant at the .05 level or lower. Judging by the square of these coefficients, monetary growth explains up to a quarter of the concurrent cyclical variation in interest rates. A few unusually large observations can sometimes account for most of an observed correlation, but omitting all the stage changes with extreme values of the money series (column 2) makes little difference here. When we also omit the period of unusually low interest rates after 1933 and the subsequent pegging of rates from 1942 to the early 1950's (column 3), the correlation is even higher.

The other three-quarters or so of this variation in interest rates can be attributed to other supply and demand factors. These would be difficult to identify and measure, but at least it is clear that many of them are associated with the business cycle, as is shown by adding to the previous regressions a proxy or dummy variable to represent movements in general business activity. Several such proxies (industrial production, personal income, gross national product) were experimented with, and a dummy variable is used in Table 9, below. The partial correlation coefficients of these variables with interest rates (not shown) are all highly significant and positive, suggesting the strong influence of cycles in the demand for loanable funds. (Supply factors with positive conformity to business cycles would tend to produce negative coefficients.) These proxies are only slightly correlated, however, with the money variable (partly because the data have been expressed as differences between cycle stages); consequently, their inclusion has little effect on the correlation found between monetary growth and interest rates.

If we ignore all but the first-round effects of monetary growth, it might be argued that time deposits at commercial banks should be excluded. The argument would be that, since they are a closer substitute for deposits at savings banks than for demand deposits, changes in loanable funds supplied by commercial banks which gain or lose time deposits will usually be offset by funds supplied by other financial intermediaries. This view receives some support from post-World War II developments, but not from earlier periods even on its own assumptions. During the 1920's and 1930's, differences in the relative growth of demand and time deposits suggest that holders shifted from one category to the other on a large scale.[10] Excluding time deposits then would misrepresent the net changes in funds commercial banks supplied to the money market. Also, before the 1930's some time deposits were subject to check and were not clearly distinguished from demand deposits. Finally, the inclusion of time deposits seems appropriate for the interest rates included here; commercial banks channel time money in large part into bonds, savings banks mostly into mortgages. As for the later-round effects of monetary growth, the question of time deposits is complicated and cannot be answered a priori.

It is difficult to settle this question by time-series regressions, because the rate of change in the money stock whether including or excluding time deposits behaves much the same. In only a few years (notably the late 1950's) is there much difference, and statistical tests

[10] Discussed in my *Determinants and Effects of Changes in the Stock of Money 1875–1960*, New York, NBER, 1965, pp. 171–73.

should not be based on evidence for a short period. Some slight support for including time deposits is provided by the correlation coefficients in the bottom panel of Table 8, which excludes time deposits but covers just the post-1914 period when time and demand deposits can be separated in the monthly data. The exclusion of time deposits lowers the correlation, though, as expected, only slightly and not significantly.

C *Two Alternative Interpretations of the Evidence*

The preceding evidence, as already suggested, supports the view that changes in the rate of monetary growth affect interest rates by producing variations in the supply of funds available for lending. Before accepting this interpretation, however, we should examine other possibilities which point to different implications. Monetary theory suggests two other possible connections between money and interest rates which might explain the correlation in full or in part and therefore deserve attention. They are (1) portfolio adjustments in which the demand to hold money depends upon rates of interest available on other assets (see footnote 6 above), or (2) an influence running in the opposite direction, in which interest-rate movements produce changes in the money stock. These two relationships are not mutually exclusive, but they can be distinguished and examined separately.

1 *Portfolio adjustments of the demand to hold money:*

The theory of portfolio balance assumes that people maintain some desired relation between their holdings of money (as well as of other assets), interest rates, and total wealth and income. An autonomous change in any of these variables produces equilibrating adjustments in the others. In equilibrium, the demand for money balances will be larger, the lower are interest rates and the greater is total wealth or income. Consistent with this, many studies have verified that interest rates are negatively associated with the *stock* of money demanded, holding wealth (or income) constant. Portfolio balance does not, however, imply any relation between interest rates and the monetary *growth rate* unless, as suggested earlier, variations in that growth rate create temporary discrepancies between desired and actual money holdings that affect the flow of loanable funds supplied by the public. Yet for purely statistical reasons the equilibrium demand relation might, if strong enough, tend to produce the appearance of negative correlation as found above between interest rates and the monetary growth rate.

TABLE 8. — CORRELATION COEFFICIENTS BETWEEN INTEREST RATES AND MONETARY GROWTH RATE, CHANGES BETWEEN REFERENCE CYCLE STAGES

Interest Rates and Period	Period Given Excluding: War Contractions and 1929–33 (1)	Period Given Excluding: Other Stages with Extreme Values[a] (2)	1919–29 and 1953–61 Only (3)
	INCLUDING TIME DEPOSITS IN MONEY SERIES		
Commercial paper, 1904–61	−.47	−.48	−.56
Treasury bills, 1921–61	−.46	−.48	−.61[b]
Bank loans, 1919–61	−.46	−.38	−.51
U.S. bonds, 1919–61	−.42	−.42	−.47
Corporate and municipal bonds, 1904–61	−.38	−.43	−.39
	EXCLUDING TIME DEPOSITS FROM MONEY SERIES[c]		
Commercial paper, 1914–61	−.38	−.44	−.49
Treasury bills, 1921–61	−.40	−.43	−.52
U.S. bonds, 1919–61	−.36	−.39	−.40
Corporate and municipal bonds, 1914–61	−.32	−.36	−.32

SOURCE: Interest rates are the series used for Appendix Table A. Money stock is currency outside banks plus demand and time deposits at commercial banks (from Friedman and Schwartz, *Monetary History*).

Note: The regression equation is $\Delta i = \alpha \Delta m +$ constant, where i is the interest rate and m the monetary growth rate. Δ stands for changes between the average standing of the series in successive reference stages I to IX.

[a] Excluded stage changes were 1904–8 VII–VIII, 1914–19 I–II and IV–V; 1919–21 VII–VIII, 1921–24 II–III, and 1933–38 I–II and IV–V, as well as those noted for col. 1.

[b] Also excluding the 1919–21 expansion stages, not available for Treasury bills.

[c] Not computed for bank loans.

A test of this statistical possibility requires that we hold the equilibrium demand for money constant. On the assumption that the short-run wealth elasticity of demand to hold money is approximately unity,[11] we may represent the stock of money demanded, given the level of interest rates, by the ratio of money holdings to wealth. Table 9 therefore adds the money-wealth ratio (in logarithms to put changes in percentage terms) to the regressions of Table 8 to see whether this additional variable absorbs

[11] One study estimated the wealth elasticity to be a little above unity (Allan Meltzer, "The Demand for Money: The Evidence from the Time Series," *Journal of Political Economy*, June 1963, pp. 219–246). Another found the long-run income elasticity to be much greater than unity (Milton Friedman, *The Demand for Money: Some Theoretical and Empirical Results*. Occasional Paper 68, New York, NBER, 1959). A cross-sectional study of households reported the elasticities of both current income and net worth to be significant, with the former somewhat above and the latter below unity (T. H. Lee, "Income, Wealth, and the Demand for Money: Some Evidence from Cross-Section Data," *Journal of the American Statistical Association*, September 1964, pp. 746–762, esp. p. 754).

TABLE 9. — REGRESSION OF INTEREST RATES ON MONETARY GROWTH RATE AND MONEY-WEALTH RATIO HOLDING REFERENCE CYCLE PHASE CONSTANT, CHANGES BETWEEN SUCCESSIVE FISCAL YEARS

	Monetary Growth Rate			Money-Wealth Ratio		
	Partial Corr.			Partial Corr.		
Interest Rates	Coef.	t Value[a]	Simple Corr. Coef.	Coef.	t Value[a]	Simple Corr. Coef.
INCLUDING TIME DEPOSITS IN MONEY-WEALTH RATIO						
Commercial paper, 1904–58						
Excl. war conts. and 1929–33	−.72	6.6[a]	−.69	−.41	2.9[a]	−.36
Excl. war cycles and 1929–48	−.87	9.3[a]	−.85	−.49	2.9[a]	−.40
Treasury bills, 1920–58						
Excl. war cont. and 1929–33	−.51	3.0[a]	−.45	−.38	2.1[a]	−.29
Excl. 1929–48	−.82	5.5[a]	−.77	−.40	1.7	−.28
U.S. bonds, 1920–58						
Excl. war cont. and 1929–33	−.46	2.6[a]	−.36	−.57	3.6[a]	−.50
Excl. 1929–48	−.78	4.8[a]	−.69	−.59	2.8[a]	−.43
Corporate and municipal bonds, 1904–58						
Excl. war conts. and 1929–33	−.56	4.4[a]	−.52	−.65	5.5[a]	−.62
Excl. war cycles and 1929–48	−.67	4.7[a]	−.67	−.57	3.6[a]	−.56
EXCLUDING TIME DEPOSITS FROM MONEY-WEALTH RATIO						
Commercial paper, 1919–58						
Excl. war cont. and 1929–33	−.58	3.7[a]	−.59	−.28	1.5	−.28
Excl. 1929–48	−.81	5.6[a]	−.78	−.43	1.9	−.34
Treasury bills, 1920–58						
Excl. war cont. and 1929–33	−.45	2.6[a]	−.45	−.22	1.2	−.21
Excl. 1929–48	−.80	5.2[a]	−.77	−.29	1.2	−.23
U.S. bonds, 1920–58						
Excl. war cont. and 1929–33	−.34	1.9	−.36	−.46	2.6[a]	−.43
Excl. 1929–48	−.74	4.2[a]	−.69	−.48	2.1	−.35
Corporate and municipal bonds, 1919–58						
Excl. war cont. and 1929–33	−.43	2.5[a]	−.43	−.61	4.0[a]	−.59
Excl. 1929–48	−.67	3.6[a]	−.63	−.54	2.6[a]	−.45

SOURCE: Basic data are the same as for Table 8; for interest rates, December figures; for monetary growth rate, annual rates of change between June figures.

Wealth is total private tangible wealth plus net debt of government held by the public, current dollars, end-of-year figures. Total private tangible wealth: 1904–44, Raymond W. Goldsmith, *A Study of Saving in the United States*, Princeton, 1956, Table W-1, col. 1 minus cols. 9, 17, 18, and 24; 1945–58, Goldsmith, *The National Wealth of the United States in the Postwar Period*, Princeton for NBER, 1962, Table A-5, col. 2 minus cols. 5, 7, 14, and 15. Plus state and local debt outstanding: 1904–31, Goldsmith, *Study of Saving*, Table G-21 (June figures for state debt interpolated arithmetically to December); 1932–44, Table V-11, col. 3; 1945–58, Raymond W. Goldsmith, Robert E. Lipsey, and Morris Mendelson, *Studies in the National Balance Sheet of the United States*, Princeton for NBER, 1963, II, Table I, line III.12. Minus cash and securities held by state and local governments: 1904–44, Goldsmith, *Study of Saving*, Table G-17, col. 1 (June figures interpolated arithmetically to December), and Table G-8, col. 1; 1945–58, Goldsmith *et al.*, *Studies*, II, Table I, line II.21. Plus net interest-bearing and noninterest-bearing debt of federal government (including Federal Reserve Banks) outside international and U.S. government agencies, Treasury Department, *Annual Report* and *Monthly Bulletin*, various issues, and cash assets of U.S. agencies from various sources.

Note: The regression equation for partial coefficients is

$$\Delta i = a\Delta m + b\Delta \log \frac{M}{W} + cD + \text{constant},$$

where i is the interest rate, m the monetary growth rate, M the stock of money, W wealth, and D a dummy variable for reference phases. Δ stands for changes between successive fiscal years, except for the long 1940–46 expansion for which the changes cover two successive years. D is unity if change falls within a reference expansion, zero if within a reference contraction, according to NBER cycle dates on a fiscal year basis. a, b, and c are regression coefficients.

Simple correlation coefficients pertain to the interest rate and one independent variable.

The first set of exclusions for each rate omits the war contractions, 1918–19 and 1945–46, and the 1929–33 contraction. The second set omits the full war cycles, 1915–19 and 1939–46, as well as the 1930's and most of the latter 1940's thus excluding all the years 1929–48.

[a] Signs of t value, which have been dropped. are all negative; s indicates value significant at .05 level.

the correlation with interest rates previously attributed to the monetary growth rate. A multiple regression of that form is not intended to express a meaningful economic relationship but merely to test for spurious correlation. Wealth is used rather than current or permanent income because Meltzer's work, cited above, showed that interest rates had larger effects on the demand for money balances when a series on wealth rather than income was held constant. Meltzer's definition of wealth, used here, comprises private tangible wealth plus the net debt of federal, state, and local governments. This series is available annually only, so Table 9 is based on changes in end-of-year figures for all the variables. To avoid any possible spurious correlation due to common cyclical patterns in the variables, the regression treats years of business expansion and contraction separately by means of a dummy variable, though this makes little difference.[12] Such spurious correlation is already largely removed by the year-to-year changes. The regressions reported for each interest rate cover two different time periods. The first is the same as in Table 8, column 1, which excludes the contraction phases of the war cycles and 1929–33. The second period also excludes 1933–48 (an unusual period of extremely low short-term interest rates).

The results confirm an association between interest rates and monetary growth. In general, the association is even stronger here than in Table 8, and so appears not to be a proxy for the equilibrium demand for money balances. The money-wealth ratio is also significant, indicating that its association with interest rates as reported in many studies is not a proxy for the effects of monetary growth. On the whole, monetary growth has the higher partial coefficients, especially when 1933–48 is excluded.

The lower panel of Table 9 repeats the regressions of the top panel except that time deposits were excluded from the money stock in deriving the money-wealth ratio. The effect is to reduce the partial correlation coefficients for the money-wealth ratio. This result seems inconsistent with theory and with other studies. Meltzer and others have found that the demand for money is more sensitive to interest-rate changes when time deposits are excluded. In theory too, since rates paid on time deposits change often while charges on checking deposits change infrequently, general interest-rate movements should have less effect on desired holdings of time deposits than of demand deposits. The contrary result here may be due to the relatively greater importance in these regressions of the 1920's, when, as noted earlier, there were large shifts from demand to time deposits largely for reasons other than changes in the differential rate of return.

The definition of money aside, its rate of growth and ratio to wealth both appear to be important. A plausible interpretation is that both variables are related to interest rates, but in different ways: monetary growth through the supply of loanable funds, and the stock of money relative to total wealth through the equilibrium demand for money balances. Changes in rates will in time influence investment expenditures (broadly defined) and affect total wealth and income, which then produces further adjustments in money demand. The direction of influence in that demand relation can therefore be viewed as running both ways, contrary to the formal treatment of the money-wealth ratio in Table 9 as an independent variable in the regressions.

A remaining question concerns the direction of influence between monetary growth and interest rates, examined next.

2 *Effect of interest rates on monetary growth:*

Interest rates are capable of affecting the monetary growth rate in various ways which might account for the observed correlation and contradict the preceding interpretation. The importance of such effects can be assessed, as explained further below, by examining the relation between interest rates and the principal sources of change in the money stock. (In this section, time deposits are included throughout.) There are three principal sources: actions of the federal government, banks, and the public. Attributing changes in the money stock to the contributions of these three sectors is the traditional way of analyzing those changes, and is

[12] The dummy variable may be viewed as a crude proxy for any factors affecting interest rates that rise and fall in perfect conformity to business cycles, such as some shifts in the demand curve for loanable funds because of changes in the level of business activity. The regression coefficient of the dummy variable (not shown in the table) was always positive, as would be expected of such demand factors.

elaborated in recent studies.[13] The derivation of a formula for measuring these contributions need be sketched here only briefly.

The federal government is responsible for changes in high-powered money, H (the monetary base which serves partly as bank reserves and partly as circulating hand-to-hand currency, and consists of currency, Federal Reserve deposit liabilities, and, before 1934, gold outside the Treasury). The money stock publicly held, M, equals currency outside banks, C, plus commercial bank deposits, D. $M \equiv C + D$. High-powered money outstanding that is not held as currency by the public is held by banks as reserves, R. $H \equiv C + R$. From these definitions it follows that

$$M \equiv \frac{H}{\frac{C}{M} + \frac{R}{D} - \frac{C}{M}\frac{R}{D}},$$

in which the money stock depends on high-powered money issued by the monetary authorities (the Treasury and Federal Reserve Banks), the currency ratio of the public, $\frac{C}{M}$, and the reserve ratio of banks, $\frac{R}{D}$. High-powered money affects the money stock positively, while the two ratios have inverse effects. Writing both sides in terms of logarithms and differentiating with respect to time gives, after collecting terms,

$$\frac{d \log_e M}{dt} \equiv \frac{d \log_e H}{dt} + \frac{M}{H}\left(1 - \frac{R}{D}\right)\frac{d\left(-\frac{C}{M}\right)}{dt} + \frac{M}{H}\left(1 - \frac{C}{M}\right)\frac{d\left(-\frac{R}{D}\right)}{dt}, \text{ or}$$

$$m \equiv h + c + r.$$

In this form, the rate of change of the money stock is the sum of three parts: the rate of change of high-powered money, the contribution of changes in the currency ratio, and the contribution of changes in the reserve ratio. The derivatives may be approximated by discrete monthly changes. This introduces a slight error; while the three parts do not then add exactly to the total rate of monetary growth, the approximation is close enough for practical purposes.

[13] Friedman and Schwartz, *Monetary History*, Appendix B; Cagan, *Determinants and Effects*, Chapter 1.

The correlation between interest rates and the monetary growth rate implies, by the foregoing identity, a correlation between interest rates and the three sources of the growth rate. Different theories of the direction of influence, however, do not all imply the same relation between interest rates and each of the three sources. If interest-rate effects are largely responsible for the inverse association with monetary growth, the effects on the three sources should be in different directions. A rise in interest rates, for example, should tend to reduce the reserve ratio and therefore to increase the money stock. And a general rise in interest rates tends, if anything, to reduce the public's desire to hold currency, and thus also increases the money stock. To be sure, there may be limits to such effects, so that higher interest rates would not be expected to raise the growth of the money stock permanently, but only for a limited period of time. Nevertheless, we still expect the main effect on the rate of change to be positive or zero.

The above formulation treats member bank borrowing from the Federal Reserve as part of the contribution of high-powered money, on the grounds that the volume of such borrowing is taken into account and offset by the monetary authorities in conducting open-market operations. Another point of view looks upon borrowed reserves as determined by member banks and implicitly disregards any offset by open-market operations. The preceding identity can incorporate this second view, if reserves borrowed by member banks are excluded from high-powered money and subtracted from bank reserves. The subtraction from reserves in excess of requirements gives free reserves of banks, which are always less than excess money reserves and may be negative. Even on this formulation, interest rates are still expected to affect monetary growth positively. A recent study of free reserves[14] argues that a rise in interest rates (relative to the

[14] A. J. Meigs, *Free Reserves and the Money Supply*, Chicago, 1962.

discount rate at which member banks can borrow from the Federal Reserve) lowers the desired level of free reserves and makes the actual level temporarily too high. To close the gap, banks step up their rate of expansion of earning assets. The result is to produce a positive association between interest rates and the rate of deposit growth.

Given these positive effects, the observed *negative* correlation between interest rates and monetary growth suggests two alternative explanations. Either (1) interest rates have a sufficiently strong negative effect on the contribution to monetary growth of the unborrowed portion of high-powered money to overcome their positive effect on the other sources, or (2) the negative correlation between interest rates and monetary growth should be attributed largely to monetary effects, interest effects on monetary growth being relatively minor.

Table 10 presents correlation coefficients of interest rates with each of these sources of monetary growth. The contribution of high-powered money is shown both in total (h_t) and with member bank borrowing excluded (h_u). To be comparable with Table 8, the observations are changes between reference cycle stages and cover the same periods. The coefficients do not reveal a strong negative relation between interest rates and the rate of change of high-powered money either including or excluding borrowing, contrary to the first explanation above. Indeed, those coefficients are virtually zero.

Most of the correlation with the contributions of the two ratios is negative, though generally not significant. This cannot reflect the response of bank reserves and the public's currency holdings to interest-rate movements, because in theory as said those responses should produce a positive relation here. (Remember that the sign

TABLE 10. — CORRELATION COEFFICIENTS BETWEEN THE SOURCES OF MONETARY GROWTH AND INTEREST RATES, CHANGES BETWEEN REFERENCE CYCLE STAGES

Interest Rate and Contribution to Monetary Growth Rate	Period Given Excluding: War Contractions and 1929–33 (1)	Period Given Excluding: Other Stages with Extreme Values[a] (2)	Period Given Excluding: 1919–29 and 1953–61 Only[b] (3)
Commercial paper, 1904–61			
h_t	.08	.06	−.14
h_u	−.06		
c	−.39[s]	−.25[s]	−.24
r	−.13	−.18	−.16
Treasury bills, 1921–61			
h_t	−.10	−.05	.00
h_u	−.05		
c	−.29[s]	−.33[s]	−.40[s]
r	−.13	−.16	−.22
U.S. bonds, 1919–61			
h_t	−.11	.02	−.05
h_u	.02		
c	−.10	−.11	−.33[s]
r	−.25[s]	−.27[s]	−.12
Corporate and municipal bonds, 1904–61			
h_t	−.05	−.02	−.06
h_u	−.01		
c	−.17	−.09	−.23
r	−.18	−.22	−.10

SOURCE: Same as Table 8, with time deposits included. Member bank borrowing from *Banking and Monetary Statistics* and *Federal Reserve Bulletin*.

Note: The regression equations are

$\Delta h_t = a\,\Delta i$ + constant,
$\Delta h_u = a\,\Delta i$ + constant,
$\Delta c = a\,\Delta i$ + constant,
$\Delta r = a\,\Delta i$ + constant,

where h_t, h_u, c, and r are contributions of total high-powered money and the total excluding member bank borrowing, the currency ratio, and the reserve ratio, respectively, to the rate of monetary growth, and i is the interest rate. Δ denotes changes between reference cycle stages, as for Table 8.

[a] Same exclusions as for Table 8.
[b] For Treasury bill rate, also excluding 1919–21 expansion stages, not available.
[s] indicates significant at the .05 level.

of changes in the currency and reserve ratios are reversed in measuring their contributions to growth in the money stock.) Although the table does not include the free reserve ratio, in theory its relation here to interest rates should also be positive. These contributions cannot, therefore, account for the much higher negative correlation between interest rates and the growth rate of the total money stock. The negative correlations in the table apparently reflect the opposite direction of influence, in which the separate sources, acting through the total money stock, affect interest rates. This interpretation does not deny that interest rates could at times have positive effects on the total money stock, but those effects are insufficient to be detected in these correlations.

Conceivably there is one other possibility. If the Federal Reserve persistently and successfully pursued a policy of controlling total high-powered money with a view to making the monetary growth rate move inversely to interest rates, the observed correlation could be produced, even though monetary growth had no effect on interest rates and even though interest rates showed little or no association with each of the three sources of monetary growth. Because high-powered money would then offset movements in the currency and reserve ratios, it might not itself show an inverse association with interest rates. But this implies that Federal Reserve policy was guided primarily by interest rates (and intended to reinforce their movements) rather than by commodity prices and business activity, insofar as financial and business indicators had divergent movements as they often did. That the Federal Reserve consistently followed any such limited guide is hardly credible in view of the variety of policies actually pursued over the years.

D *Monetary Growth and the Increased Cyclical Amplitude of Interest Rates*

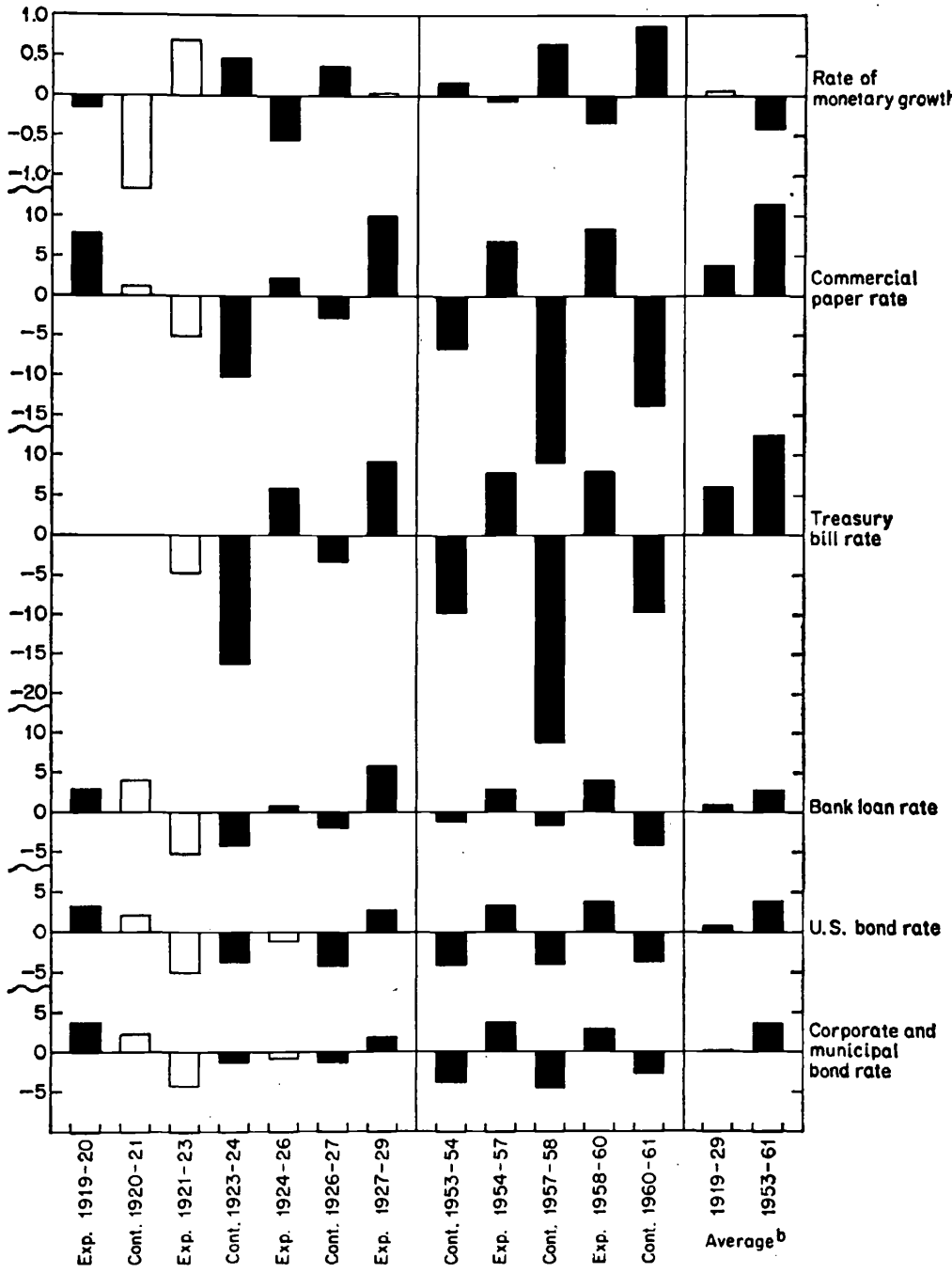
Given that the monetary growth rate affects interest rates, does it help explain their increased amplitude in later business cycles? While month-to-month fluctuations in monetary growth were milder on the average during the 1950's than formerly, its cyclical fluctuations (on an inverted basis) have conformed more closely to reference cycles (Chart 3), disregarding the period of Federal Reserve bond pegging.[15] Partly for this reason, the average amplitude over reference cycles has increased. Chart 5 depicts the reference phase amplitudes and the period averages. In the 1920's, monetary growth departed from inverted conformity in some reference cycles; in the 1920–23 and 1927–29 phases, the growth rate conformed positively. The average amplitude for that decade, with the sign of movements during reference contractions reversed, was positive though small. In the 1953–61 reference cycles, the growth rate consistently displayed an inverted pattern, and the average amplitude was negative and large.

Interest rates usually moved in the opposite direction to the monetary growth rate, and that was true in the 1920–23 cycle, when their movements ran counter to the direction of change in business activity. In the 1920's, therefore, cycles in monetary growth and business activity frequently pulled interest rates in opposite directions, resulting in low amplitudes of fluctuation; in the 1950's, the effects were mostly reinforcing, which raised interest-rate amplitudes.

Phase amplitudes for 1904–14 are plotted in Chart 6. In that period the average amplitude of monetary cycles was negative and larger in absolute value than in the 1920's and was about the same as in 1953–61, though the earlier period would rank in between if the special contractionary effects of the 1907 panic were excluded. The average amplitude of commercial paper rates corresponds (with opposite sign) to the ranking for money in these three periods. Corporate and municipal bond rates, however, did not. Although largest in the recent period, their average amplitude was about zero in the 1920's and negative in the pre-1914 period; monetary effects alone would have made the earlier period positive. Chart 6 and the other evidence indicate that monetary growth had greater effects on short- than long-term rates and does not explain the sharp change in amplitude of bond-rate cycles before and after World War I.

[15] This comparison pertains only to the behavior over reference phases and to the timing on an inverted basis (trough of money cycle to peak of reference cycle, and peak to trough). The timing on a positive basis (peak to peak, and trough to trough) behaves differently and is subject to a different interpretation (see Milton Friedman, "The Monetary Studies of the National Bureau," *44th Annual Report*, NBER, New York, 1964, pp. 7–25).

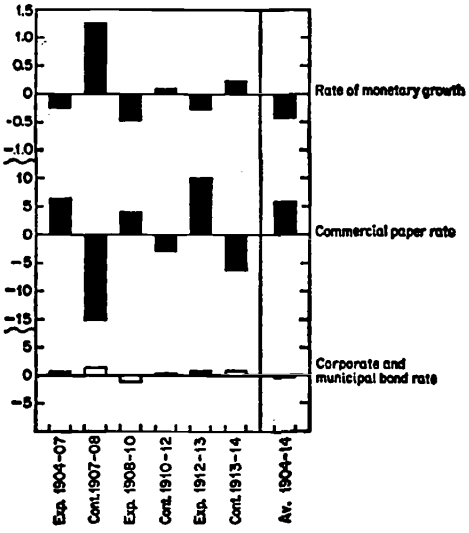
CHART 5. — REFERENCE CYCLE PHASE AMPLITUDES, 1919–29 AND 1953–61
(basis points per month)



[a] Unit of measurement: change per month over reference expansions and contractions in the percentage rate of growth per year.
[b] Contractions counted negatively.

Source: Appendix Table B and Cagan, *Determinants and Effects*, Table F-2.
Note: Solid bars are conforming movements (inverted basis for monetary growth rate, positive basis for interest rates). White bars are non-conforming.

CHART 6. — REFERENCE CYCLE PHASE AMPLITUDES, 1904–14
(basis points per month)



SOURCE AND NOTES: Same as Chart 5.

The increased amplitude in rate cycles from the 1920's to the 1950's attributable to monetary cycles can be estimated. Let us suppose that the effect of monetary growth on interest rates has remained the same over the years and can be approximated by the slopes of the regression equations underlying Table 8.[16] The contribution of this effect to the increased amplitude of interest rates is found by multiplying the amplitude increase in monetary growth (Chart 5) by the appropriate regression coefficient. Table 11 gives the estimated and actual increases. Monetary growth accounts here for a fifth to two-thirds of the actual increases (again, more for shorts than for longs).

[16] The slope coefficients for the regression of interest rates on the monetary growth rate (not shown in Table 8) are given below corresponding to the top panel of col. 3 in that table. The figures give the change in interest rate in basis points for an increase in the monetary growth rate of one percentage point per year.

Commercial-paper rate	$-6.5(\pm 3.2)$
Treasury-bill rate	$-7.9(\pm 3.6)$
Bank-loan rate	$-2.6(\pm 1.5)$
U.S. bond yield	$-2.1(\pm 1.4)$
Corporate and municipal bond yield	$-1.4(\pm 1.2)$

Range of error computed at the .05 level of significance.

TABLE 11. — INCREASE IN AVERAGE REFERENCE PHASE AMPLITUDES FROM 1920'S TO 1950'S, AND ESTIMATED INCREASE DUE TO MONETARY GROWTH RATE
(basis points per month)

Interest Rates	Actual (1)	Estimated (2)	Col. 2 / Col. 1 (per cent) (3)
Commercial paper	7.6	3.0	39
Treasury bills	6.4	3.6	56
Bank loans	1.8	1.2	67
U.S. bonds	3.0	1.0	33
Corporate and municipal bonds	3.4	0.6	18

SOURCE: Col. (1), col. 4 minus col. 3, Table 5, Panel A; col. (2), difference in amplitude for rate of monetary growth (0.46) from Chart 5, multiplied by corresponding regression coefficient in footnote 16, above.

The increased average amplitude of fluctuation in the monetary growth rate over recent reference cycles presumably reflects greater emphasis by the Federal Reserve on counteracting cycles in output and prices. So long as that policy continues, the generally greater fluctuation of interest rates since World War II compared with earlier periods will, other things the same, be a permanent feature of the money market.

E *Possible Shifts in the Demand Schedule to Hold Money*

Since the increased amplitude of cycles in interest rates cannot be entirely attributed to the monetary growth rate, it may stem partly from other sources of supply of loanable funds. This study offers no evidence on what other sources may be involved, but one possibility may at least be mentioned — a change in the cyclical behavior of the demand to hold money. This demand schedule might be expected to shift back and forth, reflecting changes in precautionary preferences for money, in general correspondence with expansions and contractions of business activity. Cyclical shifts of this kind in desired money balances dampen fluctuations in interest rates resulting from cyclical movements in investment and monetary growth, because they cause moneyholders to release some balances for lending during business expansions and to hoard more balances during contractions.[17] If

[17] Such behavior, though affecting interest rates, need not produce corresponding cyclical fluctuations in the observed money-wealth ratio, and would then not be covered by the correlations of Table 9, which do not allow for shifts due to preferences in the demand schedule.

the amplitude of such shifts moderated, they would enlarge cyclical fluctuations in interest rates. A gradual moderation over the years is plausible. The financial system, despite various setbacks, has become less volatile; the extreme fluctuations of panic and depression are half-forgotten episodes of a past era. If the public became more confident that severe contractions will no longer occur, the demand-to-hold-money schedule would shift to the left permanently, and in addition it might well be subject to less variability even in mild cycles. It appears extremely difficult by time-series regressions to confirm this explanation of increased amplitude of interest-rate cycles, and the possibility will have to be tested by other kinds of evidence than presented here.[18]

IV Summary of Findings

Judged by the behavior of interest rates, financial markets have displayed increasing sensitivity to cyclical influences over the years. If the pre-World War I period, the 1920's, and the 1950's are compared, a broad group of rates has responded to moderate cycles in business activity sooner and with greater amplitude. The most dramatic change has occurred in bond yields: before World War I they typically lagged at business cycle peaks and troughs by many months, but they now display practically no lag, and over the same period the amplitude of their cycles appears to have doubled. Although trends in the cyclical behavior of short-term rates are less clear, some decline of the average lag also occurred, though mainly at peaks. These rates once turned long before bond yields, but have not done so in recent cycles.

[18] For some evidence consistent with this possibility, see E. Bloch, "Short Cycles in Corporate Demand for Government Securities and Cash," *American Economic Review*, December 1963, pp. 1058-1077.

Monetary influences provide a partial explanation of these changes. A declining rate of monetary growth can tighten the money market and raise interest rates, and an increasing growth rate can reduce them. Although there has been disagreement on the nature and importance of these effects, this study finds them to be quite important in cyclical movements. They account for much of the variability in timing of interest rates at business cycle turns. To separate cyclical movements from trends and other fluctuations, the data were averaged within each stage of National Bureau reference cycles, and changes taken between successive stage averages. Measured in that way, cyclical fluctuations in interest rates are related negatively to cycles in the monetary growth rate. In recent cycles monetary growth and business activity more consistently had reinforcing effects on cycles in interest rates than was true in earlier periods. Presumably Federal Reserve policy is largely responsible for this change in behavior of monetary cycles. The change explains part but not all of the decline in timing lags and increase in amplitude of interest-rate cycles relative to reference cycles.

The results also contain broader implications about monetary influences on financial markets and suggest possible directions for further study. Cyclical variations in monetary growth appear to be an independent contributor to interest-rate movements, and, while not the only or the largest contributor, neither are they a mere reflection of those movements nor of common responses in the series to business cycles. Evidence of their contribution is a first step in tracing the path of monetary disturbances through the economy. That contribution points to effects beyond those implied by the static equilibrium conditions of traditional monetary theory and implies dynamic relationships as yet only partially understood.