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Chapter Author: Phillip Cagan

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# *Essays on Interest Rates*

# 1

# The Influence of Interest Rates on the Duration of Business Cycles

***Phillip Cagan***

### *Introduction*

FINANCIAL EFFECTS ON INVESTMENT. In economic theory the cost of capital has an important influence on decisions to invest and, therefore, on business cycles. Increases in capital costs may curtail investment undertakings thus contributing to a downturn in aggregate activity, and conversely for decreases. Since the rate of interest is a major item in capital costs, empirical studies have looked for rate effects on investment decisions and expenditures. Short-term rates are supposed to influence inventory investment and trade credit, while long-term rates influence plans for plant and equipment installations and for residential housing. Such an effect would show up first in orders and contracts, later in appropriations and expenditures.

The typical cyclical pattern of interest rates does not at first sight support the foregoing theory. Interest rates and investment series generally conform to business activity on a positive basis, and so their correlation with each other is positive rather than negative as the theory implies. A negative effect could still occur, and be consistent with this behavior, if offsetting factors intervened for some time to delay the effect. For example, during business upswings, at first investors look favorably upon capital projects despite the accompanying rise in interest rates; but, if the rising cost of capital eventually exceeds expected returns, the resulting reduction in investment expenditures could bring on a downturn in general activity. Then, as the downturn

NOTE: I benefited greatly from the comments and suggestions of F. Thomas Juster, Jacob Mincer, and Geoffrey H. Moore. Josephine Trubek and Jae Won Lee provided invaluable research assistance.

gathers momentum, business prospects dim even further and the remnants of optimism fade. Investment undertakings previously held back by high interest rates no longer appear attractive even when rates are much lower. If cutbacks in the demand for capital funds are large, interest rates will decline. Interest rates and investment expenditures can therefore display a positive association over cycles, even though the rates have a delayed, inverse effect which contributes to fluctuations in investment.

This view of the cyclical role of interest rates can be expressed in terms of traditional supply and demand analysis. Price in that framework would represent interest rates, and quantity would be capital borrowing per period of time. A positive association between price and quantity reflects cyclical shifts in a downward sloping demand curve combined with an upward sloping supply curve. A restriction on business expansions due to rising capital costs implies that the supply curve shifts leftward; if at a later stage of the expansion those shifts came to outweigh the rightward shifts in demand, capital borrowing and expenditures would then decline, contributing to a downturn in aggregate activity. A recession in activity, no matter how initiated, usually leads to substantial leftward shifts in the investment demand curve, overcoming all other effects on supply and demand to make interest rates and investment fall. Notwithstanding the over-all positive association between price and quantity, countercyclical shifts in the supply curve, by further raising rates and eventually reducing the quantity demanded, could be a factor in the downturn of business activity.

Deriving evidence of such supply effects, however, presents severe difficulties. To disentangle the shifts in demand and supply, econometric studies specify and attempt to measure the separate curves. Even for the more successful studies, the data requirements usually restrict the coverage to recent periods, which limits the significance of the results. It is desirable to draw on the evidence of long periods. This study reports experiments with a new test for supply effects utilizing the cyclical behavior of series just of interest rates and investment or business activity, and so allows coverage of a long period. The results are promising, though tentative because of some remaining difficulties in measurement and interpretation.

A TEST FOR SUPPLY EFFECTS. One might, in principle, draw conclusions about supply and demand effects simply from the cyclical behavior of these series at turning points. If investment and the interest rate turn down, for example, the decline reflects a predominant, leftward shift in demand—if the rate continues to rise, a predominant, leftward shift in supply. In practice, however, such inferences are subject to doubt. The interest rate may not correctly reflect the cost of financing the particular items covered by the investment series, and a comparison confined to concurrent movements does not allow for lags. A downturn in capital borrowing while the rate is, at the moment, still rising might indicate a leftward shift in the supply curve, for example, or it might indicate a decline in investment demand which reduces orders immediately but has a delayed effect on the interest rate. With lags, such comparisons have ambiguous interpretations.

The test for supply effects presented here is designed to allow for long lags, in both demand effects on interest rates and rate effects on quantities, as well as to simplify the data requirements. The test treats each cyclical phase in the rate or in investment or business activity as one observation, and is based on the assumption that cyclical fluctuations in interest rates reflect largely reinforcing shifts in both the demand and the supply curves of capital funds (that is, the demand shifts procyclically and the supply countercyclically). While such shifts in demand tend to prolong the accompanying cyclical movement in investments, those in supply tend to limit it. Cyclical fluctuations in demand and supply do not, however, have identical timing, and disparate turning points in interest rates and related investment series are often observed. Much of the independent behavior of the supply curve can be attributed to monetary and other financial factors. At business revivals, for example, the supply of capital funds often continues to expand following an upturn in investment demand, as indicated by a fall in interest rates while borrowing increases; but such a procyclical shift in supply soon ends and then is reversed, and interest rates rise. The tightening of credit restricts and eventually may help to end the expansion in investment. Therefore, for each month that the leftward shift in supply is delayed the expansion in investment would tend, other things the same, to last longer. A test of this supply effect is to determine whether investment and business expansions are longer when interest rates start to rise later. A similar test may be used for contractions.

Shifts in demand also affect rates and the duration of phases, of course, but presumably not in the same way. Demand factors may well account for the tendency of interest rates to lag at business cycle turns, contrary to the assumption here that supply shifts are responsible. But there is no reason to expect the timing of, say, an upturn in investment demand to determine the date of the subsequent downturn in business activity unless, as the test here assumes, expansion in the supply of capital funds was limited and thus restricted the duration of the upswing.

Although the logic of such a test applies in general to the price-quantity fluctuations of any sector of the economy, it uses a small part of the potentially available information and therefore appears useful primarily where the complexity of relationships and lack of data preclude a more complete analysis. Aggregate investment is such a sector. Even after making the simplifications, there are difficulties in representing the cost of financing particular investment activities by any of the available interest-rate series. Generally the investment series which cover a fairly long period pertain to certain industries. Since this study is mainly concerned with the financial effects on general business activity, most of it compares interest-rate movements with the National Bureau's chronology of business cycles, on the assumption that total investment demand in the economy is closely related to general business activity and has largely the same turning points. Later the analysis is extended to some series on residential and business construction. Since business cycles depend upon a variety of economic relationships, such a test cannot establish whether monetary and financial effects on capital costs play a dominant role in cyclical turns. But it can suggest whether they make an important independent contribution.

### *Cyclical Fluctuations in Interest Rates and the Duration of Reference-Cycle Phases*

THE LAGGED TIMING OF INTEREST RATES. Reasonably accurate estimates of the duration of business cycles extend back to the mid-1800's, providing a large number of observations. The estimates are used here with series on commercial paper rates and high-grade bond yields. Those rates are assumed to reflect the relative movements of demand and supply in the financial market as a whole. Paper rates are relevant to short-term business loans for inventory investment; bond yields, to long-term capital financing. The bond series is Macaulay's high-grade railroad average, through 1937, and Moody's Aaa public utility average, thereafter. Before the 1930's, railroad bonds were much in favor with investors seeking safety; but after the experiences of that decade, preferences shifted, in particular to public utility bonds. During the 1930's no group of corporate bonds was widely viewed as high grade. For that and other reasons, to be noted later, none of the cyclical movements between 1933 and 1945 are retained for bonds in the subsequent analysis. The turning points selected for bond series are shown in Chart 1-1. Those for commercial paper (not shown) are similar.

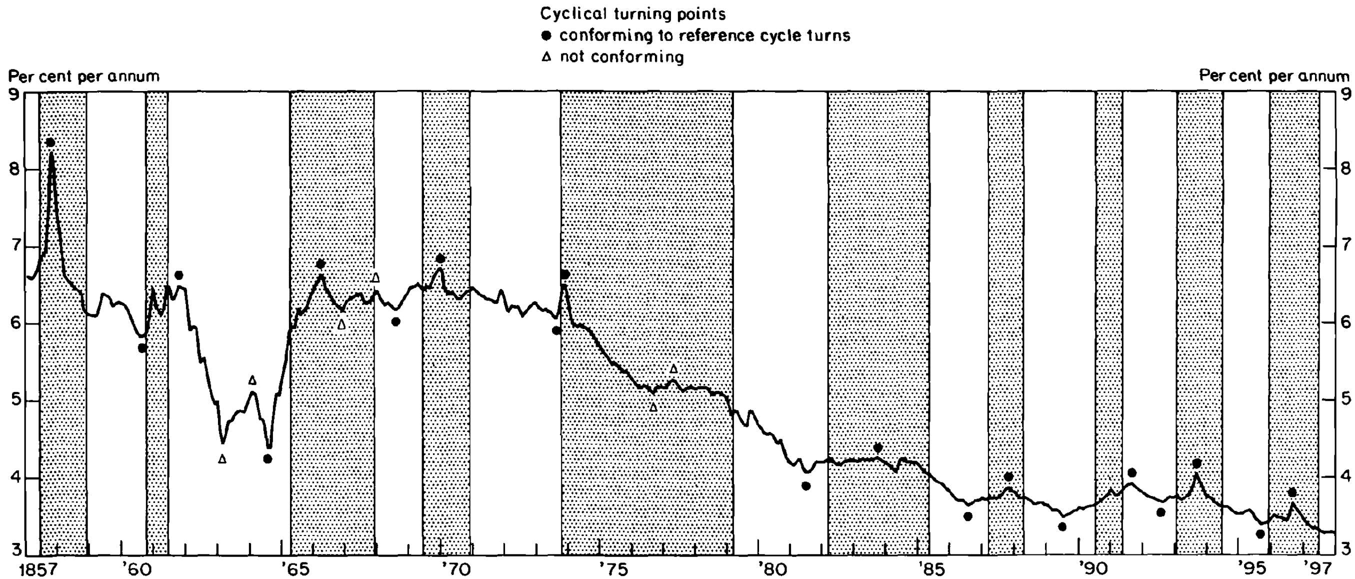
Turning points present certain problems of identification. First of all, cyclical turns are not always clearly defined, and the selection of a particular date may involve considerable error. Second, interest rates sometimes have extra cyclical movements corresponding to the same reference phase, and it is not always clear which movement corresponds to the reference phase. The choice of one turn rather than another can make considerable difference in the length of leads or lags. To avoid arbitrary matchings when the rate has multiple turns, the highest peak has been matched with reference peaks, the lowest trough with reference troughs; the extra turns are ignored. This procedure cannot be defended as always being appropriate, but multiple turns in rates are not numerous. A few of the special cases could unduly influence the statistical results, and they have been excluded. Reference phases skipped by the interest rates are also excluded; they will be discussed later.

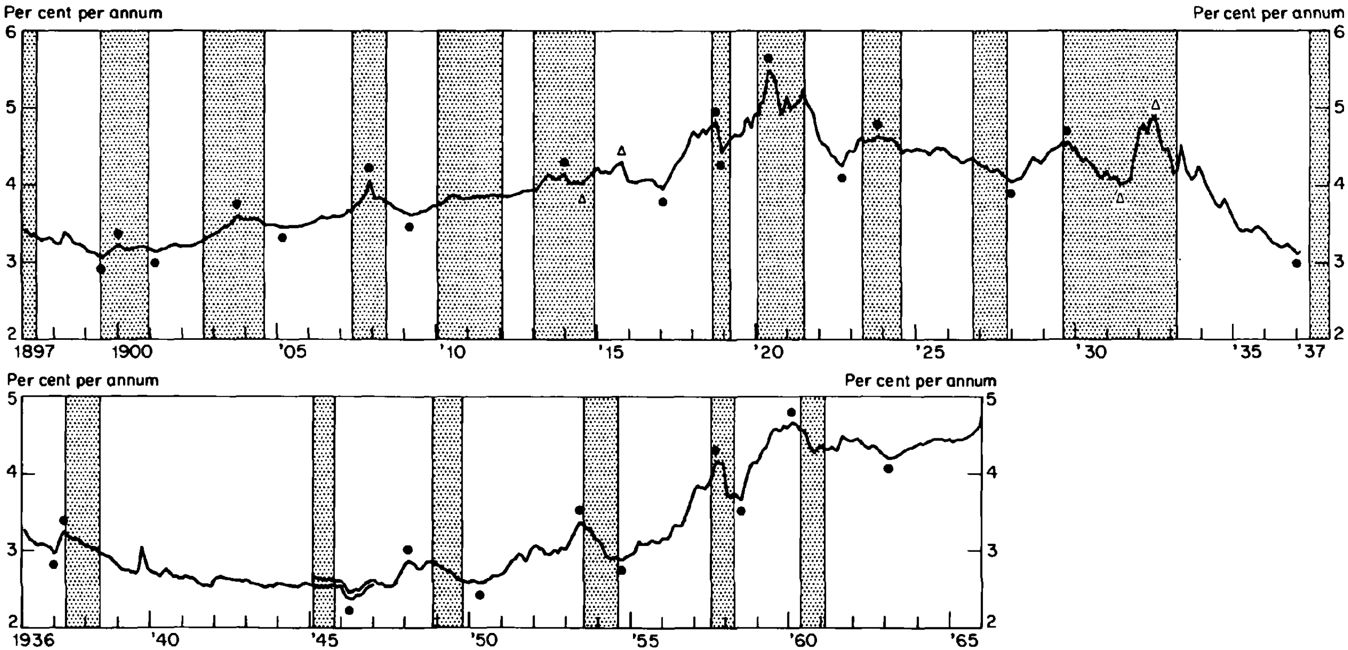
The rate series conform to most reference cycles, but usually with a lag of variable length. For the conforming movements, the median lag for bonds is six months at troughs and fourteen at peaks; for commercial paper, five and four months, respectively. A long, fairly regular lag is characteristic of few other economic variables. The lags may be attributed in part to monetary and other financial developments on the supply side.[1] Demand factors are less likely to run counter to general business activity for long and therefore to produce lags in rates.

A REGRESSION TEST. For conforming movements in the interest rate, the relevant variables may be denoted by $L_t$, $A_t$ and $D_t$ as defined in Figure 1-1. $L$ has usually been positive, indicating that the interest rate lags behind the reference-cycle turn. (Sometimes the lag is so long that $L$ even exceeds $D$.) Occasionally, when rates have led, $L$ is negative. The amplitude of movement in the interest rate during the lag segment is represented by $A$. According to the test for supply effects outlined above, both the length and the amplitude of the segment should affect the duration of the corresponding reference phase. We may separate the joint effect by treating the lag $L$ and the amplitude per month $A/L$

[1] See my "Changes in the Cyclical Behavior of Interest Rates," *Review of Economics and Statistics*, Aug. 1966, reprinted as Occasional Paper 100, New York, NBER.

CHART 1-1. Cyclical Turning Points in High-Grade Corporate Bond Yields, 1857–1965






NOTE: Shaded areas represent reference cycle contractions.

SOURCE: 1857–1937, average high-grade railroad bonds (F. R. Macaulay, *The Movements of Interest Rates, Bond Yields and Stock Prices in the United States since 1856*); 1937–65, average of Aaa public utility bonds (1937–45 from S. Homer, *A History of Interest Rates*, 1945–65 from *Moody's Public Utility Manual*).

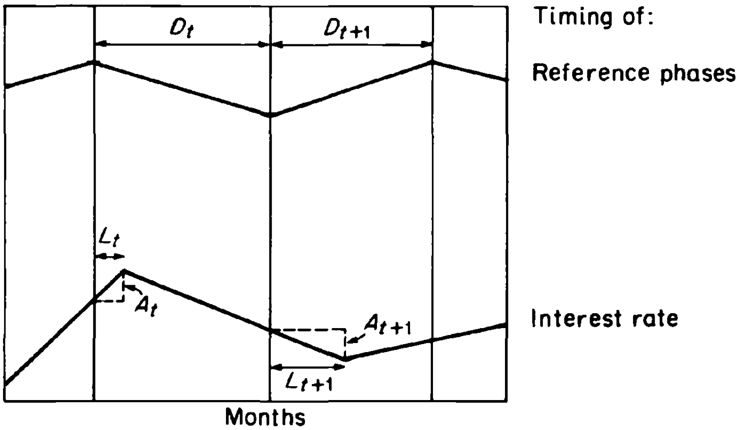



FIGURE 1-1. Movement of Interest Rates at Reference-Cycle Turns

as independent variables. An effect of interest rates on duration may then be expressed by the regression equation (assumed linear):

$$D = \alpha L + \beta \frac{A}{L} + C + \epsilon \qquad (1)$$

where $\alpha$ and $\beta$ are constant parameters, $C$ is a constant term, and $\epsilon$ is a random variable representing all the other factors which produce variations in the duration of phases. The sign of $A/L$ is defined to be positive when rates are rising between peaks in the rate and business or when rates are declining between troughs; and negative for the opposite movements. By this designation of the sign, positive movements in $A/L$ tend to shorten the accompanying reference phase, so the sign of $\beta$ should be negative.

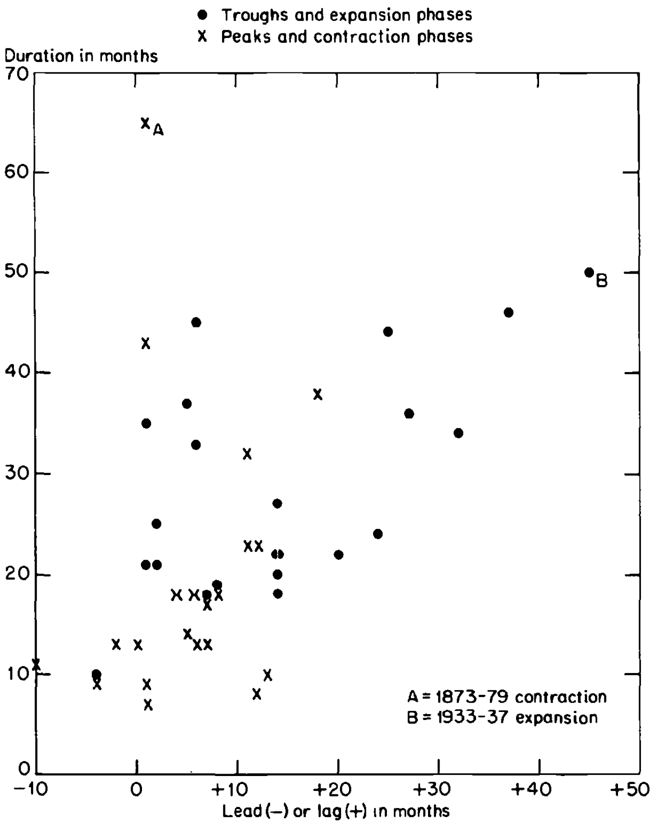
Charts 1-2 and 1-3 present scatter diagrams of $D$ and $L$ for the two interest rates. Skipped phases, as mentioned earlier, have been excluded.[2] A few extreme observations pertain to unusually long durations: 1873–79, 1933–37, and 1938–45, except that bond yields skipped the last one. The latter two had long lags in the interest rates which exaggerate the apparent correlation with duration, while the 1873–79 contraction had a leading turn in the interest rates which re-

[2] One could mechanically include them by relating the skipped phase to the nearest appropriate turn in the interest rate, but that would relate the same turn to two phases which has the implausible implication that the timing of the same interest-rate movement affects the duration of two separate phases. For this reason it seems preferable simply to exclude the few skipped phases.

duces the apparent correlation. The 1873–79 contraction was a special case: There is reason to believe that the business trough actually came earlier than 1879. Also, the interest rates had multiple cyclical turns and began a secular downtrend during that phase, casting doubt on whether our selection of the first of those turns is appropriate. In any event, the extreme observations are best excluded when examining the association for most cycles. The 1937–38 contraction is also excluded for bonds, as noted earlier, because of doubt about the data used for that period.

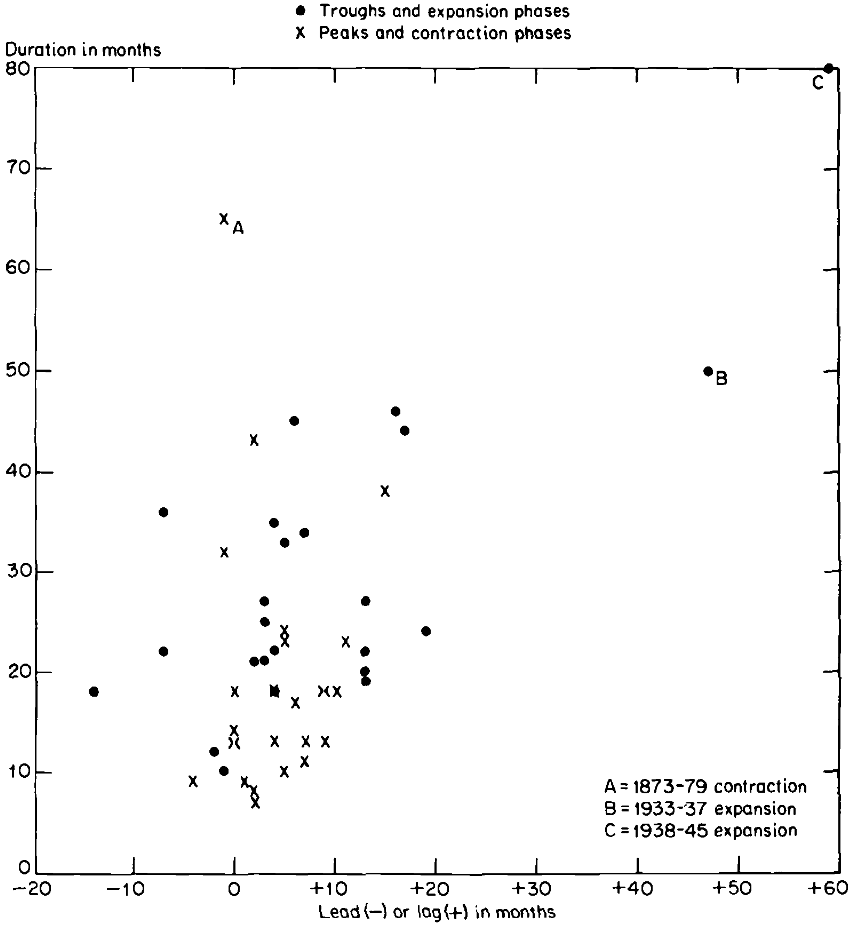
For the remaining forty-two phases for bonds and forty-six for com-

CHART 1-2. Lead or Lag in Bond Yields at Reference Cycle Turns, and Duration of References Phases, 1857–1960




SOURCE: Same as Chart 1-1.

CHART 1-3. Lead or Lag in Commercial Paper Rate at Reference Cycle Turns, and Duration of Reference Phases, 1857–1960




SOURCE: Commercial paper rate from Macaulay to February 1936, thereafter from weekly data in *Commercial and Financial Chronicle*.

mercial paper, Table 1-1 presents regressions of the duration on the lead or lag and average amplitude as in equation (1). Lack of independence in the residuals, often a serious problem in time series regressions, should be largely absent here because the observations represent separate cyclical phases spaced fairly far apart in time. However, the residuals may not be normally distributed, particularly if some effects on duration are relatively large and do not follow a normal distribution. Consequently, use of the $t$ test of significance may involve bias.

Table 1-1 indicates a relationship in the expected direction, though, as might be expected from our disregard of demand effects, the correlation is low. Yet by the $t$ test it is significant ($t > 2$) for all phases together and for bonds in expansions. The coefficient of the amplitude variable has the correct sign but is not significant. Apparently the amplitude, as distinct from the direction of movements early in the

TABLE 1-1. Interest Rates and Duration of Reference Phases 1857–1960, Regression Equations

| Interest Rate and Reference Phases [a] | Regression Coefficient [b] (and $t$ value): Lead or Lag ($L$) | Regression Coefficient [b] (and $t$ value): Amplitude Per Month [c] ($A/L$) | Constant Term (months) ($C$) | Total Correlation Coefficient | No. of Observations |
|---|---|---|---|---|---|
| Bonds | .58(3.8) | −.25(0.8) | 18 | .52 | 42 |
| Commercial paper | .52(2.2) | −.04(1.0) | 20 | .34 | 46 |
| Bonds | | | | | |
| All phases | .62(3.8) | | 17 | .52 | 42 |
| Expansions | .45(2.4) | | 22 | .49 | 21 |
| Contractions | .64(1.8) | | 14 | .38 | 21 |
| Commercial paper | | | | | |
| All phases | .49(2.1) | | 19 | .31 | 46 |
| Expansions | .41(1.6) | | 24 | .35 | 22 |
| Contractions | .58(1.4) | | 15 | .29 | 24 |
| Bonds, Expansions Added to: | | | | | |
| Subsequent contractions | .48(2.0) | | 37 | .43 | 19 |
| Previous contractions | .36(1.9) | | 37 | .43 | 18 |
| Commercial paper, Expansions Added to: | | | | | |
| Subsequent contractions | .25(0.8) | | 42 | .17 | 21 |
| Previous contractions | .27(1.1) | | 40 | .24 | 21 |

SOURCE: Same as Charts 1-1 and 1-3.

[a] Excluding 1873–79, 1933–37, and 1938–45 reference phases for commercial paper rate and first two of those phases and 1937–38 for bond yields, as well as adjacent phases for the bottom four regressions.

[b] Regression equation is eq. (1) in text. See accompanying figure for definition of variables. Signs of $t$ values have been dropped. For 19 or 20 degrees of freedom, the value of $t$ significant at the .05 level is 2.09; for 40 degrees of freedom it is 2.02.

[c] Sign is positive if change in rate during period of lead or lag relative to reference turn works to shorten corresponding reference phase, negative if to lengthen it (that is, increases relative to peaks and declines relative to troughs are positive, declines at peaks and increases at troughs are negative). If $L$ is zero, $A/L$ is also made zero.

phase, is an unimportant part of the total effect of supply shifts during the entire phase. We cannot disentangle that total effect from demand effects in a test of this kind.[3] The amplitude variable has been omitted from the other regressions in the table, which show roughly similar results for expansions and contractions separately.

The bottom group of four regressions is designed to test for possible bias due to secular variations in trend. Reference cycle turns are derived from series with growth trends whereas interest rates, being pure numbers, have no natural growth. Although bond yields exhibit long swings of 15–30 years duration, they have no clear trend over the period covered as a whole. An upward trend in a series shifts peaks forward and troughs backward, thus lengthening expansions and shortening contractions. Hence, when the intercyclical trend in business activity is relatively strong (assuming the trend in the rates is negligible), business cycles have longer expansions and shorter contractions than interest rates do. This by itself would tend to increase lags in interest rates at troughs and to reduce lags at peaks. If the magnitude of the trend varied secularly, there would appear to be a positive association between the duration of phases and the corresponding lag in interest rates, as found here. And this effect of trend could pertain separately to expansions and contractions. If we add together the *L*'s for adjacent expansions and contractions, the shifts in timing due to such trend will cancel out. The bottom four regressions in Table 1-1 give the results two ways, pairing expansions (1) with subsequent contractions and (2) with previous contractions. For each pair, the regression related the sum of the two *D*'s to the sum of the two *L*'s. Either method of pairing produces a reduction in correlation, suggesting that trend may have affected the previous results, though less for bonds than for commercial paper. The trend-adjusted relation for bonds remains on the borderline of signifi-

[3] Various regressions (not presented) were run to measure the effect on duration of the amplitude of change per month in the interest rate from its turning point to the end of the reference phase and of the amplitude for the initial sections of that segment. The partial correlation of such variables were usually negative (showing, as expected, that a larger amplitude produces a shorter phase), but on the whole they were not significant.

This may not indicate unimportance, however, because the concurrent positive effect of business activity on interest rates tends to hide the inverse effect of their changes on duration. A vigorous business expansion, for example, generates momentum to prolong the upswing while it also raises interest rates. The separate effects of demand and supply on rates cannot readily be distinguished. Indeed, the tests of Table 1-1 are specifically designed to avoid that problem by examining the early stages of the phase, before rates have turned, during which *L* and *A*/*L* measure the extent to which shifts in supply exceed those in demand. During the lag segment, supply conditions contribute to a continuation of the phase and have not yet begun to restrict it.

cance (at the .05 level). That for commercial paper rates remains positive but falls below the significance level; turns in that series appear to reflect cyclical shifts in the supply curve of total credit less strongly.

The remainder of this section discusses the problem of skipped phases and of the shift in timing of bond yields after 1914.

SKIPPED PHASES. In a few cases, the interest rates have no identifiable cyclical movement corresponding to a reference phase. Such an uninterrupted rise or decline in the rate, if supply shifts are mainly responsible, tends to shorten or prolong the phase. Table 1-2 gives the expected and actual effects for the skipped phases. In five of the six

TABLE 1-2. Reference-Cycle Phases Skipped by Interest Rates, 1857–1960

| | Reference Phase | | | Direction of Cyclical Movement and Effect on Reference Phase Skipped | |
|---|---|---|---|---|---|
| Date | Direction | Duration (months) | Relation to Average Duration[a] | Commercial Paper Rates | Corporate Bond Yield |
| Jan. 1910–Jan. 1912 | Cont. | 24 | Long | | Up, Prolong |
| Jan. 1912–Jan. 1913 | Exp. | 12 | Short | | Up, Shorten |
| July 1924–Oct. 1926 | Exp. | 27 | Equal | | Down, Prolong |
| Oct. 1926–Nov. 1927 | Cont. | 13 | Short | | Down, Shorten |
| June 1938–Feb. 1945 | Exp. | 80 | Long | | Down, Prolong |
| Feb. 1945–Oct. 1945 | Cont. | 8 | Short | Up, Prolong | Down, Shorten |
| Oct. 1945–Nov. 1948 | Exp. | 37 | Long | Up, Shorten | |

SOURCE: Same as Chart 1-1 for bond yields; Chart 1-3 for commercial paper rates.

[a] Average of all reference phases, 1857–1960: 26.9 months for expansions, 17.2 for contractions.

phases skipped by the bond series, the relative duration of the phase was consistent with the expected effect of the movement in bond yields: rising bond yields appeared to shorten, and falling yields to prolong, business expansions; and conversely for business contractions. (The evidence for the sixth phase, which is equal to the average, is neutral.) Commercial paper rates skipped but two reference phases, both in the early post-World War II years when the Federal Reserve pegged government bond prices. Those two phases had lengths inconsistent with the upward movements in commercial paper rates, but those movements were extremely small and understandably exerted little restraint on business activity. On the whole, the skipped phases are consistent with supply effects on the duration of reference phases.

THE SHIFT IN TIMING OF BOND YIELDS. Although the statistical evidence clearly indicates a financial effect by bond yields on business activity, the yields nevertheless raise questions of interpretation that require further consideration. As shown in Table 1-3, the lagged timing of bond yields, typically quite long before World War I, has shortened noticeably since then.[4] The regression results suggest that such a shortening of lags would reduce the duration of later reference phases,

TABLE 1-3. Timing of Bond Yields at Reference Turns and Average Duration of Reference Phases, Before and After 1914 (*months*)

| | Median Lag (+) at | | Average Duration of Reference Phases |
|---|---|---|---|
| | Peaks | Troughs | |
| 1857–1914 | +9.5 | +14 | 23 |
| 1915–60 | +1 | +3.5 | 23 |

NOTE: Coverage same as for Table 1-1, that is, excluding 1873–79, 1933–37, and 1937–38, as well as skipped phases.

yet the average duration has not changed. Evidently the regression lines shifted between the two periods, as is confirmed by the separate fits reported in the top part of Table 1-4. The slope of the line and the constant term increased from the earlier to the later period. For expansions and contractions fitted separately (not shown), there is the same increase in the constant term; the slope also increases for expansions though not for contractions. Such a major shift in the relationship seems to indicate that interest-rate movements do not affect duration. But that conclusion then leaves no apparent explanation for the correlations within each period.

Another interpretation is that the correlations do indicate an effect of supply shifts on investment and business activity but that the reflection of those shifts in bond movements has speeded up, altering our measuring rod. Why the timing of bond cycles changed is not clear, though, presumably, growth in the size and activity of the bond market contributed to greater sensitivity of yields to financial developments.

[4] See also "Changes in the Cyclical Behavior of Interest Rates."

TABLE 1-4. Regression of Reference-Phase Duration on Lead or Lag in Bond Yields and in Monetary Growth Rate, Before and After 1914

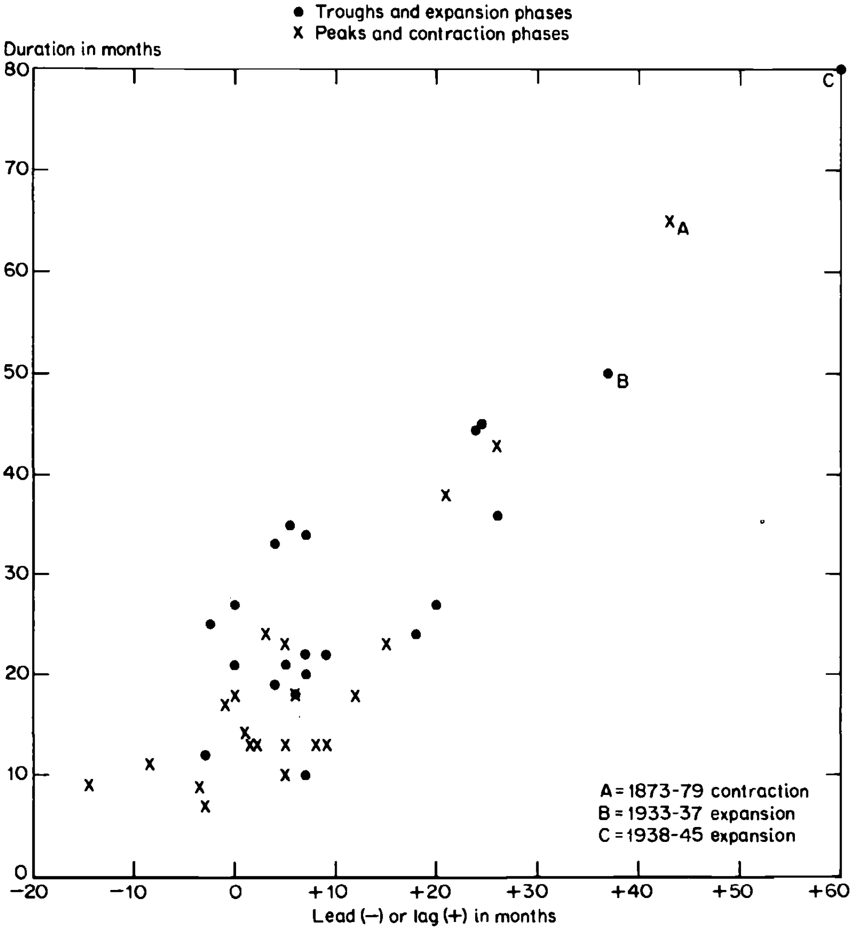
| | Regression Coefficient (and *t* value) of Lead or Lag (*L*) | Constant Term (months) | Total Correlation Coefficient | No. of Observations |
|---|---|---|---|---|
| Bonds | | | | |
| 1857–1914 | .70(4.4) | 14 | .67 | 26 |
| 1915–60 | .98(2.5) | 20 | .56 | 16 |
| Monetary Growth Rate (inverted) | | | | |
| 1870–1960 | .73(5.6) | 17 | .69 | 37 |
| 1870–1914 | .61(3.2) | 17 | .60 | 21 |
| 1915–61 | .85(4.3) | 17 | .75 | 16 |

SOURCE: Bond yields, same as for Table 1-1; money, currency outside banks plus demand and time deposits from M. Friedman and A. Schwartz, *A Monetary History of the United States, 1867–1960,* Princeton for NBER, 1963, Table A1 series revised and extended. The monetary series is annual before 1907, making the turning points less reliable in the earlier period. The dates of some of the monetary turns are different than those shown in "Changes in the Cyclical Behavior of Interest Rates," Chart 3, because of revisions.

This interpretation is further suggested by the related behavior of the growth rate of the money stock. Cycles in monetary growth contribute to cyclical shifts in the supply of loanable funds and help to account for the lagged cyclical behavior of interest rates. My earlier study [5] found that troughs in interest rates tend to coincide with peaks in monetary growth, and peaks in rates with monetary troughs—that is, monetary growth has an inverted relation to interest rates. We may therefore expect to find a relation between turns in monetary growth (inverted) and the duration of reference phases. (Chart 1-4 presents the scatter diagram.) Monetary growth (inverted) tends over the period covered there to lag behind matched reference turns, in the same way that interest rates do, and to exhibit a similar correspondence to phase durations. Correlations of this relation, shown in the lower panel of Table 1-4 which excludes the three extreme observations marked on the chart, are significant. The relation for bond yields therefore parallels a similar relation for monetary growth.

[5] *Ibid.,* Chart 1-3 and Table 1-7. That study also presented evidence that the cycles in monetary growth are not themselves produced by interest-rate movements.

CHART 1-4. Lead or Lag in the Rate of Change in the Money Stock at Nonwar Reference Cycle Turns, and Duration of Reference Phases, 1870–1960




NOTE: Troughs in the rate of change of the money stock are related to reference peaks, and peaks to reference troughs.
SOURCE: Same as Table 1-4.

This similarity suggests the following interpretation: A cyclical downturn in monetary growth during business expansion contributes to an upturn in interest rates and exerts a growing restraint on investment which eventually helps to bring on a recession in activity; and, conversely, a cyclical upturn in monetary growth during a recession contributes to a decline in interest rates, stimulates investment, and subsequently leads to a business revival. The money correlations are pertinent to the shift in timing for bonds, mentioned above, because the constant term of the money regressions is not larger after 1914 than it was before. That the timing of the monetary cycles and their relation to duration have remained the same suggests that the change in timing for bonds did not reflect a change in the cyclical effect of the supply of loanable funds on business activity.[6]

To be sure, the evidence is far from conclusive and must be viewed as tentative. Other interpretations cannot be ruled out, though two alternatives examined in the next section, at first sight appealing, are found not to be supported by the evidence.

### *Alternative Interpretations of the Evidence*

The fact that $D$ can be viewed as the sum of two correlated segments, $L$ and $D - L$, suggests two alternative interpretations of the data. One is that $D$ is spuriously correlated with $L$ because both are influenced by the same cyclical factors. Another is that the association is purely mechanical and without economic significance, because turns in interest rates occur at random somewhere within each reference phase. Thus, although $D$ is independent of $L$, if for any reason $D$ should be larger $L$ would also tend to be larger. We may consider these two alternative interpretations in turn.

COMMON INFLUENCES ON $D$ AND $L$. Some business phases, one might argue, proceed slowly and some rapidly, and interconnections across the economy maintain a similar rate of movement in each sector. In slowly developing phases which have long durations, interest rates tend to move sluggishly and to have delayed turning points; and rapidly developing phases behave conversely. There could be an association between $L$ and $D$, therefore, even though neither was directly related to the other. Since interest rates obviously depend on developments in the economy at large, this rationalization of the preceding results is plausible on the surface and deserves consideration.

To judge its importance in the correlations of Tables 1-2 and 1-4, a variable representing the pace of general business activity in each phase can be added to those regressions. Such a variable may be

[6] This conclusion disregards the increased slope of the later regressions for both bonds and money, which seems to suggest that in the later period the lag in the turning point is more nearly additive to the phase duration. It is not clear what might produce such a change.

represented by the average change per month in an index of general business activity and is denoted by $B$. If it accounted for the previous results, it would be the only variable having a significant partial correlation with duration. The results are presented in Table 1-5.

TABLE 1-5. Bond Yield and Duration of Reference Cycle Phase: Regression of Duration on Lead or Lag and Severity of Reference Phase

| | Partial Correlation Coefficient (and $t$ value) | | |
|---|---|---|---|
| | Lead or Lag ($L$) | Severity of Reference Phase ($B$) | Multiple Correlation Coefficient |
| Expansions | .48(2.3) | −.66(3.6) | .74 |
| Contractions | .27(1.2) | −.36(1.6) | .50 |
| All phases | .41(2.8) | −.54(3.9) | .69 |

SOURCE: Bond yield, same as Chart 1-1; severity of reference phase, G. H. Moore (ed.), *Business Cycle Indicators,* Vol. I, Princeton for NBER, 1961, p. 104, and unpublished extensions and revisions.

NOTE: Regression equation is

$$D = \alpha L + \beta B + C,$$

where $L$ is lead (−) or lag (+) of interest rate from reference-cycle turn, $D$ is duration of reference phase, $B$ is an index of severity of the reference phase per month, and $\alpha$, $\beta$, and $C$ are regression coefficients. Signs of $t$ values have been dropped.

Coverage is the same as for Table 1-2.

As expected, the index of business activity has a significant (negative) association with duration. The index does not, however, account for the effects found above for interest rates. The partial correlation coefficient of $D$ on $L$ is still significant in all phases, taken together, and for expansions, taken separately. Although the measure used for the average amplitude of business activity may not perfectly represent the common cyclical influences on the variables, it should be a reasonable proxy, and its failure to make a significant difference suggests that such influences are not important here.

EFFECTS OF $D$ ON $L$. It is conceivable that the financial system operates in such a manner that interest rates tend to have cyclical upturns when business activity expands and downturns when it contracts. If, in addition, the turns in rates occur at random during the concurrent reference phase, $L$ would tend to vary with $D$. There are some difficulties in specifying the economic conditions under which such a dependence could happen,[7] but the possibility has disarming simplicity and should be examined.

Evidence is afforded by the behavior of other economic series. If the correlation between $D$ and $L$ for interest rates reflects a mechanical relationship rather than financial influences on business cycles, nonfinancial series should be correlated with $D$ in the same way. A group of representative economic time series was examined for such correlation.[8] The selection favored series with a long coverage and included a broad sample of economic activity. Only one gave evidence of a systematic correlation between the lead or lag from reference turns and the duration of the concurrent reference phase.[9] Since bond yields and monetary growth exhibit a rare relationship to reference phases, it cannot be dismissed as simply a mechanical characteristic of cycles observable in a variety of series.

### *Some Statistical Properties of the Relationship*

If, as the evidence suggests, increases in interest rates restrain business expansions and decreases stimulate recovery from business contractions, such effects seem to imply a cyclical pattern of rates having an inverted conformity to reference cycles and a lead in timing. How-

[7] As a purely statistical proposition, $L_t$ can be defined as a stochastic variable drawn at random from a population whose mean value is some fraction of $D_t$. The two would then be correlated over time, consistent with the results here. But if this were taken to imply an effect of $D$ upon $L$, the inference would face difficulties in economic interpretation. Since the mean of the distribution of $L$ is proportional to the length of the concurrent business phase not yet ended, an event early in the cycle is made to depend upon future developments. For developments early in a phase to be determined by its ultimate duration seems far fetched. In addition, contrary to this determination of $L$, the turn in rates does not always occur during the phase; it sometimes occurs earlier or later.

[8] Those examined were new incorporations 1861–1960; wholesale prices 1857–1960; common stock prices 1873–1960; bank clearings outside New York City 1879–1960; new orders of durable goods 1921–60; contracts for total commercial and industrial building 1919–60; labor costs per unit of output 1919–60; capital expenditures for new plant and equipment 1918–60; production worker employment 1914–60.

[9] New incorporations, 1861–1960 (with extreme observations for 1873–79, 1933–37, and 1938–45 excluded), was the only series to show a significant correlation between $D$ and $L$ at the .05 level, though unlike bonds and money (inverted), generally this series leads reference turns ($L$ is usually negative).

ever, movements in business activity also exert a strong pull (from the demand side) on interest rates, which tends to produce positive conformity and coincident or lagging timing. Which pattern predominates may be judged from the stability of the timing relation on each basis. $\sigma_L^2$ is the variance of the timing relation on a positive basis; $\sigma_{D-L}^2$ is the variance of the timing on an inverted basis. Table 1-6 shows that $\sigma_L$ is smaller than $\sigma_{D-L}$ (though about the same in expansions, taken alone). Interest rates conform more closely to reference cycles on a positive than on an inverted basis.[10] By implication, the effect of business activity on interest rates is slightly more powerful than the effect of the rates on activity in determining the relation between the two.

TABLE 1-6. Stability of Timing in Bond Yields at Reference Cycle Turns on Positive and Inverted Basis (*standard error of lead or lag, months*)

| | Positive Basis $\sigma_L$ | Inverted Basis $\sigma_{D-L}$ | Ratio of Standard Errors $\sigma_L/\sigma_{D-L}$ |
|---|---|---|---|
| Expansions | 11.2 | 10.8 | 1.03 |
| Contractions | 5.7 | 9.2 | .62 |
| All phases | 9.3 | 10.1 | .92 |
| 1852–1914 | 8.5 | 6.3 | 1.36 |
| 1915–61 | 7.6 | 11.0 | .69 |

SOURCE: Same as for Tables 1-1 and 1-4.

It is just this—the strong effect of activity on the rates—that makes the reverse effect elusive and difficult to identify. Nevertheless, activity effects on rates do not result in a perfect positive conformity, partly because of deviations produced by monetary and other financial influences. Because of the frequent occurrence of deviations from perfect positive conformity, the preceding test of a rate effect on duration becomes possible.

The fact that $D - L$ varies more than $L$ is one reason for the low correlation with $D$, since the ratio of segment variances and the slope of the regression line jointly determine the correlation coefficient.

[10] It is easily shown that this implies $R_{D,L} < R_{D,D-L}$, which expresses the general rule that the sum of two nonidentical series has a greater correlation with the component having the larger variance.

This may be demonstrated. By definition we have

$$R^2_{D,L} = \hat{\alpha}^2 \frac{\sigma^2_L}{\sigma^2_D}$$

where $\hat{\alpha}$ is the estimate of the regression slope, $\sigma_{D,L}/\sigma^2_L$. The variance of $D$ can be decomposed into

$$\sigma^2_D = \sigma^2_{D-L} + \sigma^2_L + 2\sigma_{D-L,L}.$$

Since $\sigma_{D-L,L} = \sigma_{D,L} - \sigma^2_L = \hat{\alpha}\sigma^2_L - \sigma^2_L = -(1 - \hat{\alpha})\sigma^2_L$, we have

$$\sigma^2_D = \sigma^2_{D-L} + \sigma^2_L(2\hat{\alpha} - 1). \tag{1}$$

Hence

$$R^2_{D,L} = \frac{\hat{\alpha}^2}{(\sigma^2_{D-L}/\sigma^2_L) + 2\hat{\alpha} - 1} \tag{2}$$

The ratio of segment variances, $\sigma^2_{D-L}/\sigma^2_L$, and the slope $\alpha$ are usually greater than unity. Consequently, $R_{D,L}$ is less than $\alpha$.[11]

A regression slope below unity means that an increase in $L$ is associated on the average with a smaller numerical increase in $D$, suggesting that financial effects on duration are not additive to other effects but interact with them. Interest rates appear to influence business activity by speeding up or slowing down the effects of other factors, which in turn constrain the financial effects. Without taking those other factors into account, we cannot take full advantage of the information provided by movements in interest rates. The statistical result of specifying such a nonlinear relationship as linear is to introduce a negative correlation between $L$ and $\epsilon$. Since they are assumed to be uncorrelated by the least squares regression procedure, the negative correlation shows up between $L$ and $D - L$, the remainder of the reference phase after the turn in the interest rate.[12]

Because of this negative correlation and the relatively high variability in $D - L$, $L$ provides a weak prediction of $D$. The regression is nevertheless significant, and therefore a better predictor than the mean length of past phases. If the probability distribution of phase durations does not change over time, the error of such a prediction can be esti-

[11] It is not clear which of these quantities are independent and which are determined by the others. We might plausibly expect economic factors to determine the segment variances and the slope of the relationship between $D$ and $L$, which would make the correlation coefficient the dependent quantity. In view of the increase in $\hat{\alpha}$ after 1914, however, it is not clear whether that reasoning is correct.

[12] Since, $\sigma_{D-L,L} = -(1 - \hat{\alpha})\sigma^2_L$ as shown above, $R_{L,D-L} < 0$ if $\alpha < 1$.

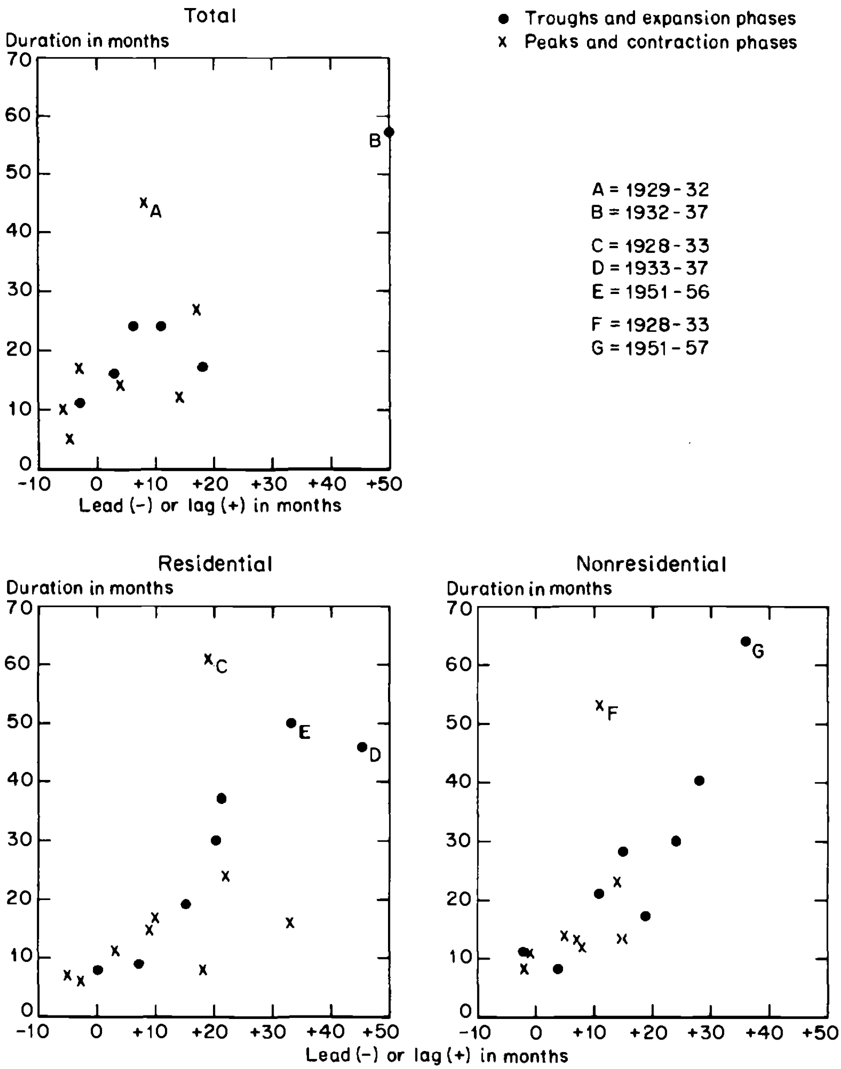
mated by the standard deviation of past durations, $\sigma_D$. Under the assumption of no change in the probability distribution, however, the regression equations of Tables 1-1 and 1-4 give a better prediction, namely $\hat{\alpha}L_t + \hat{c}$, where $\hat{\alpha}$ and $\hat{c}$ are the estimated regression coefficients. The standard error of their predictions is less than $\sigma_D$ by the fraction $\sqrt{1 - R^2}$, where $R$ is the correlation coefficient of the regression fit. For bonds in all phases it is 85 per cent ($\sqrt{1 - .52^2}$); and in the earlier and the later period separately, 74 and 83 per cent, respectively. That provides a slight improvement over simply projecting the mean value of past durations, though the comparison disregards the few phases listed in Table 1-2 in which the interest rate failed to give any prediction at all because of no cyclical turn. It is also true that the regression prediction can be made only after the interest rate turns—and $L_t$ becomes known. While this usually occurs during the phase, not at its beginning, the evidence still suggests that a phase is most unlikely to end before the interest rate turns.

### *Interest-Rate Effects on Construction Contracts*

Changes in bond yields mainly affect the capital or durable goods sector of the economy where interest costs are relevant to purchasers. Therefore, the previous evidence will be extended to examine the relation between cycles in interest rates and investment. Unfortunately, there are few monthly or quarterly series on investment having a broad and fairly long coverage. Construction is one sector that partially meets those criteria. We have series on the value of construction contracts, subdivided into business and residential construction. Since cycles in these series often deviate considerably from general business activity, their use does not involve a repetition of the previous test. Indeed, contracts are signed well before any expenditures are made and represent an early stage of investment undertakings.

The three sections of Chart 1-5 show scatter diagrams of the lead or lag in bond yields at cyclical turns in the contract series and the duration of the corresponding phase in contract cycles. Skipped or nonmatching cyclical movements in the series have been excluded. In some cases there is no turn in bond yields during a contract phase, and it is not always clear whether an earlier or later turn in bonds should be matched with the phase in contracts. All matchings which appear at all reasonable are included in Chart 1-5. It would be desirable, in

CHART 1-5. Lead or Lag in Bond Yields at Turning Points in Value of Total, Residential and Nonresidential Construction Contracts, and Duration of Phases in Construction.




SOURCE: F. W. Dodge Corporation. Periods covered are total construction 1912–60, residential 1916–60, nonresidential 1919–60.

addition, to examine many other series covering a variety of capital-goods industries, and different interest rates. The chart nevertheless provides one sample of the timing relationship between interest rates and investment.

For the cyclical phases covered, the scatter diagrams reveal a positive association between the lead or lag in interest rates and the duration of the phases in contracts similar to the previous findings for reference phases. There are a few extreme observations dated on the chart. Most of these pertain to the 1930's as before, but one is for the 1950's: Residential and total construction contracts skipped the 1953–54 recession (except for a mild decline in 1951, not matched in bond yields), which produces an unusually long expansion from 1951 to 1956 or 1957. These dated observations would strongly influence regression estimates and have been excluded from the correlations presented in Table 1-7.

TABLE 1-7. Relation Between Interest Rates and Duration of Cyclical Phases in Value of Construction Contracts: Regression of Duration on Lead or Lag in Rates, and Stability of Timing

| | | | Standard Error of Lead or Lag | | | |
|---|---|---|---|---|---|---|
| | Regression Coefficient (and $t$ value) (1) | Correlation Coefficient (2) | Positive Basis $\sigma_L$ (3) | Inverted Basis $\sigma_{D-L}$ (4) | Ratio $\sigma_L/\sigma_{D-L}$ (5) | No. of Observations (6) |
| Total, 1912–60 | .84(5.3) | .83 | 8.7 | 5.2 | 1.7 | 15 |
| Nonresidential, 1919–60 | .49(2.5) | .64 | 8.4 | 6.5 | 1.3 | 11 |
| Residential, 1916–60 | .55(3.5) | .73 | 10.7 | 8.6 | 1.3 | 13 |

SOURCE: Same as Chart 1-3 excluding dated points.

The table gives results broadly similar to those of Tables 1-4 and 1-6 for reference phases. There are some differences: The regression coefficients are smaller and the correlation coefficients higher here than in Table 1-4 for the later period.

One indication that bond yields are related more closely to investment than to general business activity is the smaller variation in timing on an inverted basis (Table 1-7, Col. 4). Troughs in interest rates lead corresponding peaks in construction contracts, and peaks in rates lead troughs in contracts, with less variation in the length of leads $(D - L)$ than is true for reference phases (Table 1-6). As was shown by identity (2) on page 23, however, these statistical measures are not independent of each other. When the ratio of timing variances (Table

1-7, Col. 5) favors the positive basis, the correlation coefficient tends to be higher, while it tends to be lower for a smaller slope of the regression. Because of the limited coverage, these differences may be in the nature of random variations. The over-all results here for construction activity nevertheless support implications of the previous tables and suggest, if tentatively, an interest-rate effect on investment undertakings.

*Summary*

Business commentators have long pointed to the importance of financial effects in business cycles. Yet it has proved difficult to measure these effects statistically because of their complex interaction with other cyclical developments. This paper examines one aspect of the financial role, and partly avoids some of the difficulties, by comparing turning points in interest rates with the duration of cyclical phases in business activity. Most interest rates have, as a rule, lagged business-cycle turns. On the assumption that shifts in the demand for loanable funds conform closely to movements in business activity, the lagged turns reflect nonconforming movements in the supply function for funds. If autonomous shifts in supply play an important role in cycles, they will affect the timing of interest-rate cycles and contribute with a lag to the turning points in business activity. The test of such effects presented here is whether delayed upturns in rates prolong business expansions and delayed downturns prolong contractions, and whether the converse is true for early turns in rates. To be sure, the test ignores much relevant information about business cycles, but it has the important advantage of not requiring a large variety or high quality of data and therefore allows the coverage of a long period. The analysis relates bond yields and commercial paper rates to business cycles for the period 1857 to 1960, and to cycles in construction contracts for the period since World War I.

The statistical results point to a weak but significant association between the duration of business cycle expansions and contractions and the corresponding lag in rates at the initial turn of the phase. The association appears to reflect a financial influence on business activity rather than some mechanical characteristic of cyclical movements. The finding that turns in bond yields account for variations in the duration of cyclical phases in the value of construction contracts supports the results for business cycle phases.

The expansion of business activity since 1961 (not included in the analysis) dramatically illustrates the relationship, though of course no single instance is conclusive by itself. The cyclical upturn in bond yields came in early 1963 (Chart 1-1), two years after the business cycle trough and uncommonly late, while by the end of 1968 the business expansion had lasted nearly six years, the longest on record. On the previous interpretation, the supply of loanable funds in the early 1960's kept pace with the demand for funds and prevented financial restraint from impeding investment undertakings until 1963, and even then the restraint did not become strong, judging by the rate of rise in interest rates, until the second half of 1965.

The results suggest that interest-rate effects on business are not simply added to other factors but interact with them. If the upturn in interest rates is delayed so many months, the business expansion is not prolonged, on the average, by an equal number of months, but only by a fraction of the time. This makes interest-rate turns a less than ideal predictor of cycle duration; indeed, the predictive power of the relationship was found to be very small, except that business phases are unlikely to end while interest rates continue a cyclical movement in the opposite direction. Turning points in interest rates contain only a minimal amount of information about financial developments, and are often difficult to pinpoint even well after they have occurred. Consequently, interest rates cannot be seriously proposed as more than of marginal value for short-term forecasting.

The findings also require qualification for other reasons. Turning points in interest rates are sometimes ambiguous even by hindsight and may involve considerable error. Attempts to extend the analysis to the amplitude of movements in interest rates were not entirely successful, though in theory the amplitude as well as the direction of movements should be important. Finally, the regression for bond yields shifted after 1914, the explanation and relevance of which is not entirely clear. Despite these qualifications, the findings have value in lending concrete statistical support to other studies which point to financial influences in the business cycle. A similar relationship between turning points and the duration of reference phases also holds true for the monetary growth rate (inverted), which represents an autonomous source of fluctuations in the supply of loanable funds. Although indirect, the evidence suggests that monetary and other financial factors produce cyclical variations in bond yields which have important effects on business activity.