Volume Title: Statistical Indicators of Cyclical Revivals and Recessions

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business cycles. Eight of our 21, indeed, had an 'extra' contraction in 1933-35, as the chart reveals.

At the 1938 revival the turning points are fairly closely bunched a few months in advance of the reference trough; the leads are less numerous at the 1937 peak, but that is what one would expect from the averages. The sequences that might be inferred from the average timing at preceding peaks or troughs were, however, only roughly followed at the 1937 peak and the 1938 trough, and the fallibility of single series as indicators is evident. As will be shown more fully below, at every cyclical turn some of the series that typically lead are likely to lag. Moreover, while on the whole the series confirm one another in indicating a recession about May 1937 and a revival about June 1938, the chart exhibits many little puzzles that would have plagued, and no doubt did plague, contemporary observers of month by month developments.

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Varieties of Cyclical Behavior and Their Consensus

Chart 1 and Table 2 demonstrate, in some degree, the varieties of cyclical behavior to be found in economic processes. The 21 series differ in their amplitude of cyclical fluctuation, in their smoothness or freedom from erratic movements, in the general pattern of their movement during 1932-39, in the timing of their fluctuations relative to business cycles. The problem of selecting statistical indicators of business cycles is essentially to systematize this variety, so that it may be put to use.

The variety that actually exists in statistical records far exceeds that exhibited in the table and chart. A more extensive view will be provided by the materials presented in subsequent sections of this report.[3] Meanwhile it may be helpful to examine a small sample of series selected for the diversity of their behavior. Chart 2 shows 'reference cycle patterns' of 7 monthly series during 5 successive business cycles, 1919-38, together with their average patterns for this period. Two of the 7, residential building contracts and the industrial production index, are from the 21 indicators of Chart 1; the rest are different.

[3] A still more comprehensive analysis of varieties of cyclical behavior will be presented in Wesley C. Mitchell's forth-coming volume, *What Happens during Business Cycles.*

Since we shall have occasion later to use measures based upon reference cycle patterns, an understanding of how they are computed is essential. First, the monthly seasonally adjusted series is divided into so-called reference cycle segments—the intervals between successive reference troughs. Next we compute the average standing of the series during each segment, and express the monthly figures as percentages of this base. These percentages are called 'reference cycle relatives'. This step reduces the original data for every series to a common unit, so that series expressed in diverse units may be compared. The third step is to compute a 9-point pattern for each reference cycle segment by breaking the segment into 9 stages and computing the average of the relatives for each stage. Stage I covers the three months centered on the initial trough, stage V the three months centered on the peak, and stage IX the three months centered on the terminal trough. Stages II, III, and IV cover successive thirds of the length of the expansion, and stages VI, VII, and VIII successive thirds of the contraction. By averaging the reference cycle relatives for the months included in each stage we get the reference cycle patterns plotted in Chart 2.[4] Finally, the 9-point patterns for a series may be averaged over as many cycles as the series covers, or any subset. The averages in Chart 2 are confined to the five cycles of 1919-38, though some series cover earlier cycles.

Let us examine first these average patterns. The pattern for residential building contracts declines before the expansion in general business activity ends and rises in the later stages of the general contraction. The index of industrial production moves roughly synchronously with the ebb and flow of general business. Deliveries of railroad locomotives fluctuate widely and lag at both peaks and troughs. Failures of manufacturing enterprises, measured by their liabilities, decline as prosperity advances and rise in depression, but tend to lead. Their average pattern is almost an inverted replica of that of residential building contracts. Stocks of refined copper also are 'inverted', declining steadily as business expands and rising when it contracts, neither leading nor lagging perceptibly. Bond sales in the financial markets begin to

[4] The effect of this process may be visualized by comparing the patterns in Chart 2 for residential building contracts and the industrial production index, 1933-38, with the corresponding monthly data for these series in Chart 1. The reference patterns and conformity measures used in this report are based on reference dates as they stood *before* the revisions noted in Table 1; but the measures of timing of specific cycles are based on the revised dates.

Chart 2

Reference Cycle Patterns of Seven Series, 1919 - 1938

1 Residential Building Contracts, Floor Space
2 Industrial Production Index, FRB
3 Railroad Locomotive Shipments
4 Business Failures, Liabilities, Manufacturing Companies
5 Refined Copper Stocks
6 Bond Sales, New York Stock Exchange
7 Agricultural Marketings Index

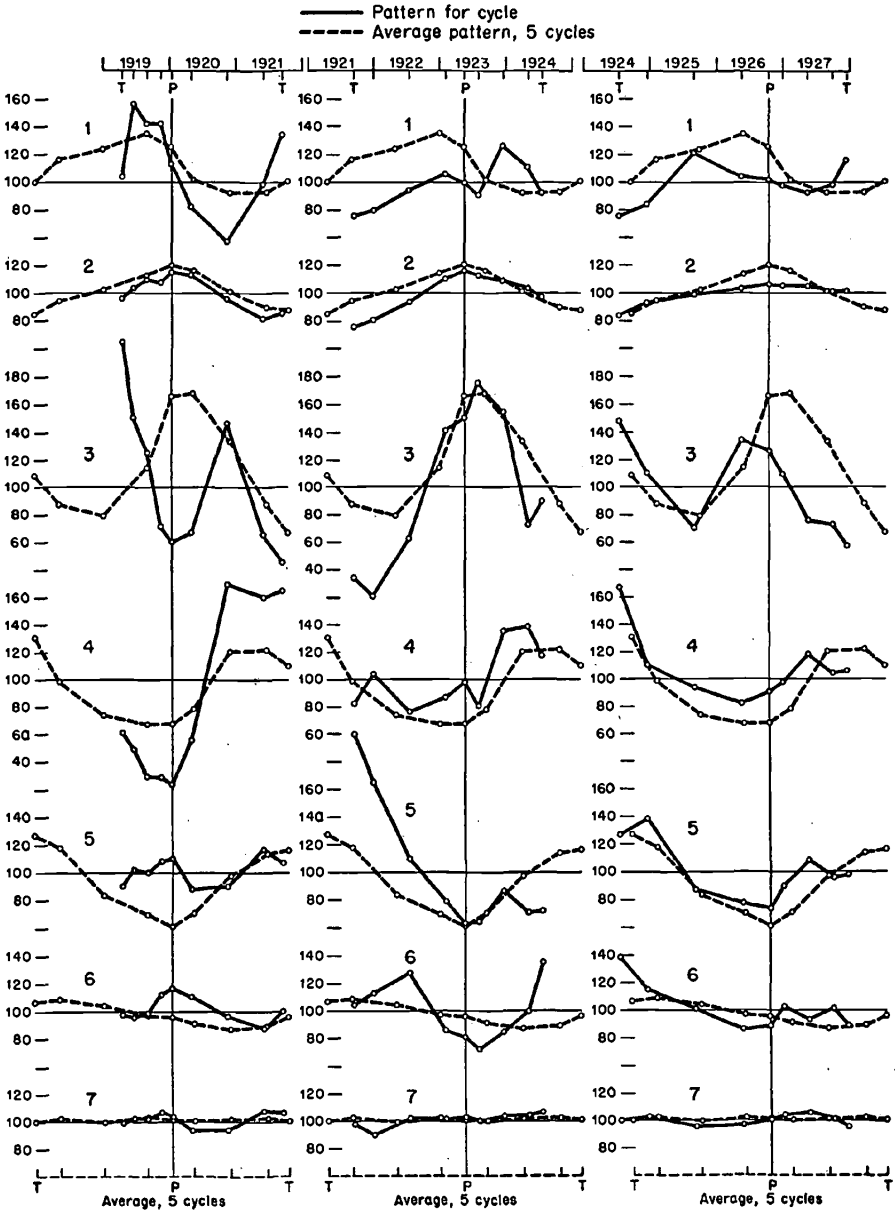
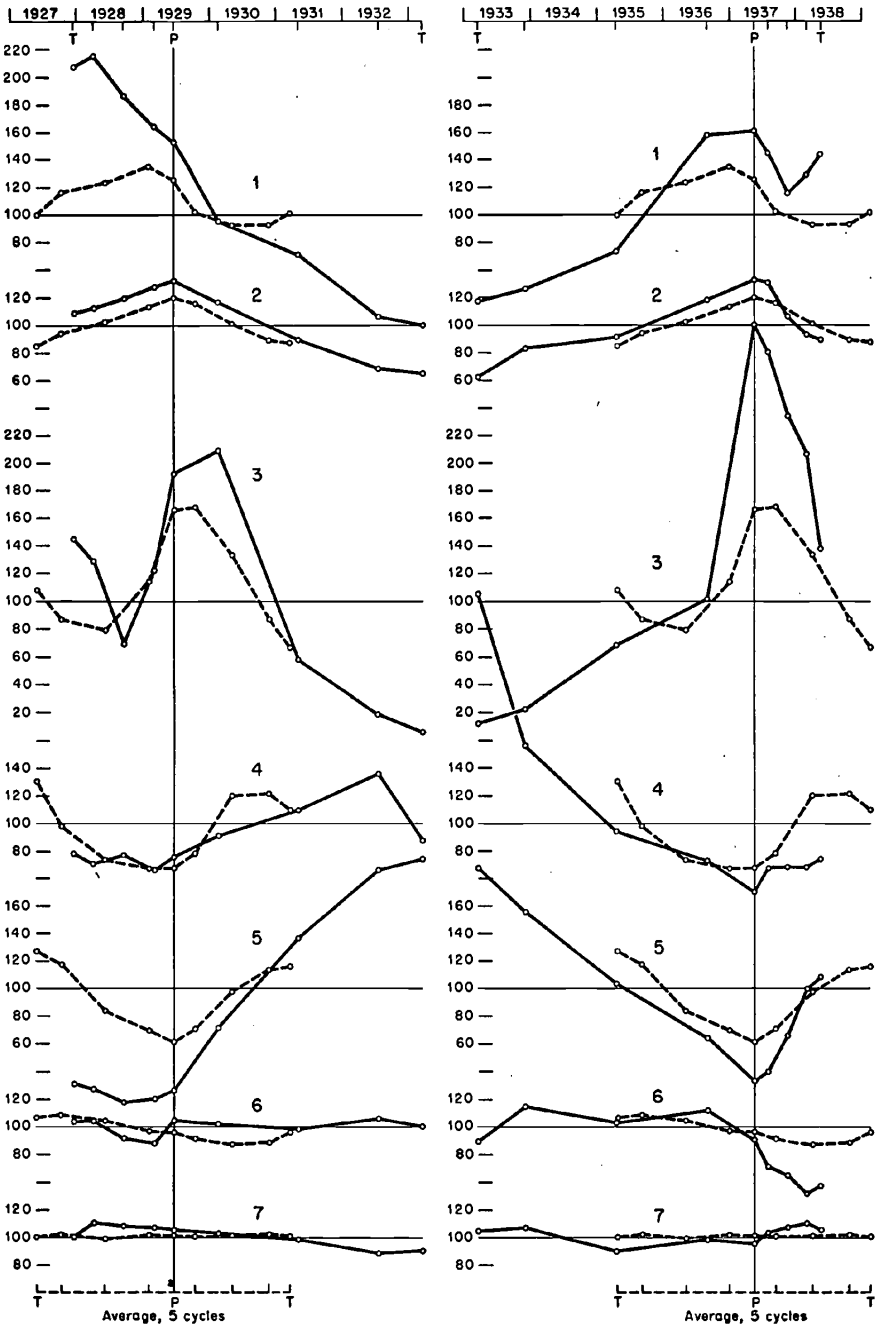


Chart 2 (concl.)



decline early in expansion and continue to decline until the business contraction is well advanced, when they begin to rise. Their timing is but one step removed from that of residential building contracts. The average pattern for marketings of agricultural products deviates little from a horizontal line.

Now if the average patterns were strictly representative of the individual cycle patterns, the variety of behavior depicted would be considerable. But clearly they understate the variety that actually exists. The set of patterns for each individual cycle differs from the average set in countless ways. Sometimes, as in 1919-20, the expansion is much shorter than average; sometimes, as in 1933-37, much longer. In the 1926-27 contraction the movements of most series were smaller than their average movement in contractions; in the 1937-38 contraction most of the movements were larger than average. In four contractions the upturn in residential building contracts preceded that in the index of industrial production, as it did on the average; but this did not happen in the 1929-33 contraction.

The averages are far more representative for some series than for others. There is so little repetition in the behavior of the index of agricultural marketings in successive business cycles that the fluctuations largely cancel themselves out in the average; hence the latter approximates a straight line. At the opposite extreme is the index of industrial production, which matches almost perfectly the successive phases marked out by the reference dates. The behavior of the other series is moderately consistent in successive cycles; but the distinctive timing of their average patterns is not repeated in every cycle.

Chart 2 makes it plain that no two business cycles are exactly alike—amplitudes, durations, and timing sequences differ. Cycle forecasting is not simple. However, the sample of series in this chart is too small to represent well what happens during business cycles. Timing sequences there are, and they are a vital feature of every business cycle. But there is also a consensus: ". . . a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle. . . ."[5] What Chart 2 fails to demonstrate is that most economic activities, on any reasonable definition, expand and contract roughly in unison.

[5] *Measuring Business Cycles,* p. 3.

This consensus can be demonstrated in various ways. One can examine the reference cycle patterns of various series of broad scope, such as production indexes, total employment, national income, bank debits, retail sales, railway traffic, price indexes. Or one can summate, in one way or another, the reference cycle patterns of the 800 odd individual monthly or quarterly series we have analyzed for the United States. The use of reference cycle patterns, of course, presupposes that the reference dates are at least roughly accurate; if no consensus were revealed, it might be due to inaccuracy in the dates. On the other hand, one can examine the concentration in time of specific cycle turning dates, either in the broad aggregates or in the mass of lesser series. These are determined independently of the reference dates and independently in the different series.[6]

We need not pursue this matter far, for it is treated at length, especially by use of reference cycle materials, in Mitchell's *What Happens during Business Cycles* (see note 3). Besides, here we are primarily interested in timing sequences. However, one product of this study is a chronology of specific cycle peaks and troughs in a large number of series, and this chronology is worth examining for the light it throws not only on the consensus of cyclical behavior but also on the nature of revivals and recessions.

From our full collection of more than 800 series we selected, by a process described in Sections 4 and 5, the 404 series whose fluctuations conformed most consistently to business cycles over the period each series covers, after allowance for systematic differences in timing. The number reaching a peak or a trough in a given month, taken as a percentage of the total number of series available in that month, is recorded in Chart 3.[7] The number available does not remain the same over the whole period, as the accompanying figures taken in January at ten year inter-

	1890	*1900*	*1910*	*1920*	*1930*	*1940*
No. of series	83	140	175	326	356	330

vals show. New series are incorporated whenever they begin (or rather, in order to simplify the procedure, they are treated as if they began one month before their initial specific cycle turning point), and some drop out, so that the total included at any one

[6] Exceptions in both respects are occasionally made; see ibid., pp. 58 and 138-9.

[7] In series that are considered to be inverted in relation to business cycles, troughs are counted as peaks and vice versa; see note 9.

Chart 3

Percentage of Series Reaching Specific Cycle Peaks and Troughs and Percentage Expanding
All Series with 'Acceptable' Conformity

(solid vertical lines indicate reference troughs; broken vertical lines, reference peaks)

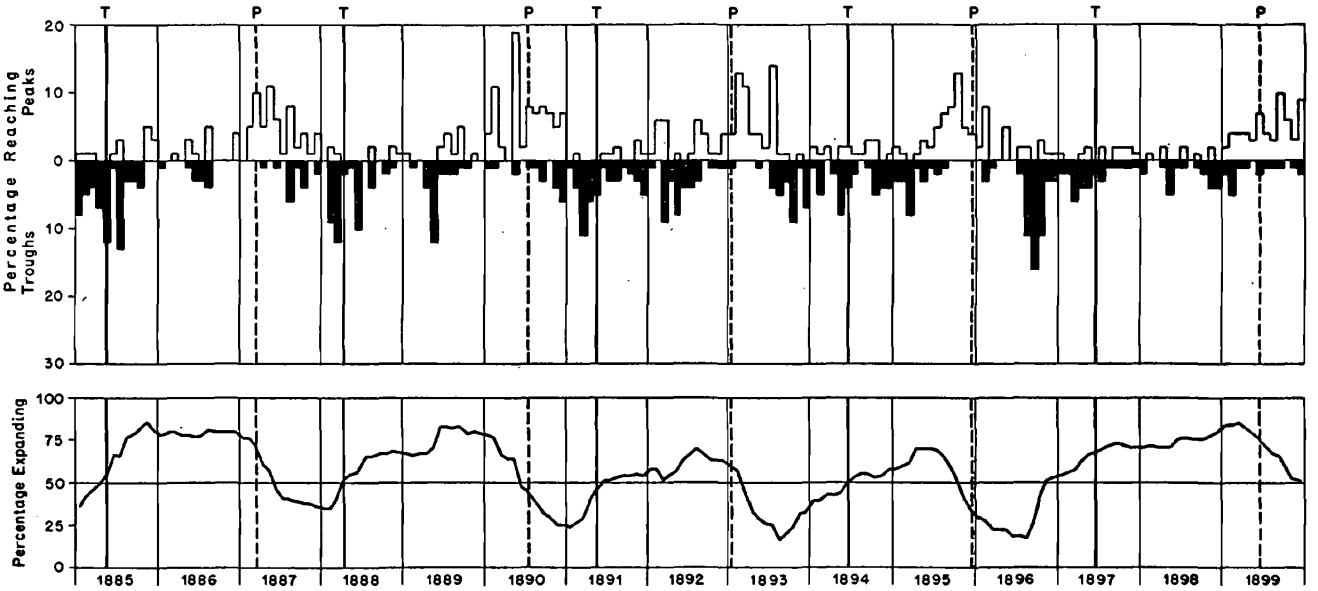


Chart 3(cont.)

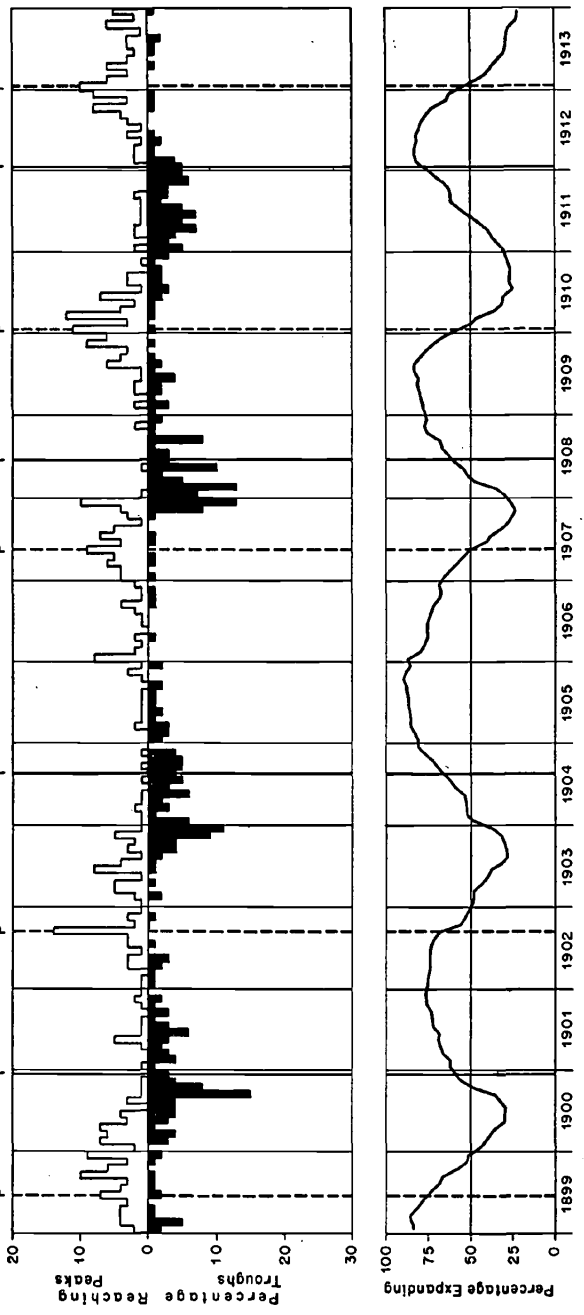

Percentage Reaching
Troughs
Peaks
20
10
0
10
20
30
P
T
P
T
P
T
P
T
P
Percentage Expanding
100
75
50
25
0
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913

Chart 3 (cont.)

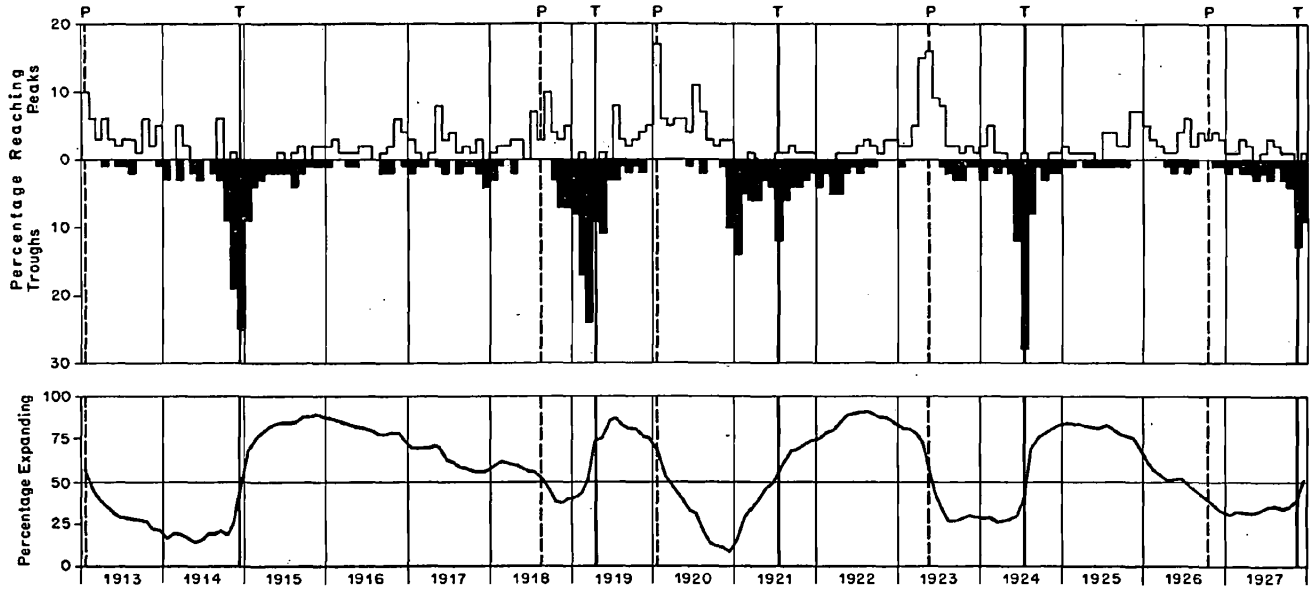
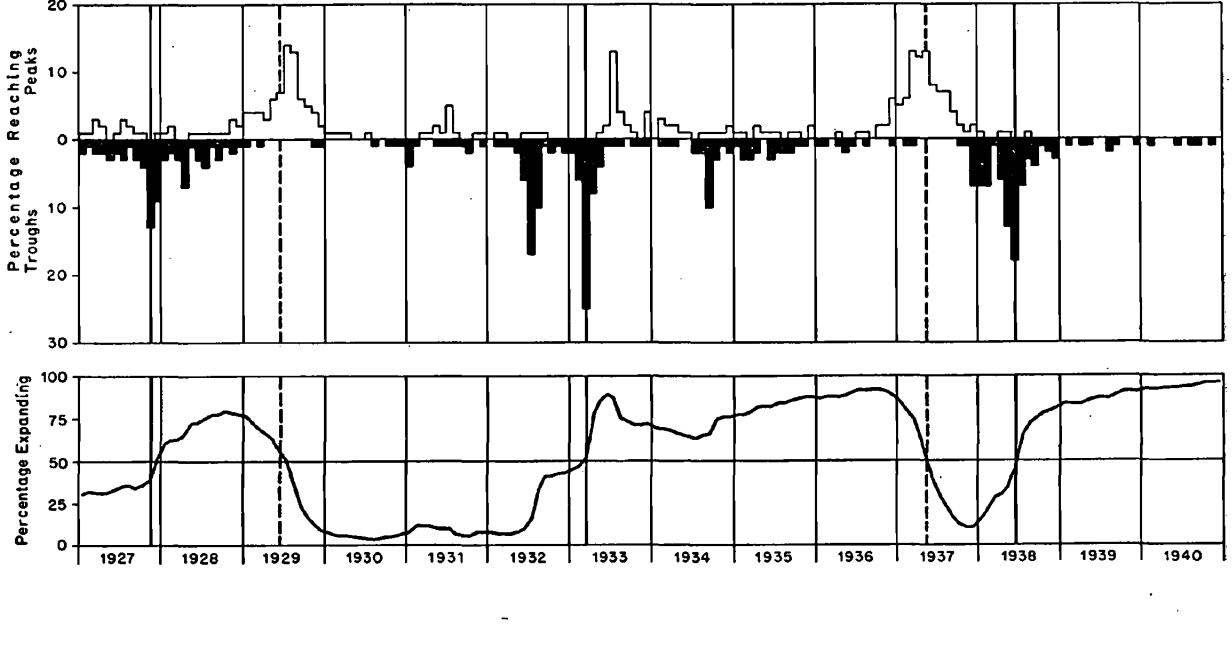

P
T
P
T
P
T
P
T
P
T
20
10
0
10
20
30
Percentage Reaching Peaks
Troughs
100
75
50
25
0
Percentage Expanding
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927

Chart 3(concl.)



time never reaches 404. Since the number of series available is much smaller in earlier years, we begin the chart in 1885, though it could be extended back to 1854.

The sample, therefore, varies in size and content. Also it is biased by the way it was selected. Nevertheless it covers a large proportion of our full collection and a broad array of economic processes (see Sec. 5). The inclusion of similar information for the other 400 odd series would only reduce, not eliminate, the relative concentration of peaks and troughs around particular dates that appears in Chart 3.

It is illuminating to record the data also in terms of the percentage of series undergoing specific cycle expansion in each month. If in a given month 20 out of 100 series are contracting, including, say, 10 series that reach troughs in that month, while 80 are expanding, including 20 that reach peaks, then the number expanding the next month will be $80 + 10 - 20 = 70$. The number expanding in each succeeding month can be determined simply by adding the difference between the number reaching troughs and the number reaching peaks each month. The wave-like line in Chart 3 shows the result of this operation, when changes in the number of series available are allowed for by reducing the figures to percentages of that number.

Whereas the white and black bars in the chart reveal the concentrations of specific peaks in the vicinity of reference peaks, and of specific troughs in the vicinity of reference troughs, the continuous curve shows that the proportion of series expanding has invariably reached its highest point some time before the reference peak and its lowest point some time before the reference trough. The curve is, as stated above, mathematically related to the turning point distribution; but what they both show is not a mere piece of statistical arithmetic. The percentage of series expanding begins to decline when the percentage of series reaching peaks begins to exceed the percentage reaching troughs, and continues to decline until the percentage reaching troughs exceeds that reaching peaks. Its cyclical course has been fairly continuous because the first condition (peaks more prevalent than troughs) has persisted for a fairly long interval, and has gradually given way to a period in which the second condition is dominant, and so on.

Thus Chart 3 demonstrates a consensus: "expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals

which merge into the expansion phase of the next cycle." The reference dates identify these general cycles with tolerable accuracy. No additional cycles of similar generality seem to appear, nor could any that are identified as reference cycles have well been omitted.[8]

But from Chart 3 we can draw a more complete picture of a business cycle. To be specific, let us trace the developments in 1921-24, a fairly typical cycle. The reference trough, July 1921, is roughly in the center of a period in which many series reached troughs, few reached peaks. Troughs apparently associated with this zone began to appear as early as June 1920, even while other series were reaching peaks apparently associated with the preceding peak zone. By July 1921 the percentage of series expanding had already been rising for seven months, and had reached approximately 50. It continued to grow until July 1922, when it was 90 percent. By this time most of the series had already reached troughs, and a few peaks were beginning to appear. A concentration of peaks occurred in the first half of 1923, neatly grouped around the May reference peak. The percentage of series expanding had by then receded from 90 to 60, while the percentage contracting had grown, of course, from 10 to 40. The contraction continued to spread until the autumn of 1923, when the percentage contracting reached 75, where it remained until the middle of 1924. During that interval approximately as many series were reaching troughs as were reaching peaks. In July 1924, the reference trough, nearly 30 percent of the sample reached troughs, and the percentage expanding shot up rapidly. While the concentration of troughs in June, July, and August 1924 was much denser than in the corresponding months of 1921, the zone of troughs apparently associated with the 1924 revival extended from the middle of 1923 until late in 1925. By that time the next expansion was well under way.

[8] In 1933-35 there is some concentration of peaks and troughs, but the percentage of series expanding never falls below 63, whereas in every other reference contraction it falls well below 50. See the discussion of this period in *Measuring Business Cycles*, pp. 87-90, and the analysis of the dependability of the reference dates, ibid., pp. 94-114. Although in Chart 3 reference dates often coincide with the month of highest concentration of peaks or troughs, this does not necessarily indicate their accuracy, or their failure to do so their inaccuracy. For one thing, Chart 3 does not take into account differences in the economic significance of the series; for another, it does not allow for differences in their typical behavior during business cycles. These considerations and others underlie the concept and procedures used in selecting reference dates (cf. ibid., pp. 71-81.)

Thus even the series in this sample, selected for the regularity with which they conform to business cycles, show wide differences in the timing of their cyclical fluctuations. The percentage of series expanding rarely exceeded 80 or fell below 20 in any month between 1885 and 1940. The zones in which the peaks (or troughs) concentrate extend over a year or two or three, and the peak zones often overlap the trough zones. In the words of Mitchell and Burns (*Bulletin 69,* p. 2), a business cycle revival or recession "is not an event that happens in a single month, but a complicated series of changes that occur cumulatively in various economic processes during a period that may last a year or more". This very fact spells some hope for the user of statistical indicators.

4

Criteria for Selecting Indicators

Bulletin 69 described an ideal statistical indicator of cyclical revivals and recessions in the following terms:

1) It would cover half a century or longer, thus showing its relation to business cycles under a variety of conditions.
2) It would lead the month around which cyclical revival centers by an invariable interval—say three months, or better, six months. It would also lead the central month of every cyclical recession by an invariable interval, which might differ from the lead at revival.
3) It would show no erratic movements; that is, it would sweep smoothly up from each cyclical trough to the next cyclical peak and then sweep smoothly down to the next trough, so that every change in its direction would herald the coming of a revival or recession in general business.
4) Its cyclical movements would be pronounced enough to be readily recognized, and give some indication of the relative amplitude of the coming change.
5) It would be so related to general business activity as to establish as much confidence as the nature of such things allows that its future behavior in regard to business cycles will be like its past behavior.

As is, of course, obvious from Table 2 and Chart 1, no series possessing all these characteristics was found. Nor have we had