Step cycles

The second approach does not deal with the indicators themselves, but with their growth rates. This has the advantage of focusing on that aspect of economic change which today attracts the greatest interest. The problem with this approach is that growth rates cannot, for our purpose, be analyzed in the same fashion as the original series. For one thing, their timing is different. Growth tends to be most rapid when it starts from a low base, i.e., shortly after the end of a period of slowdown or decline. Conversely, rates tend to be lowest shortly after the termination of a rapid-growth period.

Ample evidence can be found for this growth rate pattern. For instance, the rate of increase of U.S. gross national product in constant dollars was 60 per cent higher, on the average, in the first halves of the seven expansions (1921-38, 1949-61) than in their second halves. The rate of fall in the corresponding seven contractions was twice as large in the earlier part than in the later one.

Furthermore, the average monthly rate of change of thirty-four comprehensive American series before 1938 was more than twice as high between business cycle troughs and the first third of expansions than in later expansion stages. The average rate of decline was largest in the first half of contractions.[23]

Thus, if cycle phases were defined by growth rate peaks and troughs, they would tend to lead business cycles by one half to nearly one full phase. Expansions, for instance, would usually include only the beginning of a high-growth period, while most of this period would be included in the contraction phase. Since this would run counter to generally accepted ideas on business cycles, peaks and troughs in growth rates cannot serve to delimit cycle phases. Instead, the downturn must be defined as the end of a period of relatively high growth and the upturn as the end of a period of relatively low growth. In terms of growth rates, business cycles thus are defined as alternations of high and low rates, rather than as alternations of rising and falling rates. Growth rates are classified as high or low by comparisons of rates in three tentative successive cycle phases. The average rate during a high step must exceed the average rates during the preceding and succeeding low

[23] See Wesley C. Mitchell, *What Happens During Business Cycles*, New York, NBER, 1951, p. 299. For similar results regarding the rate of change of the money supply, see Phillip Cagan, *Determinants and Effects of Changes in the Stock of Money, 1875-1960*, New York, NBER, 1965, p. 271.

steps. The main difference between the two methods thus is in the definition of the average growth rate which serves as standard for distinguishing high and low rates. In deviation cycles the average rate is given by the long-run trend, in step cycles it is given by three successive cycle phases. If these three phases were seventy-five months long, i.e., if step cycles averaged fifty months in duration, the average rates of change obtained with the two methods should be similar since the long-run trend in deviation cycles is measured by a seventy-five-month moving average.

Step cycles were first analyzed by Milton Friedman and Anna Schwartz in their work on money. The timing of these cycles, they found, is in most instances the same as that of the trend adjusted series proper. The method we use is essentially a computerized version of their method.[24]

Analysis of rates of change also presents another problem, especially in monthly series. Month-to-month percentage changes are often highly jagged series with a sawtooth appearance and, at first glance, reveal neither cycles nor cyclical turns. The rate of change of industrial production in Chart A-13 is a good illustration.[25] To deal with this problem, we first find the approximate dates when a period of high growth ended and low growth began, and vice versa, on a chart showing the twelve-month moving average of the rates of change. It is noteworthy how clearly the underlying cyclical movements stand out in the smoothed rates of change on curve 4 in Charts A-1 to A-21 even for rates as choppy as those for industrial production (Chart A-13) and job vacancies (Chart A-4). Selecting the zone where a step turn occurred is thus not difficult in most instances. The exact month of the step turn is then tentatively identified by inspection of the chart of the unsmoothed rates.

At this point the computer program takes over. Each tentative cycle, i.e., each period between two like tentative step turns is broken into two parts at every intervening month. For each of these possible breaking points the variance between the average rates of change in the two parts (the step means) is computed. The breaking point that yields the largest variance is selected as the turning point. For instance, if a tentative cycle had a duration of twenty-four months, the program would test the variance between the mean rates of change for partitions into six and eighteen months, seven and seventeen months, eight and sixteen months, etc.

One reason for maximizing the variance rather than the simple difference between the step means is that the latter neglects the influence of

[24]The main difference between the Friedman and Schwartz method and ours is that Friedman and Schwartz used computations only in doubtful cases and otherwise decided by inspection, while we rely on computations in all instances.

[25]One reason is that independent errors of measurement in the original series introduce a negative serial correlation into rates of change.

the step length. Doubtful months would be assigned to the longer step, because this would increase the difference between step means even if the series' standing in the month in question were much closer to the average rate of the short step than to that of the long step.

If the computed turning point differs from the tentatively selected one, every analysis which used the latter must be repeated with the former. This procedure is continued until each upturn has been confirmed as the correct partition between the adjacent downturns and each downturn as the correct partition between the adjacent upturns. Each turn thus has to be confirmed by three computations. It must be valid (1) as the end of one cycle; (2) as the beginning of the next cycle and (3) as the correct partition between two adjacent turns of the opposite type.[26]

All the step turns in the twenty-one indicators have been confirmed in this manner. In the case of some quarterly indicators all tentative turns were validated at the first trial. For some very erratic series, on the other hand, up to fifty periods had to be partitioned before some five or six steps meeting the requirements could be identified.

It should be noted that this objective validation procedure eliminates most of the subjective element which adheres to the initial selection of the tentative turns. In some difficult cases a decision must be made whether to treat a given period as part of a step phase or as a separate step cycle. The computer program cannot handle this. In such rare instances, subjective judgment must be used.

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[26]To illustrate: assume that December 1955 and January 1961 have been tentatively selected as dates of downturns in German industrial production. The computer program then divides the tentative cycle into two phases, the first one of low growth and the second one of high growth, at each intervening month. For each partition the variance is computed. Assume it is found that partition in April 1959 yields the largest variance between the two steps. (Partitions at points less than six months from the tentative turns are excluded by requiring a six-month minimum phase duration.)

Next, the computer-determined upturn in April 1959 is used together with the next tentative upturn in February 1963 in order to check whether the downturn in January 1961 (used previously for the selection of the upturn of April 1959), is the correct partition between April 1959 and February 1963. If the downturn in January 1961 is confirmed, we proceed to the checking of the following turn. If the downturn in January 1961 is rejected, however, and replaced by, say, March 1961, the first analysis must be repeated with the new date. This means that the period from December 1955 to March 1961 will be partitioned in the manner described above. This either may confirm the previously found upturn in April 1959 or may result in a different date. In the latter case the 1959 to 1963 analysis has to be repeated with the new date. And so on.

The first turns at either end of a series, obviously, cannot be confirmed in this fashion. All that can be done in order to identify the best possible turns at the ends is to experiment with several alternative dates. For each such date the maximum variance between the two following, or the two preceding, steps is computed. The alternative turn that yields the highest maximum variance is the one chosen.

TABLE 1

Comparison of Turning Points in Deviation Cycles (DC) and Step Cycles (SC), Twenty-One German Indicators, 1953-67 (number of turning points)

Indicator	Turns Covered		Matching Turns in DC and SC			
			Total	Coincide Exactly	Differ by Months	
	DC	SC			1-3	4 and over
1. No. employed, mfg.	6	6	6	3	1	2
2. Man-hours, mfg.	7	7	7	4	0	3
3. No. unemployed, (inverted)	7	8	7	0	2	5
4. Job vacancies	7	8	7	4	1	2
5. GNP, current DM	7	9	7	6	0	1
6. GNP, 1954 DM	7	7	7	4	0	3
7. Investment, equipment, 1954 DM	7	7	7	5	1	1
8. Investment, constr., 1954 DM	8	10	7	7	0	0
9. Inventory changes, 1954 DM	7	9	7	7	0	0

(continued)

TABLE 1 (continued)

Indicator	Turns Covered DC	Turns Covered SC	Matching Turns in DC and SC: Total	Coincide Exactly	Differ by Months 1-3	Differ by Months 4 and over
10. Employee income	6	6	6	5	0	1
11. Disposable income	9	9	9	6	1	2
12. Property and entrepreneurs' income	7	7	6	5	0	1
13. Indus. prod., total	7	7	7	4	2	1
14. Indus. prod., investment goods	7	7	7	4	0	3
15. Wages and salaries, mfg.	6	9	6	4	0	2
16. Sales, domestic, mfg.	7	9	7	6	1	0
17. Producers' prices, indus. prod.	6	7	6	4	0	2
18. Stock prices, industry	7	7	7	4	0	3
19. Short-term lending changes	8	10	7	6	0	1
20. Imports, raw materials, indus.	7	7	7	5	0	2
21. Imports of semimfgs., indus.	7	7	7	4	1	2
Total, all indicators	147	163	144	96	10	38

NOTE: Pre-1953 turns are omitted from this table. Series numbers 5 through 12 are quarterly, other series are monthly. Step cycles are cycles in growth rates, deviation cycles are cycles in percentage deviations from trends.

Step Cycles

The steps are indicated in Charts A-1 to A-21, by horizontal lines drawn at the average level of the step. On the whole, the timing of the step cycles agrees well with that of the deviation cycles. This is shown for individual indicators in the aforementioned charts, and by a summary count for all indicators in Table 1.

The table shows that 96 out of 147 turns in deviation cycles coincide exactly with the corresponding step cycle turns. Another forty-eight turns can be classified as matching although there are intervals of one month to two years between them. Conversely, only 3 turns in deviation cycles and 19 out of 163 turns in step cycles are not matched by similar turns in the other type of cycle.

This correspondence is impressive when one considers the difference in methods used, the large erratic component of the movements analyzed and the numerous borderline cases. Most divergent turns are matters of double peaks or double troughs, with different selections made by the two types of analysis. The downturns in job vacancies, 1955-56 (Chart A-4) are an example. The deviation cycle analysis picks the later of two downturns (April 1956), the step cycle analysis the earlier (August 1955).

Another example is the 1965 downturn in industrial production. In this case it is the deviation cycle which gives the earlier and the step cycle which gives the later turn.

Clearly, agreement between the step and deviation turns is much better at certain dates than at others for most indicators. There are strong turns and weak turns, as will be brought out further in the discussion of the reference cycles. The greatest uncertainty surrounds the turns at either end of the period covered. The deviation cycles are here based on extrapolated trends which may differ widely from actual ones. Similarly the growth rate step averages cannot be compared to preceding nor to following ones. Hence turns close to the beginning or end of the series should be considered highly tentative.

We shall see below that the discrepancies which do occur between the two types of cycles in individual indicators are largely eliminated when the indicators are combined into business cycles.