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CHAPTER 19

An Amplitude Adjustment for the Leading Indicators

Geoffrey H. Moore

One of the uses to which diffusion indexes can be put is to show the general consensus of movement of a group of economic series that are incommensurate—for example, the eight leading indicators. This is done by counting directions of change and ignoring magnitudes of change, except insofar as magnitude is taken into account by smoothing or other devices that determine what magnitudes of change are to be counted. Once the smoothing device or criterion is settled upon, all movements within a series and among series are counted alike. One effect of this is to produce a kind of amplitude correction. The movements of series that typically move in large swings count for no more in the diffusion index than those of series with small cyclical amplitudes. For some purposes, at least, this can be considered an advantage. On the other hand, *within* a given series large cyclical movements occurring at one time are also counted the same as small movements occurring at another time, and this may well be a disadvantage.

An experiment with a method of adjusting the average cyclical amplitudes of different series to a common level and converting the adjusted series to index numbers so that they could be combined was conducted for the eight leading series.[1] The measure of average cyclical amplitude ($\bar{C}$) was the average percentage change per month without regard to sign in the fifteen-month weighted moving average (Spencer graduation) of each series, 1947–57, as obtained in the electronic computer program described by Shiskin.[2] Each of the series was adjusted so that its relative cyclical amplitude was equal to that of the FRB industrial production index, by the formula

$$\log s' = \log s \left[\frac{\log (1 + \bar{C}_p)}{\log (1 + \bar{C}_s)}\right]$$

where s' = amplitude-adjusted series;

s = original series (adjusted for seasonal variation, if any);

Note: The method is described in "Forecasting Industrial Production—A Comment," by Geoffrey H. Moore, *Journal of Political Economy*, February 1958. The formula given in that article (p. 78) is in error; the correct formula is given here.

[1] For other experiments with amplitude adjustment, see Chapters 4 and 18. The methods are basically similar to that used by Edwin Frickey in *Economic Fluctuations in the United States*, Cambridge, Mass., 1942, pp. 91–100.

[2] See Chapter 17.

$\bar{C}_s$ = average cyclical amplitude of series s (average percentage change per month, 1947–mid-1957, in ratio form—e.g. .0309, not 3.09%);

$\bar{C}_p$ = average cyclical amplitude of industrial production index;

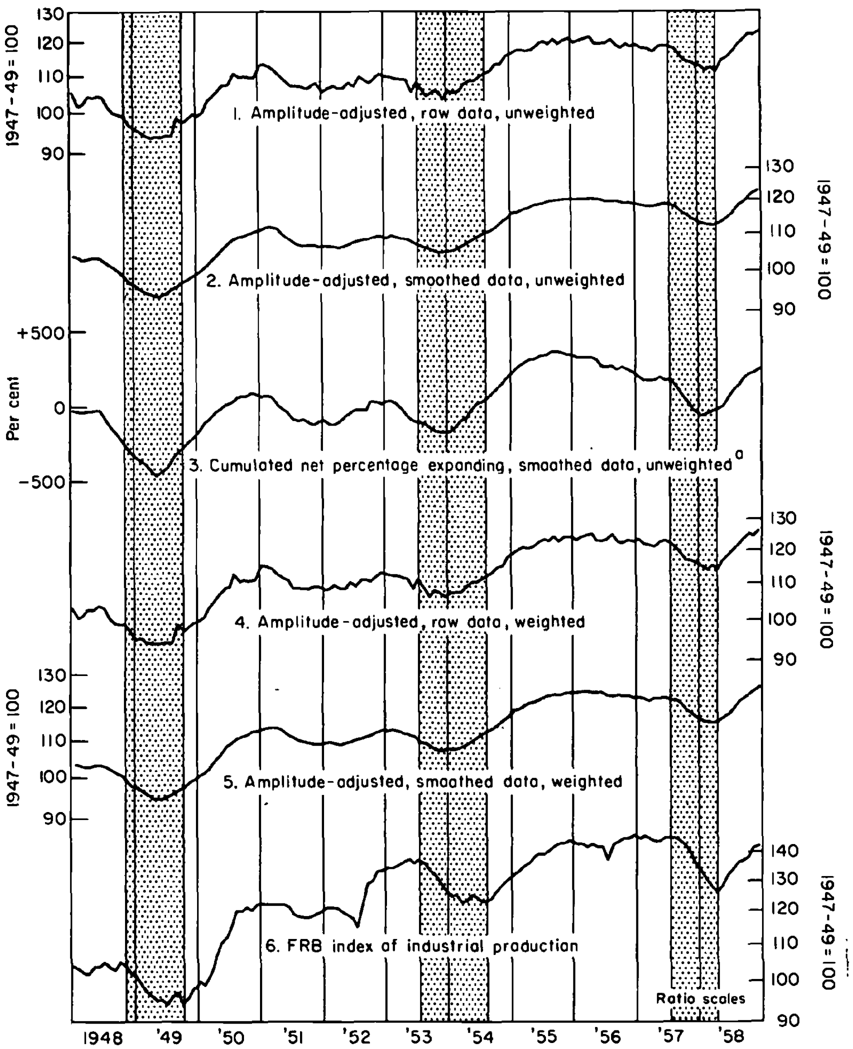
The adjusted series were converted to relatives on the base of their 1947–49 average (for business failures, which move inversely to the other series, the reciprocals of the relatives were used), and averaged together to form an index number. The procedure is illustrated in Table 19.2 in the appendix.

The operations were performed on both the raw (seasonally adjusted) series and the smoothed series (using the same moving-average periods that we have used in the diffusion index since 1950—see Chapter 3, Table 3.3). The series were combined with equal weights and also with weights that roughly take account of factors considered important in utilizing the series as indicators of the movements of the FRB index—i.e. the past record of the series in relation to the FRB index, the directness of its economic relationship to the process of production of manufactured goods and minerals, whether it is expressed in dollars or physical units, and the statistical accuracy or coverage of the series. On these grounds considerable weight was given to the average workweek (20 per cent) and new orders for durable goods (17.5 per cent), intermediate weights to stock prices (15 per cent) and the two building contract floor space series (12.5 per cent each), and smaller weights to new incorporations, business failures, and commodity prices (7.5 per cent each). The differences among the weights are not extreme, the largest being not quite three times the smallest, and this no doubt accounts in part for the relatively small difference between the weighted and the unweighted index (see below). It should be noted, of course, that in relation to measures of business activity other than the FRB index, such as gross national product, the weights might well be different.

The results for each series are shown in Chart 3.3, Chapter 3; and the several indexes, together with the industrial production index, are shown in Chart 19.1 below. As a graphic device, the method permits the plotting of each series on the same semilog scale, which otherwise is difficult to accomplish satisfactorily when series have such widely different relative amplitudes as, say, new orders and the average workweek. By inserting the appropriate value of $\bar{C}_p$ in the formula given above, one can adjust the series to any amplitude desired, such as that of employment, gross national product, a stock price index, or even the sales of an individual company. Or these series themselves might be adjusted. For some purposes (for example, in an electronic computer time series program), the series might be adjusted to a standard amplitude. A cyclical amplitude of, say, 1 per cent per month might be selected as the standard ($\bar{C}$ for the FRB

CHART 19.1

Indexes of Leading Series and Industrial Production, 1948–58



Arithmetic scale.

Shaded areas represent business contractions; unshaded areas, expansions.

TABLE 19.1

Cyclical Timing and Amplitude of Index of Leading Indicators and Index of Industrial Production, 1948–58

Specific Cycle	Index of Leading Indicators, Unsmoothed	Index of Industrial Production	Lead (−) or Lag (+) (months)	*Percentage Change per Month, from Preceding Peak or Trough* Index of Leading Indicators, Unsmoothed	Index of Industrial Production
Peak	Nov. 1947	Oct. 1948	−11		
Trough	Jun. 1949	Oct. 1949	−4	−0.8	−0.9
Recovery[a]	May 1950	Apr. 1950	+1		
Peak	Feb. 1951	May 1951[b]	−3	+1.1	+1.6
Trough	Jan. 1952	July 1952[b]	−6	−0.6	−0.4
Recovery[a]	...	Aug. 1952	...		
Peak	Dec. 1952	July 1953	−7	+0.4	+1.6
Trough	Dec. 1953	Aug. 1954	−8	−0.5	−0.8
Recovery[a]	Aug. 1954	May 1955	−9		
Peak	Apr. 1956	Feb. 1957	−10	+0.6	+0.6
Trough	Apr. 1958	Apr. 1958	0	−0.4	−1.0
Recovery[a]	Oct. 1958	...	...		
Average			−6.1	0.6[c]	0.9[c]

[a] Date when index regained level at preceding specific cycle peak. Excluded from average.

[b] Not a specific cycle contraction, but decline matches the specific cycle contraction in index of leading series.

[c] Weighted average without regard to sign, where the weights are the number of months of rise or fall.

index is 0.71 per cent per month), the seasonally adjusted and perhaps also the smoothed figures for the series would be adjusted to this amplitude, converted to index numbers, and printed out separately. An analogous method has been used by Shiskin in the programs described in Chapters 17 and 18 above. It should be noted that $\bar{C}$ is influenced, and may on occasion be dominated, by secular trend as well as cyclical amplitude. Its representative character for the purpose at hand should, therefore, be carefully examined.

The index based on the raw, equally weighted series (top of Chart 19.1 and Table 19.3 in the appendix) is fairly smooth, though not quite as smooth as the FRB index; has a flatter trend (the 1956 peak was 121 [April] in the leading series index, 146 [February 1957] in the FRB index); undergoes cyclical movements that are similar to but slightly smaller than those in the FRB index; and leads the FRB index by varying intervals in the neighborhood of six months (Table 19.1). Since each of the eight components of the leading series index is adjusted so that its cyclical amplitude is the same, on the average, as that of the production index, the reduced amplitude of the leading series index must be attributable to offsetting movements in the components.[3]

The indexes based on smoothed data (lines 2 and 4 in Chart 19.1) are noticeably smoother than the FRB index. The weighted version has a somewhat steeper trend and hence parallels the FRB index more closely than the unweighted. Both smoothed indexes are very similar in general configuration to the cumulated net percentage expanding (line 3). The most intriguing difference is that the smoothed indexes are smoother than the cumulated diffusion index, despite the fact that in both the amplitude-adjusted indexes and the diffusion index the component series are smoothed by the same moving averages.

Apparently the reason for this is that the amplitude adjustment, which equalizes the average cyclical amplitudes of the series, also tends to reduce the influence on the index of the more erratic series and to increase the influence of the less erratic. Julius Shiskin has pointed out that economic series with large cyclical amplitudes usually have large irregular movements.[4] His results for the eight leading series show this clearly:

	Average Percentage Change per Month,[a] *1947 to Mid-1957, Without Regard to Sign*		
	Cyclical Component[b] ($\bar{C}$)	Irregular Component[c] ($\bar{I}$)	Ratio $\bar{I}/\bar{C}$
8.0 Business failures, liabilities	3.09	15.10	4.89
6.0 Commercial contracts	2.84	12.84	4.52
5.1 Residential contracts	2.59	7.67	2.96
4.0 New orders	1.99	4.60	2.31
12.2 Basic prices	1.26	1.39	1.10
7.1 Incorporations	1.20	4.20	3.50
10.1 Stock prices	1.15	1.42	1.23
1.0 Workweek	0.21	0.33	1.57
15.0 Industrial production	0.71	0.71	1.00

[a] These figures differ slightly from those in Shiskin's paper (Table 17.2) because they are based on analyses that cover a somewhat longer period.

[b] 15-month weighted moving average (Spencer graduation) of seasonally adjusted data.

[c] Ratio of seasonally adjusted data to 15-month weighted moving average.

[3] It would be possible to inflate the amplitude of the index to approximate more closely the production index' amplitude, by applying the same procedure to the index as was applied to its components.

[4] Chapter 17 above. See also Wesley C. Mitchell, *What Happens during Business Cycles*, New York, NBER, 1951, Chapter 8. Since Shiskin's measure of cyclical amplitude ($\bar{C}$) is based on a 15-month weighted moving average, it may be influenced to some extent by the magnitude of the irregular factor. That is, the larger the irregular factor, the less smooth the moving average will be, and this will tend to increase $\bar{C}$. Although this means that the correlation between $\bar{C}$ and $\bar{I}$ may be exaggerated, the value of $\bar{C}$ as an amplitude-adjustment factor may, in fact, be enhanced, since the movements of highly irregular series will be damped more than they would be otherwise.

Adjusting the relative movements in each series according to the magnitude of $\bar{C}$ reduces the influence of such erratic series as business failures and increases the influence of such smooth series as the workweek. The result is a smoother index.[5] This would seem to have some useful implications for index number construction.

Another interesting difference between the amplitude-adjusted index and the cumulated diffusion index (lines 2 and 3 in Chart 19.1), which are both based on smoothed data, is that the cyclical turning points in the latter are more sharply angular. The reason is that a moving average has a graduating effect on the rates of change in individual series in the vicinity of cyclical turns, and this effect is reflected in the amplitude-adjusted index. The directions of change in the moving averages are, of course, not subject to such an effect, and it consequently does not show up in the diffusion index. Insofar as sharp cyclical turns are easier to detect, this imparts an advantage to the diffusion index.

[5] This result is consistent with two other pieces of evidence. First, the amplitude-adjusted index based on raw data (line 1 in Chart 19.1) is smoother than a similar index constructed by Leonard Lempert, which is based on raw data without amplitude adjustment (*Statistical Indicator Reports,* June 22, 1955, and following issues). Second, a diffusion index constructed by Frank Morris using amplitude-adjusted rates of change is smoother than a diffusion index that ignores rates of changes (see Chapter 4). The smoothing effect of the amplitude adjustment appears to lie in the fact that the error term of an average (i.e. the index) is at a minimum, other things equal, when the error terms of the components of the average are equal (assuming that these error terms are either uncorrelated or positively correlated). The degree to which the error terms (irregular components) are equalized by the amplitude adjustment is indicated by a comparison of the last with the next to last column in the text table above. It seems likely that the irregular components of these series are, if anything, positively correlated. I am indebted to Millard Hastay for this point.

Appendix

TABLE 19.2

Amplitude-Adjustment Method Applied to December 1958 Data

Series No.	Indicator	Av. Cyclical Amplitude, C_s (1)	Seas. Adj. Data, Dec. 1958 (2)	Log. of Seas. Adj. Data (3)	Amplitude-Adj. Factor (4)	Adjusted Log. (5)	Amplitude-Adj. Series (6)	Index Base (1947–49 av.) (7)	Amplitude-Adj. Index (1947–49 = 100) (8)
1.0	Av. hours worked per week, mfg., BLS	.0021	39.8	1.59988	3.37241	5.39545	248,575	250,428	99.3
4.0	New orders, durable goods indus., value, OBE	.0199	13.673	1.13586	0.35905	0.40783	2.5576	1.9885	128.6
5.1	Residential building contracts, fl. sp., Dodge	.0259	124.50	2.09517	0.27669	0.57971	3.7994	2.9742	127.7
6.0	Commercial and industrial building contracts, fl. sp., Dodge	.0284	29.06	1.46330	0.25264	0.36968	2.3425	2.2105	106.0
7.1	No. of new incorporations, Dun and Bradstreet	.0120	15.577	1.19248	0.59311	0.70727	5.0965	3.4670	147.0
8.0	Business failures, liabilities, indus. and comm., Dun and Bradstreet	.0309	54.88	1.73941	0.23248	0.40438	2.5374	2.0088	79.2[a]
10.1	Industrial stock price index, Dow-Jones	.0115	566.43	2.75315	0.61874	1.70348	50.522	24.764	204.0
12.2	Wholesale price index, 22 basic commodities, BLS	.0126	86.0	1.93450	0.56503	1.09315	12.392	13.473	92.0
	Leading series index (unweighted average)								123.0

SOURCE: Col. 1: See p. 649.
2: See Volume II.
4: Log $(1 + C_p) \div \log (1 + C_s)$. $C_p = .0071$.
5: Col. 4 × col. 3.
6: Antilog of col. 5.
7: Av. of col. 6 for 1947–49.
8: (Col. 6 ÷ col. 7) × 100.
[a] Reciprocal (i.e. col. 7 ÷ col. 6).

TABLE 19.3

Amplitude-Adjusted Index of Leading Series, 1947–58[a]
(average 1947–49 = 100)

	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Jan.	104.7	105.1	95.7	99.1	112.9	105.4	109.4	105.6	116.4	119.4	119.0	112.6
Feb.	103.9	101.4	95.0	100.1	113.2	106.5	109.1	105.3	117.4	120.2	117.9	111.5
Mar.	103.5	101.9	94.0	102.4	112.3	106.9	108.9	105.4	117.4	120.9	117.7	112.4
Apr.	102.5	103.8	93.7	104.2	111.0	106.4	108.8	107.3	117.2	121.4	117.2	110.1
May	101.2	104.0	93.8	105.4	109.4	106.6	108.5	108.4	117.5	119.2	118.5	114.4
June	99.9	104.3	93.7	107.1	108.3	107.9	105.3	108.4	119.2	119.2	119.0	115.3
July	101.2	104.0	94.1	107.4	106.9	106.9	108.4	109.6	120.1	119.4	118.9	117.2
Aug.	102.4	100.8	94.1	110.6	106.8	109.2	105.7	110.5	119.2	120.9	117.8	119.1
Sep.	103.3	99.5	98.4	109.3	106.6	108.6	104.2	111.2	120.4	119.1	116.3	120.5
Oct.	104.1	99.0	97.5	109.6	106.0	107.7	105.5	113.0	118.9	118.0	114.6	122.0
Nov.	105.3	98.6	97.9	109.2	106.9	109.2	105.2	113.0	120.2	119.0	113.6	122.0
Dec.	104.0	96.8	99.3	109.3	107.6	110.1	103.2	115.3	120.2	118.5	113.3	123.0

[a] Based on seasonally adjusted data, unsmoothed and unweighted.