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On the Appraisal of Cyclical Turning-Point Predictors

Arthur M. Okun

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In order to review past economic forecasts and to investigate methods of improving economic predictions in the future, economists require criteria for appraising the predictive accuracy of their forecasts. For quantitative predictions of national product and its components, such criteria have been advanced and discussed. Forecast errors are naturally measurable as dollar deviations between predicted and actual magnitudes. The errors in a number of different forecasts can therefore be readily compared. In addition, "naive models" which imply persistence of either the rate of change or the level of national product have been accepted as benchmarks for comparison with economists' predictions. There has been little discussion, however, of criteria for appraising the accuracy of cyclical turning-point forecasts, which project reversals in the direction of change of economic activity. This paper advances a method for evaluating turning-point predictions and illustrates the operation of the system on historical data collected by the National Bureau of Economic Research. The assumptions underlying the scoring system and the characteristics of the method are discussed below. Few claims are made for the system; it is far from ideal. It is offered with the conviction that some objective standard of appraisal is required for turning-point forecasts and that the specification of one possible system may evoke fruitful

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discussion of the problem. If existing methods of forecasting are to be evaluated and if new methods are to be sought, it must be possible to recognize a good forecast and to distinguish degrees of accuracy. Even if a particular forecasting tool or method is used in combination with other evidence, it is necessary to determine the predictive contribution of that element of the forecast.

In principle, the value of a prediction should be gauged in terms of the uses for which the forecast is desired. The productivity of a particular forecast depends on whether decision-makers are made better off by reliance on it rather than on other views of future prospects which could guide their actions. The principle is difficult to apply in practice because the potential uses and users of a forecast cannot be generally specified. Therefore, appraisals are usually restricted to an examination of the amount and the accuracy of information supplied by the forecast. In the case of predictions of cyclical turning-points, the users are offered an assessment of the prospective direction of change of economic activity. The prediction during an expansion that a turning-point will occur at some point in the future expresses the belief that the upward movement of the economy will continue until that time and will then be followed by a downward path of business activity.

The making of "up" and "down" forecasts implies that direction of change is crucial to the policy-maker. This proposition raises questions: if the difference between a change in output of +2 and -2 per cent is important, the difference between +2 and +6 per cent would also be expected to have significance. Even where forecasting is designed principally to alert decision-makers to major prospective swings in the economy, the magnitude (as well as direction) of the expected change will determine whether the alarm should be sounded. These are relevant and interesting issues concerning the purpose and uses of turning-point forecasts, but they can be set aside for this paper. The business cycle approach does not, after all, restrict the forecaster to predictions of the direction of movememts. He can estimate prospective amplitudes after making his turning-point forecast. Thus, there is no need to draw a sharp distinction between business cycle and national product forecasting. The prediction of cyclical turning-points can be appraised separately and yet viewed as a possible first-step in the quantitative forecasting of aggregate economic variables.

On occasions, a method designed to forecast a turning-point is loosely termed a "success" whenever it signals prior to the turn. This is thoroughly unsatisfactory as a criterion of accuracy. There is no more difficulty in forecasting that a turn will occur than in predicting that rain will stop. During any contraction, it is safe -- and hence devoid of content -- to advance the prediction that economic activity will rise again. Similarly, even in the stable post-war world, there is little risk in going on the record to assert that another recession will occur.

The issue is whether the timing of a turning-point can be predicted. For some purposes, one may wish to know how far away the next turning-point is, whether it be one or 40 months in the future. Unlike national product projections which restrict the forecaster to a fixed forthcoming period, the business cycle approach permits forecasting over a variable period. However, the planning period of government and business decision-makers dictates emphasis on the prospects for the near future. The length of the usual planning period has been an important determinant of the conventional twelve month period of national product forecasts. The same one-year fixed period is here assumed for the cyclical forecaster. His task is viewed as predicting the signs of monthly changes in general business activity for the coming twelve months. He may predict no turning-point over that interval; in that event, his forecast in an expansion is simply 12 + 's ; in a contraction, 12 - 's . It is assumed that he forecasts, at most, one cyclical turning-point which he must date: in an expansion, placing a peak seven months in the future means predicting 7 + 's followed by 5 - 's for the year. Furthermore, it is assumed that predictions are made each month for the coming 12 months, so that 144 monthly-signs (or forecast-months) are predicted each year. The resulting score is simply the ratio of signs correctly foreseen to total predictions. The assumptions underlying "forecast-month" scoring are thus:

1. Equal weight is placed on each of the next twelve months; zero weight is attached to months more than a year away. The same penalty is associated with an error concerning the next month as with one for the eleventh month in the future.

2. Type I and Type II errors are weighted equally: predicting a turn one month too soon carries the same penalty as predicting the turn one month too late.

3. Errors made at any time in dating the turning-point are penalized in proportion to the magnitude of the error: being wrong by 2 months is twice as bad as a deviation of one month.

In appraisals of turning-point predictions employing the forecast-month method, an obvious benchmark is a naive model in which no turning-point is ever predicted. Consider the accuracy of this naive model. So long as the turn is 12 or more months away, the 12 sign-predictions are correct. However, in the eleventh month before the turn, one error is made out of the 12 months predicted. In the next month, two of the 12 forecast-months are inaccurate; the following month, there are three errors, etc. until, in the month of the peak or trough, all 12 sign-predictions are incorrect. The total number of errors is the sum of the digits from 1 to 12, or 78. Thus, for any cycle-phase which exceeded 11 months in length, the number of incorrect forecast-months is 78 and the percentage of accuracy depends simply on the length of the phase. In the unusual case of an expansion or contraction shorter than a year, fewer errors are made: for example, the total number of inaccurate forecast-months for a 10 month contraction is the sum of the digits from 3 to 12, or 75.*

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* Strictly speaking, fewer are also made in the preceding cycle-phase. Consider the expansion just before the ten-month contraction. In the month of the peak, twelve + 's are predicted and the last two of these are actually correct. However, it seems reasonable not to credit the naive model for these since it misses the intervening contraction. The same rule is applied to more sophisticated methods discussed below.

Another possible method of predicting a turning-point could rely on the distribution of the lengths of past business cycle phases. After an expansion has proceeded for, say, 3 months, the forecaster can estimate, on the basis of past performance, that the phase is likely to continue for the next twelve months. By the National Bureau chronology, only 2 of the 25 expansions since 1854 have lasted less than 15 months. It is relatively safe to predict no turning-point for the year ahead at that point. However, if the expansion has gone on for, say, 18 months, the task is not so simple. The historical records show that 23 expansions lasted 18 months or longer and that only 11 of these had a duration of 30 months or more. The naive model would get perfect forecast-month scores in fewer than half of the cases. To take maximum advantages of the historical data in terms of forecast-month scoring, the predicted turning-point should be placed at the median length of all expansions with a length of 18 months or more. The median is optimal since forecast-month scoring penalizes absolute deviations and the total of absolute deviations of a set of items is minimized when those deviations are measured from the median. In this instance, the median length of all expansions lasting 18 months or more is 27 months. Thus, the median length remaining at 18 months is 9 months. The forecast is thus for nine + 's followed by 3 - 's.*

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* All of this assumes that there have been no secular changes in the lengths of cycle phases over time. In fact, the chronology shows that contractions since World War I have been shorter, on the average, than previously. See Moore, Measuring Recessions, Occasional Paper No. 61, National Bureau of Economic Research, (New York, 1958), p. 260.

Obviously, if the median length remaining of past surviving expansions exceeds 12 months, no turning-point is predicted for the year ahead.

The distributions of lengths of expansions and contractions are recorded in the first two accompanying figures. These are National

Bureau data arranged to supply the information required for predictions of median remaining length at any point in an expansion or contraction. The figures are constructed to show the median length of all expansions (or contractions) which lasted at least as long as the number of months shown along the horizontal axis. A diagonal line of unit slope is drawn through the origin on each figure. The distance along a vertical between this 45° line and the median length shown above it is the median length remaining for all surviving expansions (or contractions). For example, after 31 months from a trough, the median remaining length of the ten surviving expansions is (41-31) or 10 months. Lines of unit slope with intercepts of six months and 12 months respectively are also drawn on the diagrams as guides for measuring median remaining lengths.

For 15 months after the start of an expansion and for 6 months after the onset of recession, no turning-point is predicted for the next year. Then, the median remaining lengths decline to 6-10 months for an expansion in a region of 15 to 35 months after the trough. During a contraction, the corresponding median lengths remaining run 4-13 months, over the period 6 to 24 months after the peak. Over these ranges, as time passes and shorter-lived phases die out, there is no general tendency for the median length remaining to decline. Thus, there is little support for the view that old expansions have a short life expectancy.*

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* Despite its careful statement and qualification, Moore's suggestion to this effect (Ibid., p. 262) must be rejected in terms of the data.

The performance of the median remaining length model is shown for expansions and contractions, respectively, in the third and fourth accompanying figures. The total number of incorrect forecast-months per cycle-phase is shown for phases of varying lengths. For very short expansions or contractions, median remaining length forecasts coincide with the naive model. For expansions lasting between 15 and 47 months, median remaining length predictions make 50 to 70 forecast-month errors in contrast with the 78 of the naive model. For contractions lasting 6 to 24 months, the median remaining length model is superior to the naive forecast; for durations in the range of 17 to 21 months, fewer than 40 errors are made. Only for the atypical expansion longer than 47 months or the atypical contraction longer than 24 months is median remaining length inferior.

Turning-point predictions are most frequently based on the use of leading indicators. Among the leading indicators employed are time-series of individual economic variables which are expected to display peaks and troughs in advance of the reference cycle turning-points; a diffusion index which records the percentage expanding of a large number of economic time-series; or a quantitative measure of the rate-of-change of one or more economic variables. A downturn or upturn in the leading indicator used as a predictor is taken as a signal of a forthcoming reversal in general business activity.

If leading series are to be used as turning-point predictors, an expected lead must be attached to the indicator. If the expected lead of a particular series during expansion is 7 months, then once it displays a downturn, the forecaster should predict a downturn in general business activity 7 months hence. It is assumed that, in the next month, the downturn is predicted six months in the future; five, the next month, etc. provided no downturn is experienced. If no reference-cycle turn takes place in the next seven months, the forecaster is assumed to predict a downturn for the next month in each succeeding month until the turning-point occurs. Whenever no signal has been given by the leading indicator, the forecast is taken to be equivalent to the naive model, i.e., that no turn will occur within the coming year. Thus, if the leading indicator fails to precede a downturn, it yields the same forecast-month error total as the naive model, usually 78.

Hypothetical scores for varying expected and actual leads are shown in Table 5. Only when the indicator signals very prematurely can it be worse than the naive forecast. For example, when the expected lead of a predictor is 5 months, an actual lead of 18 months puts the forecaster out on the limb too soon and makes the error total 128. On the other hand, an actual lead of one month with an expected lead of 5 months saves 8 forecast-months compared with the naive model and reduces the error total to 70. It should be evident that a lag of six months is no worse than a lag of one month: if the indicator fails to lead, the forecaster still is capable of recognizing the turning-point in the reference cycle. The table of errors shows that the value of a leading indicator in forecast-month scoring depends on:

1. The reliability with which it leads, i.e., the fraction of all phases in which the signal precedes the reference-cycle peak or trough.
2. The length of the lead. A consistent lead of 3 months produces 45 errors per phase improving on the naive model by (12+11+10) or 33 forecast-months. A consistent lead of 6 months yields only 21 errors per phase.

3. The stability of the lead. An indicator with an expected lead of 4 months which has variable actual leads of 2 and 6 months is inferior to a series with a consistent lead of 4 months.*

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* It may seem paradoxical that an indicator with an expected lead of 4 scores better when it leads by 5 than by 4. But, if the series led consistently by 5, forecasting performance could be improved further by attaching an expected lead of 5 months to the indicator.

The expected lead for any indicator should be selected in light of the scoring system. Since the series is never used as a predictor in those cases where it lags (or is coincident with) the reference cycle turning-point, the expected lead should be established solely from the cases where the indicator has led. In historical data employed below, the expected lead for each indicator in expansions is taken as the median lead of all cases in which the series displayed a peak prior to the corresponding peak of the reference cycle. The same method is used to derive an expected lead for contractions.

The optimum choice for the expected lead will depend on the assumed distribution of actual leads of the indicator. For certain plausible distributions of leads, the median lead is smaller than the ideal expected lead because of the heavy penalty that forecast-month scoring places on very premature signals. Also, it is here assumed that the expected lead at the time of the signal does not depend on the number of months that have elapsed since the preceding reference cycle turning-point. The expected lead is taken to be the same when a downturn of a leading indicator is experienced three months after a trough as when it occurs 20 months after a trough. The data provide rough support for the use of the median and for the assumption of independence, but the number of observations on the behavior of any leading series is far too small for a thorough exploration of alternative forecasting rules.

In using the National Bureau's historical data on statistical indicators, one assumes, in effect, that specific-cycle turning points can be identified as soon as they occur and that no "wiggle" of a series is ever misinterpreted as a genuine cycle turn. In fact, distinguishing turns from wiggles may take several months. Of course, the naive and median remaining length models above were evaluated as if reference cycle turning points were recognizable at once, so that the advantage given to leading series forecasts may not be very large.

Tables 6 and 7 present the results obtained from Moore's diffusion index of all conforming series * and from the series on business failures

* Moore, "Statistical Indicators of Cyclical Revivals and Recessions," Occasional Paper 31, (National Bureau of Economic Research, 1950), pp. 46-47.

(inverted), which is one of the National Bureau leading series. The period covered is 1879-1938 and the expected leads are derived from observations over this period in the manner described above. The result of median remaining length and naive forecasts are presented for comparison.

For expansions, the data show that the diffusion index scores best, but its margin over median remaining length is very slight; and these two methods are only a little superior to business failures and the naive model. Two premature signals, in 1879-82 and 1914-18, account for nearly two-fifths of all errors made by the diffusion index.

For contractions, the four methods show greater differences. The percentage accuracy of the naive model is smaller than in expansions, simply because contractions are shorter. Median remaining length is substantially better than the naive model with about one-fourth fewer errors. The diffusion index stands slightly better than median remaining length; again its performance is seriously impaired by two premature signals, in 1910-12 and 1929-33. Greatest accuracy is shown by the business failures series; its error total is only half that of the naive model. The business failures indicator fails to signal in 4 of the 16 contractions, while the diffusion index signals in all instances; but business failures earns a higher score because it does not have markedly premature signals.

Tables 8 and 9 show results obtained from historical data on eight leading series for the 1920-54 period with expected leads derived from these years. For expansions, five of the eight indicators are inferior to the naive model, and only one, hours worked per week, improves substantially on the naive results. The superiority of the work-week emerges because it alone displays no premature signal over the period. All other indicators are marred by a very large error total for either 1938-45, 1945-48, or 1949-53. Thus, the favorable verdict for the work-week rests on a difference of one observation. Because wholesale prices and new orders had one early signal, their scores are far inferior to the work-week's error total. Clearly, this does not justify the conclusion that the work-week has a zero propensity to give premature signals. The data provide no firm grounds for selection among the leading indicators.

In an attempt to eliminate premature cases by pooling the series, the method of first two indicators and first three indicators was introduced. Here all eight leading series are treated equivalently, and the second (or third) downturn of the eight in any expansion is the signal for predicting a reference cycle turning-point. As shown in Table 8, this technique is not successful -- premature signals are still experienced and no improvement is made over the naive model.

Contractions again present a very different story. All eight indicators are superior to the naive model. Median remaining length is considerably more accurate than the naive method but not so good as six of the eight leading series. The method of first two indicators is the best of the lot, and it performs impressively; its error total is only 36.5 per cent as large as that of the naive model.

Tables 10 and 11 show the results obtained from the same set of leading indicators for 1920-54 when the forecasting rules are slightly modified. Here, prior to the leading series signal, the forecast is derived from the median remaining length model (based on 1854-1957) rather than the naive model. There are only slight differences between these results and those of the two preceding tables. Typically the differences stand in favor of the combination of leading series and the naive model rather than the combination of leading series and median remaining length. This is somewhat surprising since, taken alone, median remaining length forecasts are superior to the naive model. Logically, if the median remaining length model is to be employed in the period prior to a signal, the estimate of remaining length at any point should be derived only from those surviving phases in which there has been no signal. However, there are no data on many indicators prior to World War I, and hence such calculations cannot be made on the 1854-1957 chronology.

When forecast-month scoring is applied to leading series, two outstanding characteristics of the system of appraisal become evident. These are that the penalty placed on a failure to signal is relatively light while the penalty on a premature signal can be very heavy. A leading series is supposed to lead and its failure to signal deprives the forecaster of the benefit he seeks from reliance on the series. However, if a signal comes too soon and persuades the forecaster to insist incorrectly for a year that a turning-point is imminent, the early signal is clearly more harmful than no signal at all. A forecaster who warned of an impending recession throughout 1947 and 1948 deserves lower scores than one who insisted that the post-war boom would continue throughout this period and recognized the 1948-49 recession only when it could be read from current data. Indeed, it is surprising how much emphasis has been placed on the desirability of predicting the turn and how little concern there has been for the danger of forecasting it too soon.

On the other hand, the frequency of very premature signals in expansions depends on the particular forecasting method adopted for the use of leading series. In order to score the indicators, it was necessary to construct a set of forecasting rules. It was assumed above that once a signal led the forecaster to expect a turning point in June, he continued to place the turn in June until June passed; if still no turning-point occurred, he would tenaciously insist that the turning-point was imminent until it occurred It may be argued that this imputes an unreasonable degree of obstinacy to the forecaster. It is certainly true that some shut-off device is needed to avoid the danger of early signals, but the leading indicators do not themselves provide such a device. One must ask how the forecaster can decide when to be persistent and when to reject the signal.*

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* If sufficient data were available, it would be possible to oonstruct a system based on the median remaining lengths of phases after a signal was experienced. Then, five months after an indicator turned, the forecaster would put the turn at the median remaining length of all phases which survived five or more momths after the signal of that indicator. A large number of observations would be needed to apply this technique.

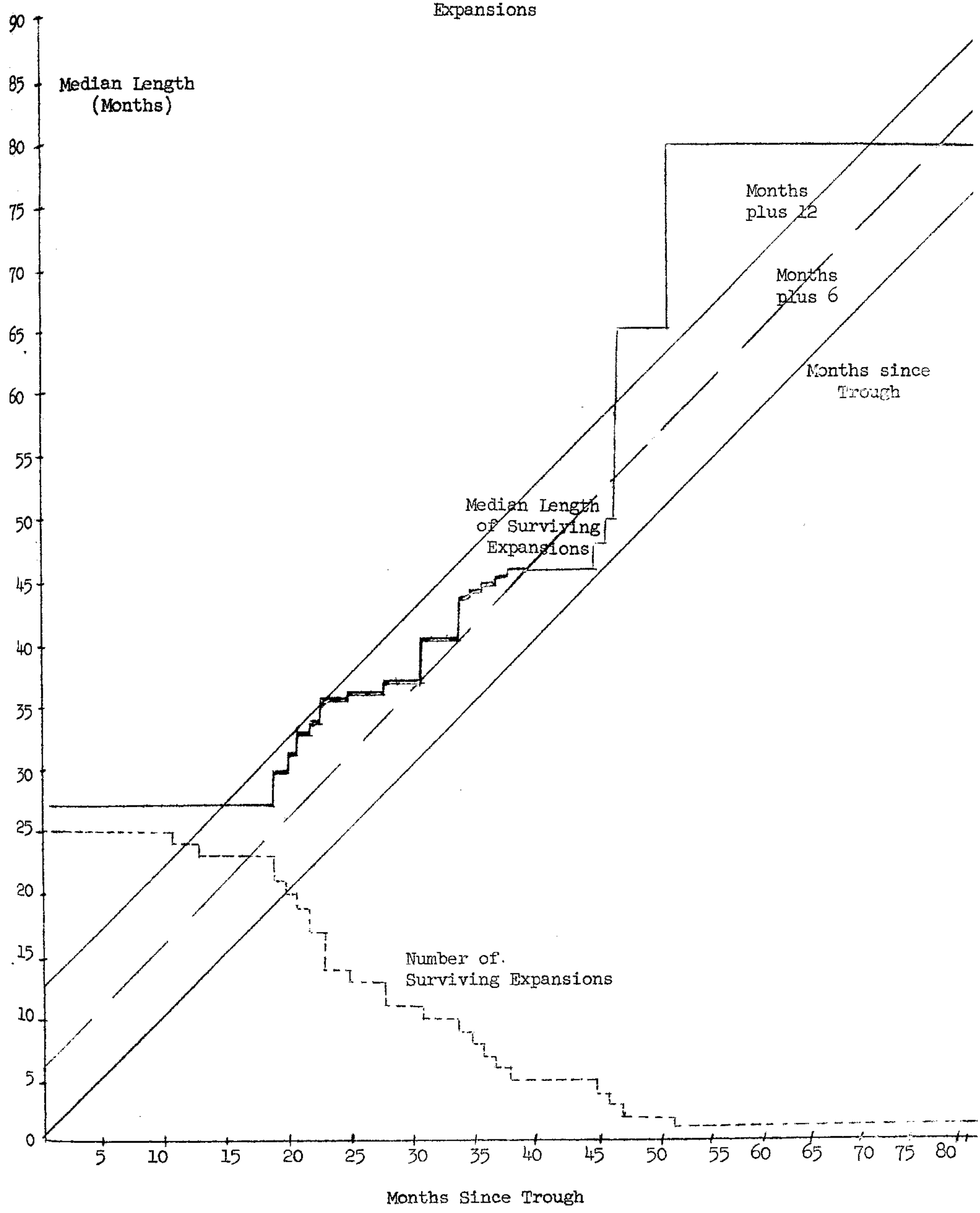
In other respects, the quantitative appraisal is probably generous to the leading indicators. They are favored by the 12-month forecast period in comparison with a shorter period which would accentuate even further the problem of premature signals. The selection of expected leads from the same observations on which the leading series are scored also works to the advantage of the indicators. The use of historical specific-cycle turning-points as signals is still another factor which bolsters the scores of the leading indicators.

Leading series have earned a rather good score in predicting troughs and a rather poor score in predicting peaks by the criteria of appraisal advanced above. But these empirical findings should be carefully qualified. This study has been intended to present and discuss a method of scoring rather than to evaluate comprehensively the predictive accuracy of turning-point indicators. The empirical results cannot be readily applied to an actual forecasting situation. In particular, the findings above rely on historical reference cycle and specific cycle dates which are not available to the forecaster in practice. In actual predictions, distinguishing wiggles from genuine turning-points is a serious and difficult problem.

Unlike the hindcasting procedure above, actual predictions of turning-points must determine when a reversal in a leading series is to be taken as a genuine signal and when a reversal in business activity is to be taken as a reference cycle turn. However, actual forecasting does confront the problems discussed above of requiring a rule for predicting prior to the signal, of associating a lead with the signal, and of developing a shut-off device to reduce the costs of premature signals. Moreover, forecasting in practice requires a criterion of accuracy for the selection and evaluation of optimal predictive techniques. Forecast-month scoring is one eligible method of appraisal.

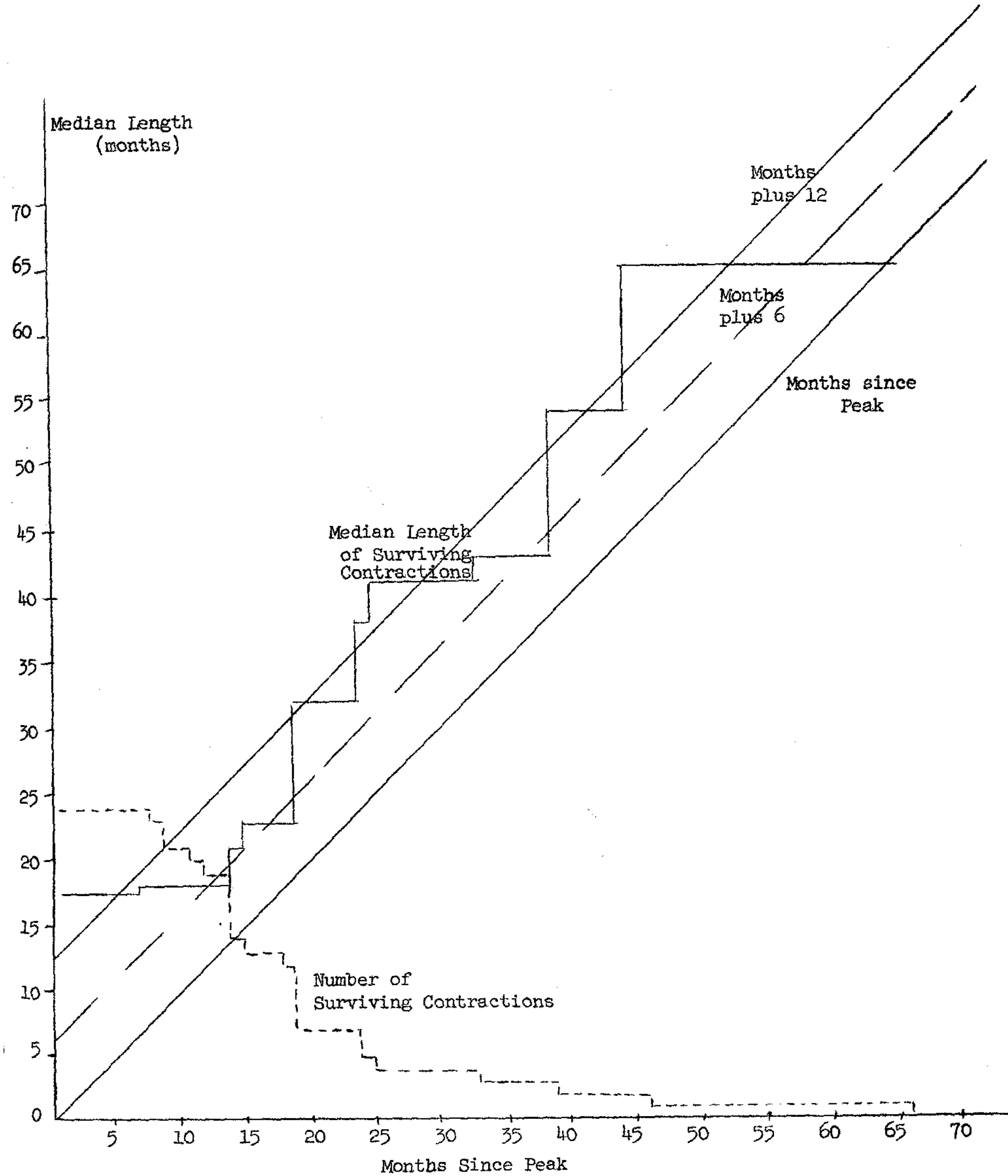
MEDIAN LENGTH OF EXPANSIONS, Dec. 1854 - July 1957

Expansions



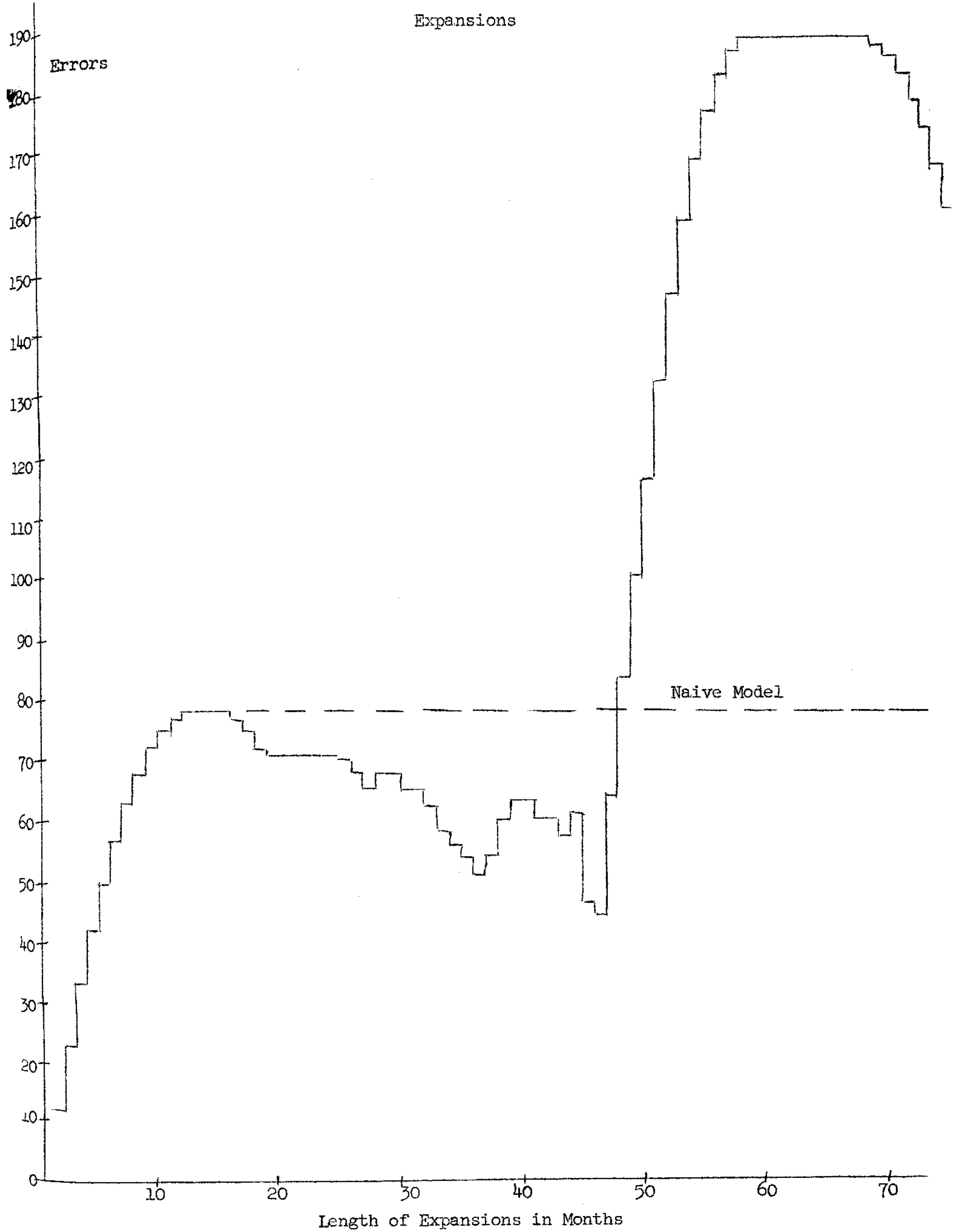
MEDIAN LENGTH OF CONTRACTIONS, June 1857 - Aug. 1954

Contractions

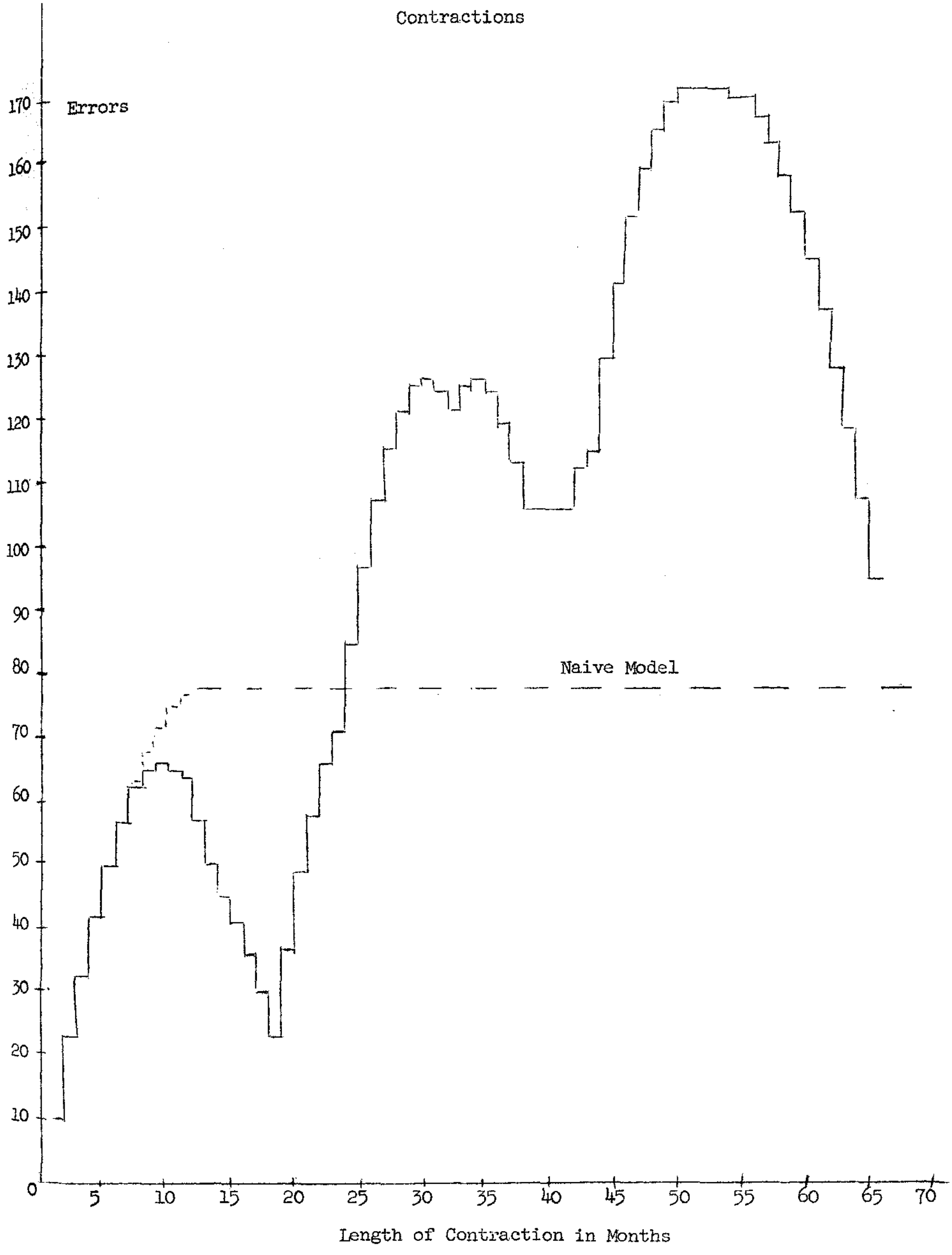


FORECAST ERRORS USING MEDIAN REMAINING LENGTH MODEL

Expansions



FORECAST ERRORS USING MEDIAN REMAINING LENGTH MODEL



Scoring of Errors for Leading Series*

Expected Lead in Months	Actual Lead in Months																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	78	66	56	48	42	38	36	36	38	42	48	56	66	78	90	102	114	126	138	150	162
2	78	67	55	47	41	37	35	35	36	41	47	55	65	77	89	101	113	125	137	149	161
3	78	68	57	45	39	35	33	33	35	39	45	53	63	75	87	99	111	123	135	147	159
4	78	69	59	48	36	32	30	30	32	36	42	50	60	72	84	96	108	120	132	144	156
5	78	70	61	51	40	28	26	26	28	32	38	46	56	68	80	92	104	116	128	140	152
6	78	71	63	54	44	33	21	21	23	27	33	41	51	63	75	87	99	111	123	135	147
7	78	72	65	57	48	38	27	15	17	21	27	35	45	57	69	81	93	105	117	129	141
8	78	73	67	60	52	43	33	22	10	14	20	28	38	50	62	74	86	98	110	122	134
9	78	74	69	63	56	48	39	29	18	6	12	20	30	42	54	66	78	90	102	114	126
10	78	75	71	66	60	53	45	36	26	15	3	11	21	33	45	57	69	81	93	105	117
11	78	76	73	69	64	58	51	43	34	24	13	1	11	23	35	47	59	71	83	95	107
12	78	77	75	72	68	63	57	50	42	33	23	12	0	12	24	36	48	60	72	84	9[illegible]

* Scores apply to expansions or contractions lasting 12 months or more

Performance of Moore's Diffusion Index and Business Failures (Inverted) Historical Series, in Predicting Cyclical Turning Points

Indicators Combined with Naive Model Monthly Predictions for 12-month Forecast Period

EXPANSIONS	Moore's Diffusion Index Expected Lead = 9		Business Failures Expected Lead = 11		Median Remaining Length Model
	Lead	Error	Lead	Error	Error
March 1879 - March 1882	26	198	25	167	51
May 1885 - March 1887	16	78	16	59	71
April 1888 - July 1890	10	12	23	143	65
May 1891 - January 1893	5	48	5	58	71
June 1894 - December 1895	6	39	15	47	72
June 1897 - June 1899	3	63	*	78	71
December 1900 - September 1902	9	6	17	71	71
August 1904 - May 1907	19	114	19	95	58
June 1908 - January 1910	5	48	4	64	71
January 1912 - January 1913	10	12	*	78	78
December 1914 - August 1918	33	282	*	78	61
April 1919 - January 1920	6	39	5	58	72
July 1921 - May 1923	9	6	*	78	71
July 1924 - October 1926	21	138	7	43	65
November 1927 - June 1929	8	18	4	64	71
March 1933 - May 1937	8	18	4	64	116

Total Forecast Months	4836	
Total Naive Errors	1242	
Percent Correct Forecasts with Naive Model		74.3%
Total Errors Using Moore's Diffusion Index	1119	
Percent Correct Forecasts Using Moore's Diffusion Index		76.9%
Total Errors Using Business Failures Series	1245	
Percent Correct Forecasts Using Business Failure Series		74.3%
Total Errors Using Median Length Remaining Model	1135	
Percent Correct Forecasts Using Median Length Remaining Model		76.5%

*Indicator failed to signal prior to cyclical turning point.

Performance of Moore's Diffusion Index and Business Failures (Inverted), Historical Series, in Predicting Cyclical Turning Points

Indicators Combined with Naive Model Monthly Predictions for 12-Month Forecast Period

CONTRACTIONS	Moore's Diffusion Index Expected Lead = 7		Business Failures Expected Lead = 8		Median Remaining Length Model
	Lead	Errors	Lead	Errors	Errors
March 1882-- May 1885	12	45	12	38	106
March 1887 - April 1888	2	65	8	10	50
July 1890 - May 1891	4	48	6	33	65
Jan. 1893 - June 1894	10	27	13	50	30
Dec. 1895 - June 1897	10	27	9	14	23
June 1899 - Dec. 1900	5	38	7	22	23
Sept. 1902 - August 1904	12	45	13	50	71
May 1907 - June 1908	7	15	6	33	50
Jan. 1910 - Jan. 1912	18	117	*	78	85
Jan. 1913 - Dec. 1914	7	15	6	33	71
August 1918 - April 1919	5	38	*	68	65
Jan. 1920 - July 1921	7	15	*	78	23
May 1923 - July 1924	4	48	9	14	45
Oct. 1926 - Nov. 1927	10	27	7	22	50
June 1929 - March 1933	31	273	8	10	141
May 1937 - June 1938	7	15	3	60	50

Total Forecast Months	3696	
Total Naive Errors	1235	
Percent Correction Forecasting With Naive Model		66.6%
Total Errors Using Moore's Diffusion Index	858	
Percent Correct Forecasts Using Moore's Diffusion Index		76.8%
Total Errors Using Business Failures Series	613	
Percent Correct Forecasts Using Business Failures Series		83.4%
Total Errors Using Median Length Remaining Model	948	
Percent Correct Forecasts Using Median Length Remaining Model		74.4%

*Indicator failed to signal prior to cyclical turning points.

Performance of Alternative Indicators of Cyclical Turning Points

Indicators Combined with Naive Model Monthly Predictions for 12-Month Forecast Period: Errors = Forecast-Months with Incorrect Sign

EXPANSIONS	Expected Lead	July '21-May '23 Errors	July '24-Oct. '26 Errors	Nov. '27-June '29 Errors	Mar. '33-May '37 Errors	June '38-Feb. '45 Errors	Oct. '45-Nov. '48 Errors	Oct. '49-July '53 Errors	Total Errors	Errors as % of Naive Model
Business Failures (Inverted)	6	78*	21	44	44	78*	78*	243	586	107.3
Common Stock Prices	5	61	78*	78*	51	78*	272	26	644	117.9
New Orders	6	44	41	78*	33	327	33	21	577	105.7
Residential Building Contracts	15	78*	12	12	78	78*	180	78*	516	94.5
Comm. and Indust. Building Contracts	11	24	23	58	78*	78*	251	78*	590	108.1
Average Hours Worked per Week	7	27	35	78*	65	17	78*	15	315	57.7
Number of Incorporations	5	70	56	28	28	78*	272	78*	610	111.7
Wholesale Price Index	11	73	1	83	73	78*	13	215	536	98.2
First Two Indicators	13	63	0	36	68	50	204	180	601	110.1
First Three Indicators	5	40	56	28	40	78*	272	26	540	98.9
Naive Model		78	78	78	78	78	78	78	546	100.0
Median Remaining Length Model		71	65	71	116	110	54	46	533	97.6

* Indicator failed to signal prior to cyclical turning point.

Performance of Alternative Indicators of Cyclical Turning Points

Indicators Combined with Naive Model Monthly Predictions for 12-Month Forecast Period; Errors = Forecast-Months with Incorrect Sign

CONTRACTIONS	Expected Lead	Jan. '20-July '21 Errors	May '23-July '24 Errors	Oct. '26-Nov. '27 Errors	June '29-Mar. '33 Errors	May '37-June '38 Errors	Feb. '45-Oct. '45 Errors	Nov. '48-Oct. '49 Errors	July '53-Aug. '54 Errors	Total Errors	Errors as % of Naive Model
Business Failures (Inverted)	7	78*	21	15	17	57	68*	26	27	309	50.4
Common Stock Prices	9	78*	6	78*	6	69	68*	55	20	380	62.0
New Orders	3	33	57	78*	78*	57	47	44	39	433	70.6
Residential Building Contracts	6	21	78*	21	54	21	68*	26	78*	367	59.9
Comm. and Indust. Building Contracts	3	39	78*	57	35	78*	68*	56	78*	489	79.8
Average Hours Worked per Week	5	28	78*	78*	28	26	68*	39	40	385	62.8
Number of Incorporations	6	21	71	41	78*	78*	68*	20	78*	455	74.2
Wholesale Price Index	1	66	66	38	66	78*	68*	41	78*	501	81.7
First Two Indicators	7	27	21	15	17	27	68*	28	21	224	36.5
First Three Indicators	6	21	63	21	23	54	68*	21	21	292	47.6
Naive Model		78	78	78	78	78	68	77	78	613	100.0
Median Remaining Length Model		23	45	50	141	50	65	62	50	486	79.3

* Indicator failed to signal prior to cyclical turning point.

Performance of Alternative Indicators of Cyclical Turning Points

Indicators Combined with Median Remaining Length Model Monthly Predictions for 12-Month Forecast Period; Errors = Forecast-Months with Incorrect Sign

EXPANSIONS	Expected Lead	July '21-May '23 Errors	July '24-Oct. '26 Errors	Nov.'27-June '29 Errors	Mar.'33-May '37 Errors	June '38-Feb. '45 Errors	Oct.'45-Nov. '48 Errors	Oct.'49-July '53 Errors	Total Errors	Errors as % of Naive Model
Business Failures (Inverted)	6	71*	14	44	82	110*	54*	246	621	113.7
Common Stock Prices	5	54	65*	71*	89	110*	272	43	704	128.9
New Orders	6	38	40	71*	79	429	23	38	718	131.5
Residential Building Contracts	15	71*	12	12	116	110*	180	46*	547	100.2
Comm. and Indust. Building Contracts	11	24	23	58	116*	110*	251	46*	628	115.0
Average Hours Worked Per Week	7	26	34	71*	103	117	54*	37	442	81.0
Number of Incorporations	5	63	56	28	74	110*	272	46*	649	118.9
Wholesale Price Index	11	66	0	83	111	110*	20	216	606	111.0
First Two Indicators	13	62	0	36	114	150	204	183	749	137.2
First Three Indicators	5	34	56	28	78	110*	272	48	626	114.7
Naive Model		78	78	78	78	78	78	78	546	100.0
Median Remaining Length Model		71	65	71	116	110	54	46	533	97.6

* Indicator failed to signal prior to cyclical turning point.

Performance of Alternative Indicators of Cyclical Turning Points

Indicators Combined with Median Remaining Length Model Predictions for 12-Month Forecast Period; Errors = Forecast Months with Incorrect Sign

CONTRACTIONS	Expected Lead	Jan.'20-July '21 Errors	May '23-July '24 Errors	Oct.'26-Nov. '27 Errors	June '29-Mar. '33 Errors	May '37-June '38 Errors	Feb.'45-Oct. '45 Errors	Nov.'48-Oct. '49 Errors	July '53-Aug. '54 Errors	Total Errors	Errors as % of Naive Model
Business Failures (Inverted)	7	23*	21	15	84	47	65*	26	26	307	50.1
Common Stock Prices	9	23*	6	50*	75	54	65*	54	20	347	56.6
New Orders	3	12	36	50*	141*	42	47	41	39	408	66.6
Residential Building Contracts	6	6	45*	20	118	20	65*	26	50*	350	57.1
Comm. and Indust. Building Contracts	3	6	45*	42	99	50*	65*	50	50*	407	66.4
Average Hours Worked Per Week	5	0	45*	50*	95	25	65*	38	34	352	57.4
Number of Incorporations	6	0	43	41	141*	50*	65*	20	50*	410	66.9
Wholesale Price Index	1	18	38	35	129	50*	65*	40	50*	425	69.3
First Two Indicators	7	6	21	15	84	26	65*	26	21	264	43.1
First Three Indicators	6	0	42	20	90	44	65*	20	20	301	49.1
Naive Model		78	78	78	78	78	68	77	78	613	100.0
Median Remaining Length Model		23	45	50	141	50	65	62	50	486	79.3

* Indicator failed to signal prior to cyclical turning point.