Forecasting With the Index of Leading Indicators

by Gary Gorton*

Henry: Yes, that's right.
John: Can you foretell the future?

Judging by how long they have been in use, leading indicators of economic activity must be considered a forecasting success. Even with the widespread development of econometric models, the use of leading indicators has continued and even flourished in popularity. Indeed, the announcements of such indicators are widely reported in the popular press. Such widespread acceptance and attention probably are explained by the appealingly simple logic of this forecasting approach: if the indicator goes one way today, economic activity will go the same way tomorrow.

Not only are leading indicators apparently easy to use, they are rather easy to construct. Unlike econometric modeling, the leading indicator approach to forecasting does not require assumptions about what causes people's economic behavior. Instead, it relies on statistically detecting patterns among economic variables which can be used to forecast turning points in economic activity.

Using the leading indicators is a simple means of accomplishing the difficult task of predicting the future. But does this approach pay high dividends? In particular, does it forecast turning points accurately? Is it reliable? Does it have any problems? In the main, is it worth using? The predictive abilities of the Index of Leading Indicators can be evaluated by examining its past performance and its method of construction. On balance, although it has certain weaknesses, the Index of Leading Indicators also has particular strengths that make it a useful tool for prediction.

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THE NATIONAL BUREAU BUSINESS CYCLE CHRONOLOGY

Business cycles are recurring alternations of prosperity and recession. The first business cycle indicators were published in the 1920s by the Harvard Economic Service. Popular during the 1920s, these indicators were discontinued when they failed to predict the Great Depression.[1] During the sharp recession of 1937-38, Henry Morgenthau, Jr., the Secretary of the Treasury, asked the National Bureau of Economic Research to devise a system of indicators that would signal when the recession was nearing its end.[2] The National Bureau, under the leadership of Wesley C. Mitchell and Arthur F. Burns, had assembled and analyzed hundreds of economic time series since the 1920s. Based on this analysis, Mitchell and Burns selected a number of series which seemed to have been good predictors of past business upturns. The Treasury Department published the list in May 1938.

There have been numerous refinements and modifications of that original list. The Bureau has, by now, analyzed over 1,000 economic series. Today a wide variety of indicator data is published in a monthly *Business Conditions Digest* by the Bureau of Economic Analysis, a divison of the Department of Commerce. The basic approach, however, is the one originally devised by the National Bureau.

In studying the business cycle, statistical techniques must be used to separate the cyclical component from other movements (such as seasonal and trend-related changes) in a particular economic series. Once the cyclical component of the series has been identified, the peaks and troughs can be picked out—sometimes easily, sometimes with difficulty.[3] The basic procedure for identifying a business cycle is to plot the cyclical component of each series against calendar time and then to inspect the movements of the series for common turning points. An historical plot shows that there are dates around which many of the series move downwards and other dates around which many of the series move upwards. The dates of these clusters of turning points are called reference dates, and the collection of reference dates is called the business cycle chronology. This chronology shows the peaks and troughs, when booms turn into recessions and recessions turn into upswings.

The cyclical components of different series don't all move in exactly the same way, but inferences about the business cycle pattern can be made by identifying clusters of turning points. If the turning points of many different series are bunched closely together, then the procedure will not likely go astray.[4]

Given the business cycle chronology, various economic series can be classified with respect to the reference dates. The cyclical components of some series almost always have peaks *before* the reference troughs. Such series are called *leading indicators*. In many cases the relation between a series and the cycle is easy to explain. Some series, such as housing starts, contracts for

[1] This early system of indicators, called the Harvard ABC curves, is described by Oskar Lange, *Introduction to Econometrics*, pp. 85-94.

[2] The National Bureau of Economic Research is a private, not-for-profit research group.

[3] See Arthur F. Burns and Wesley C. Mitchell, *Measuring Business Cycles* (New York: National Bureau of Economic Research, 1946), Chapter 4, Section 1.

[4] Sometimes it is difficult to date a business cycle if the turning points of the individual series are widely scattered or if they are concentrated around two separate dates. The method of *visually* examining the plots of the series in search of turning points is somewhat arbitrary. Burns and Mitchell concede that there are problems with the notion of a reference date, writing: "If this concept is somewhat fuzzy, so must be our dating" (p. 95). They go on to say: "Neater results could be attained by estimating the cyclical turns of a quantity corresponding to some precise concept of aggregate economic activity. But . . . the existing records virtually rule out this course except for the most recent business cycles" (p. 95).

construction, and new orders for machinery and equipment, represent decisions made early in a lengthy investment process. For example, changes in actual production lag behind new orders because the orders must first be filled, and how soon they are filled depends on the volume of unfilled orders and on the state of inventories. Thus unfilled orders and order backlogs are leading indicators of production activity. Another example of a lead-lag relation is changes in the workweek and employment. Many employers find that it is cheaper to increase or decrease hours of work for existing employees than to hire or fire workers. Consequently, most manufacturers increase or decrease the workweek before they increase or decrease the level of employment. As a result, the workweek leads employment.

For most series, however, the relations are not so clear cut. Rather than analyze very complicated economic relations, the general strategy of the National Bureau procedure is to measure leads and lags against the common standard of the business cycle chronology. Using the chronology, individual series can be classified without assuming a theory of the business cycle. Consequently, the approach may be thought of as "measurement without theory," since it does not try to explain the behavior of each series but simply notes its relation to the chronology.[5] The lack of explicit economic theory is considered a virtue by some economists, a vice by others (see ECONOMETRIC MODELS AND THE INDEX OF LEADING INDICATORS overleaf).

The National Bureau, recognizing that fluctuations in business activity typically are spread over a number of sectors in the economy, employs a variety of leading indicators. The individual components are weighted to reflect their relative importance as turning-point indicators, then added together to form a single Index of Leading Indicators. This composite index should consistently turn down (up) prior to business-cycle troughs (peaks) if the National Bureau approach is to be useful for prediction.

HOW WELL DOES THE INDEX PERFORM?

One frequently used measure of economic activity is the Federal Reserve Board Index of Industrial Production. Its turning points correspond closely to the business cycle reference dates.[6] Because of this close coincidence, the forecasting performance of the Index of Leading Indicators can be tested by examining its ability to predict the Index of Industrial Production. There are two ways to evaluate the performance of the Index of Leading Indicators. One way is to look at its ability to predict business cycle turning points only. The other is to look at its ability to predict movements of economic activity at all points of the cycle.

The Turning Point Approach. The first method of evaluation accepts the National Bureau's emphasis on turning points. The Index of Leading Indicators is supposed to predict business cycle turning points, but how do we know when the Index is predicting a turning point? One common approach is to decide that an upturn (downturn) in economic

[5] See Thomas J. Sargent and Christopher A. Sims, "Business Cycle Modeling Without Pretending To Have Too Much *A Priori* Economic Theory," in *New Methods in Business Cycle Research* (October 1977), Federal Reserve Bank of Minneapolis.

[6] The Index of Industrial Production put out by the Federal Reserve Board goes back to 1923. An older version goes back to 1919, and a still older version to 1913. Consequently, it could not be used by the National Bureau to construct the business cycle chronology for earlier periods. The forecasting performance of the Index of Leading Indicators is evaluated in this article for the post-World War II period, so the Index of Industrial Production is used instead of the reference dates. Another possibility is to use the Gross National Product. Construction of this measure, however, began in the 1920s. In addition, the GNP is only available on a quarterly basis, while the Index of Leading Indicators comes out monthly.

ECONOMETRIC MODELS AND THE INDEX OF LEADING INDICATORS

Both macroeconometric models and the Index of Leading Indicators are designed to forecast future economic activity. Econometric models are typically quarterly or annual models which can accommodate long-run and short-run forecasting as well as some policy simulation. The Index of Leading Indicators is very simple in comparison to large econometric models. The Index cannot be used for simulation, nor can it make long-range forecasts.

The Index of Leading Indicators, however, is an example of an approach to forecasting which represents a major alternative to econometric models. Construction of the Index does not rely on the type of *a priori* theory embodied in econometric models, though it does require choosing individual series and a method of combining them to construct an index. A main virtue of the Index of Leading Indicators is that it may detect statistical regularities which are missed by large scale econometric models precisely because the data are not subject to the type of restrictions imposed by such models.* Some of these restrictions, which are hypotheses about how people behave, may be mistaken. The Index of Leading Indicators also imposes restrictions on the data, in the form of the weights attached to the individual series in the Index. But the weights on the individual series are not derived from assumptions about people's economic behavior. Though it is not known for sure, the Index may contain different, and possibly more, information than econometric model forecasts.†

As with econometric models, however, it is not now known how the behavior of the Index is affected when the government makes major changes in policy. People's economic behavior changes when new policies come into existence, making econometric models which are based on people's previous behavior patterns inadequate for forecasting behavior under the new policies.‡ A policy change can also affect the way leading indicators are related to the underlying pattern of economic activity. How a policy change affects this relation cannot be known in advance, so the problem with the Index of Leading Indicators when policy changes is the same as with econometric models.

Economists do not agree on whether econometric models are inherently deficient or not, or on whether forecasting methods in the spirit of the National Bureau's approach represent a positive step forward in forecasting. In the face of this disagreement, the practical forecaster should use all available information; so a method which does not specify causal-economic relationships, like the Index of Leading Indicators, is worth using.

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*For evidence that large scale econometric models fail to detect important statistical regularities see: J.P. Cooper and C.R. Nelson, "The *Ex Ante* Prediction Performance of the St. Louis and FRB-MIT-PENN Econometric Models and Some Results on Composite Predictors," *Journal of Money, Credit, and Banking* 7, 1 (February 1975), pp. 1-32; also, C.R. Nelson, "The Prediction Performance of the FRB-MIT-PENN Model of the U.S. Economy," *American Economic Review* 62, 5 (December 1972), pp. 902-917.

†For a discussion of the comparative performance of econometric models and time series, see: C.W.J. Granger and Paul Newbold, *Forecasting Economic Time Series* (New York: Academic Press, 1977), pp. 289-302; and R.L. Cooper, "The Predictive Performance of Quarterly Econometric Models of the United States," in *Econometric Models of Cyclical Behavior* (New York: Columbia University Press, 1972), edited by B.G. Hickman. Also, see Ray C. Fair, "An Analysis of the Accuracy of Four Macroeconometric Models," *Journal of Political Economy* 87, 4 (August 1979), pp. 701-718.

‡Economists disagree on how important this problem is. See Richard W. Lang, "Using Econometric Models To Make Economic Policy: A Continuing Controversy," forthcoming in this *Review*. Also, Robert E. Lucas, "Econometric Policy Evaluation: A Critque," *The Phillips Curve and Labor Markets*, Carnegie-Rochester Conference on Public Policy (Supplement to the *Journal of Monetary Economics*, ed. by Karl Brunner and Allan H. Meltzer, 1976).

activity will occur if the Index has been above (below) its previous high (low) for a specified number of months. The problem is to decide how many months should be looked at before deciding that the Index is predicting an upturn or downturn.

Since movements in the Index of Leading Indicators are partly random, many upward or downward movements are reversed if we wait long enough. Suppose, for example, that the Index declines for two months in a row. If we adopt a two-months rule, we would conclude that the Index is predicting a downturn in economic activity. It could well be the case, though, that in the next month the Index will rise to a level above that of three months ago. Then under a three-months rule, it would *not* predict a downturn.

There is an inherent arbitrariness to the number-of-months approach. It is not obvious how many months the Index of Leading Indicators must move in the same direction before a turning point in economic activity is predicted. Different rules for determining turning points in the Index of Leading Indicators result in different predictions about turning points in the Index of Industrial Production.

Using the one-month rule, the Index of Leading Indicators successfully predicts all ten turning points in the Index of Industrial Production during the period 1948-70 (Figure 1).[7] This seems to be persuasive evidence of the predictive ability of the Index of Leading

FIGURE 1

LEADING INDICATORS PREDICT WITH DIFFERENT LEAD LENGTHS*

Performance of the Index of Leading Indicators, 1948-1970, Using the One-Month Rule

Date of Turn in Index of Leading Indicators		Date of Turn in Index of Industrial Production	Lead Months
	Peaks		
June 1948		July 1948	1
January 1953		July 1953	6
November 1956		February 1957	3
January 1960		January 1960	0
September 1969		July 1969	-2
		Average Lead	1.6
	Troughs		
May 1949		October 1949	5
November 1953		April 1954	5
February 1958		April 1958	5
December 1960		February 1961	2
May 1970		November 1970	6
		Average Lead	4.0

*Figure 1 summarizes the results of a study by Stekler and Schepsman which applied the one-month rule to leading indicators. The left hand column shows the turning points chosen in the Index of Leading Indicators. At these dates the Index predicted turning points in Industrial Production. The middle column shows the subsequent turning points in the Index of Industrial Production. The last column shows the lapse of time between the change in the Index of Leading Indicators and the actual turning point in Industrial Production.

SOURCE: H.O. Stekler and Martin Schepsman, "Forecasting With an Index of Leading Series," *Journal of the American Statistical Association* 68, 342 (June 1973), pp. 291-296.

Indicators. The Index produces a number of false signals, however, over the same period. That is, one-month changes appear in the Index of Leading Indicators which do not correspond to any subsequent turning point in the Index of Industrial Production. Under the one-month rule, over the period 1948-70, the Index of Leading Indicators predicted twenty-four peaks and nine troughs *which did not happen* (Figure 2).

At the other extreme, if we adopt a four-month rule or a five-month rule, we make fewer mistakes but the average lead declines. In general, the accuracy of the prediction from the Index of Leading Indicators increases as the number of months used for the rule increases. But while the accuracy of the prediction increases, the Index loses its ability to give advance notice.[8] Using a five-month rule, business cycle peaks are, on average, detectable two and one-half months *after* they have happened. Troughs, using the five-month rule, are identified, on average, just as they are happening. Thus there is a trade-off between the accuracy of the prediction of the Index of Leading Indicators and the length of time of advance notice. Further, the trade-off is not the same for peaks as for troughs. The Index of Leading Indicators predicts troughs more accurately than peaks under any month rule. Also, the length of the advance notice period quickly declines as the number of months increases when predicting peaks.

[7] H.O. Stekler and Martin Schepsman, "Forecasting With an Index of Leading Series," *Journal of the American Statistical Association* 68, 342 (June 1973), pp. 291-296.

[8] In a similar study by Hymans, the Index of Leading Indicators not only signaled false turns, but, for the period 1956-71, the Index *did not* signal half the peaks and 42 percent of the troughs which actually occurred. Hymans, roughly speaking, used a two-month rule. Saul H. Hymans, "On the Use of Leading Indicators to Predict Cyclical Turning Points," *Brookings Papers on Economic Activity* 1973, 2, pp. 339-384.

FIGURE 2

LEADING INDICATORS SOMETIMES SIGNAL FALSE TURNS*

True and False Turns, 1948-1970

Criterion	Peaks			Troughs		
Number of months up or down	Average Lead	Number of True Turns	Number of False Turns	Average Lead	Number of True Turns	Number of False Turns
1	1.6	5	24	4.0	5	9
2	0.6	5	15	3.0	5	3
3	-0.4	5	9	2.0	5	2
4	-1.4	5	5	1.0	5	1
5 or more	-2.4	5	3	0.0	5	0

*A negative number for "average lead" means that the Index is "predicting" turning points *which have already happened.*

SOURCE: H. O. Stekler and Martin Schepsman, "Forecasting With an Index of Leading Series," *Journal of the American Statistical Association* 68, 342 (June 1973), pp. 291-296.

Though the Index of Leading Indicators occasionally signals turning points in economic activity which do not occur, much of the time it is successful. Evaluated from the standpoint of the number-of-months approach, the Index does not always predict accurately, but at least it does not miss turns in the direction of economic activity. If the Index of Leading Indicators could be used to predict economic activity at all points in time, however, then the difficulties of choosing a months rule could be eliminated.

The Whole-Cycle Approach. A number of economists have used so-called time series methods to investigate the historic lead-lag relations between the Index of Leading Indicators and economic activity over *all* points in the cycle rather than just near turning points.[9] These methods can identify certain movements in one series which are associated with movements in another series.[10]

The length of time it takes for a complete business cycle, up-down-up, is called its period. The National Bureau has found that business cycles average about three years from peak to peak, for a period of thirty-six months. Studies of the relations between the business cycle and the Index of Leading Indicators should focus on cycles with periodicities close to those of the business cycle.

The cyclical behavior of an individual series can be represented by adding together many cycles of different periodicities. That is, any cyclical pattern can be approximated by adding together many waves with different periods (see REPRESENTING A SERIES BY CYCLES . . . overleaf). There is a statistical indicator that measures the correlation, or strength of association, between cycles of the same periodicity from any two series. This measure is called squared coherence.[11] The more closely related these movements are, the closer the squared coherence is to unity for each periodicity. If the movements of the two series are not related for a given periodicity, then the squared coherence is zero for that periodicity. Calculating the squared coherence for the whole range of periodicities yields a profile of the degree of association between two series.

Time-series tests of the relationship between the leading indicators and the business cycle also typically use industrial production as the basic measure of economic activity. At a periodicity of twenty-four months, the squared coherence between the Index of Leading Indicators and the Index of Industrial Production is .83, close to unity (Figure 3 overleaf). Futhermore, for two-year cycles the Index of Leading Indicators leads the Index of Industrial Production by about two months on average. Hence, for two-year cycles the predictive content of the Index of Leading Indicators is high; that is, the move-

[9] Hymans, "Leading Indicators;" M. Hatanaka, "Application of Cross-Spectral Analysis and Complex Demodulation: Business Cycle Indicators," in C.W.J. Granger, *Spectral Analysis of Economic Time Series* (Princeton: Princeton University Press,1964); Alan J. Auerbach, "The Index of Leading Indicators: 'Measurement Without Theory,' Twenty-five Years Later," National Bureau of Economic Research, Working Paper No 761; Salih N. Neftci, "Lead-lag Relations, Exogeneity and Prediction of Economic Time Series," *Econometrica* 47, 1 (January 1979), pp. 101-113.

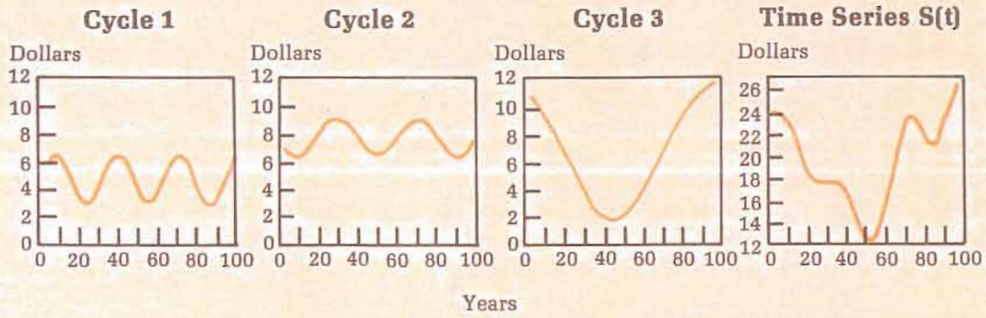
[10] A time series is a sequence of values usually recorded at equidistant time intervals. Examples are the monthly unemployment rate, the weekly money supply, the annual Gross National Product. Time series analysis is a statistical method which aims to make inferences about the basic features of the random process generating the series from the information contained in the observed series. This is done by constructing a model from the data, but it is a purely statistical model, not a model based on economic theory like econometric models. For an introduction to the subject, see C.W.J. Granger and Paul Newbold, *Forecasting Economic Time Series* (New York: Academic Press, 1977).

[11] The squared coherence is analogous to an R^2 statistic in regression analysis. It shows the proportion of the variance in one series at frequency ω that is accounted for by variation in the other series.

ments in the two series at a periodicity of two years are very close. For cycles of 20 to 60 months the Index of Leading Indicators is also a good predictor. It has high squared coherences at these periodicities, and it leads. But the lead length is highly variable depending on which periodicity dominates the cycle. The lead varies in length from seven and a half months (for cycles of 60 months) to less than two months (for cycles

REPRESENTING A SERIES BY CYCLES OF DIFFERENT PERIODICITIES

A time series is a sequence of observations of some economic variable recorded at equidistant time intervals. The weekly money supply and the monthly Index of Leading Indicators are examples of time series. Even though the observations are at discrete intervals (weeks, days, months, years), they can be regarded as coming from a continuous process. In the right-hand panel, the hypothetical time series, S(t), is plotted as a continuous function, even though the observations are at intervals of years. S(t) is measured in dollars in this hypothetical example.



The other three panels show three artifically generated component cycles of different periodicities. The time series, S(t), is approximated by the strictly periodic cycles in the other panels.* Thus each of the three cycles has been chosen in such a way that, when they are added together at each year, the resulting series is very close to the series, S(t). Some of the values plotted in the panels are:

Year	Cycle 1	Cycle 2	Cycle 3	S(t)
1	5.39734	7.00505	11.4135	23.8159
5	6.68294	6.54500	10.7285	23.9565
10	6.81859	6.68682	9.5775	23.0829
20	3.48640	8.63025	6.7081	18.8248
30	4.44117	9.40234	3.9407	17.7842
40	6.97872	7.56815	2.2420	16.7889
50	3.91196	6.53656	2.2054	12.6539

In this example, the three cycles have been chosen so that their values at each year exactly add up to the time series, S(t). Actual time series can only be approximated.

* See Gwilym M. Jenkin and Donald G. Watts, *Spectral Analysis and its Applications* (San Francisco: Holden-Day, 1969), for an introduction to these approximation methods.

of 20 months).

The shortest peak-to-trough or trough-to-peak duration on record is six months, corresponding to a one-year cycle. So cycles with periods of less than one year are not of much practical interest when studying business cycles. This is fortunate, since the data indicate that leading indicators would perform quite poorly for short cycles. The time-series approach suggests that leading indicators work best for cycles with periods of two years or more.

When the Index of Leading Indicators is evaluated using the whole cycle approach, many of the same conclusions reached in the turning-point analysis hold up. The Index still can give false signals, and the lead time still varies. Thus, while there is some information about future economic activity in the Index, its signals are highly variable and therefore somewhat unreliable.

POSSIBLE PROBLEMS WITH THE INDEX OF LEADING INDICATORS

False signals and variable lead times appear whether the Index is evaluated by the turning point approach or by the whole cycle approach. If these problems could be eliminated, or at least minimized, the Index of Leading Indicators would be a more accurate predictor of future economic activity.

It could be that false signals and variable lead times are, at least partially, the result of the method used to construct the Index of Leading Indicators. Constructing the Index involves choosing the component series, then deciding how to weight each of them in importance in adding them together. Both of these steps are difficult, and they may be the source of some of the Index's undesirable features.

The Bureau of Economic Analysis, which produces the Index of Leading Indicators, chose the twelve component series of the Index and their weights after evaluating over 150 candidate leading series with respect to six criteria.[12] These criteria were: (1) economic significance; (2) statistical adequacy;

FIGURE 3

THE INDEX OF LEADING INDICATORS IS A GOOD PREDICTOR FOR SOME CYCLES, NOT FOR OTHERS

Lead-Lag Relations Over the Whole Cycle (1948-Mid-1972)

Periodicity (months)	Squared Coherence	Phase Lead (+) or Lag(−) of ILI* Relative to Index of Industrial Production (months)
60	0.85	7.6
40	0.92	4.3
30	0.93	2.8
24	0.83	2.3
20	0.54	1.5
12	0.46	-0.1
8	0.49	0.2
6	0.35	0.2
4.8	0.19	0.4
4	0.14	0.3
3.4	0.18	0.0
3	0.19	-0.2
2.7	0.11	0.0
2.4	0.10	0.0
2.2	0.16	-0.1
2	0.10	-0.1

*Index of Leading Indicators.

SOURCE: Saul H. Hymans, "On the Use of Leading Indicators to Predict Cyclical Turning Points," *Brookings Papers on Economic Activity* 1973, 2, pp. 339-384.

[12]The Index of Leading Indicators has recently been changed by the removal of one of the twelve series. The Index of Net Business Formation has been eliminated because of data collection problems. No new series replaced the Index of Net Business Formation. Instead,

(3) timing at turning points; (4) conformity to historical business cycles; (5) smoothness; (6) currency or availability of data. Candidate series were scored; that is, points were given to each series for each criterion, and then they were totaled. The twelve chosen had high scores but not necessarily the highest, since diversified coverage of economic activities was also desired. The weights are the scores (Figure 4).[13]

Choosing Series. A good leading indicator consistently leads business cycles by at least a few months, as evidenced by its having turning points just prior to the reference dates. But choosing series on this basis suggests a particular notion of *causality* based on the temporal ordering of the turning points. This notion of causality is a statistical one which is used in forecasting.[14] An inference can be drawn about future economic activity when a turning point in the leading series is observed. When the leading series rises, it implies a rise in future economic activity. For the leading series to "cause" subsequent economic activity, forecasts using the leading series must be more accurate than forecasts which do not use the leading series. It is not enough that turning points in the leading series come before reference dates.

If the classification of economic series using the National Bureau turning point approach is valid, then forecasts of, say, the Index of Industrial Production should be more accurate when the leading indicators are used than when they are not used. After all, forecasts about future Industrial Production can be made from observing past and current values of the Index of Industrial Production alone. If forecasts of Industrial Production based on the leading indicators are more accurate than forecasts using only Industrial Production's own past history, then the leading indicators have been chosen in a useful way. The particular leading indicators which most improve forecasting accuracy would be the most useful ones.

The National Bureau's only criterion for leading indicators is that they consistently lead. But an indicator which consistently leads the Index of Industrial Production, for example, does *not* necessarily help predict the Index of Industrial Production any better than can be done by using only current and past values of the Index of Industrial Production. In other words, there may be no additional information in a leading indicator; the leading indicator may not "cause" the Index of Industrial Production.[15]

Using modern statistical techniques, the various leading series can be tested to see if they contain information which is really useful for predicting. Testing eleven of the twelve component series in this way reveals that six of the component series are not helpful in predicting the Index of Industrial Production when the individual series are adjusted to remove regular seasonal movements (Figure 5 overleaf). When the past history of Industrial Production is used to forecast its future value, taking account of these six leading series does not improve the forecast.

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the weights on the remaining eleven series were adjusted. Since the bankruptcy rate reached Depression levels during the current recession, the removal of the Index of Net Business Formation is not a trivial change and has, consequently, led to a minor controversy. See, for example, *Business Week*, July 26, 1982, p. 11.

[13]For a complete description of the criteria and the "scoring" procedure, see Victor Zarnowitz and Charlotte Boschan, "Cyclical Indicators: An Evaluation and New Leading Indexes," *Handbook of Cyclical Indicators* (May 1977), Bureau of Economic Analysis, U.S. Department of Commerce.

[14]See C.W.J. Granger, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," *Econometrica* 37, 3 (1969); and Christopher A. Sims, "Money, Income, and Causality," *American Economic Review* 62, 4 (1972).

[15]Thomas Sargent gives some theoretical examples of this in his book *Macroeconomic Theory* (New York: Academic Press, 1979), pp. 247-248.

FIGURE 4

THE INDEX OF LEADING INDICATORS INCLUDES TWELVE DATA SERIES

Component Series of the Index of Leading Indicators

BEA Series Number	Description of Series	Weight
1	Average workweek of production workers, manufacturing	.984
3	Layoff rate, manufacturing (inverted)	1.025
8	New orders, consumer goods and materials, 1972 dollars	1.065
12	Index of net business formation	.984
19	Index of stock prices (Standard and Poor)	1.079
20	Contracts and orders, plant and equipment, 1972 dollars	.971
29	Building permits, private housing	1.025
32	Vendor performance	.930
36	Change in inventories on hand and on order, 1972 dollars	.957
92	Percent change in sensitive prices (smoothed)	.971
104	Percent change in total liquid assets (smoothed)	1.011
105	Money supply (M1), 1972 dollars	1.065

SOURCE: *Handbook of Cyclical Indicators* (May 1977), U.S. Department of Commerce.

When nonseasonally adjusted data is used, only one component series is not helpful. These results suggest that it would be better not to seasonally adjust the data, contrary to the Commerce Department's current procedure. Also, other series which are not presently used as components of the Index of Leading Indicators have yet to be tested to see if they could improve the forecasting power of the Index of Leading Indicators.

Choosing Weights. Perhaps the unreliability of the Index of Leading Indicators could be reduced if the weights used to combine the twelve included series were chosen differently. The twelve series chosen represent a fairly diverse coverage of economic activity.[16] The Index is for all practical purposes unweighted since the weights vary so little (from .930 to 1.079). In a statistical sense, these weights were not chosen in the best way. That is, they were not estimated from the data, but rather were computed according to a more or less subjective scoring procedure.

When the weights to be used in constructing the Index are statistically estimated they do not resemble those currently used in the Index. Indeed, some of the statistically estimated weights turn out to be negative. Moreover, one researcher found that estimating the weights over different sample periods indicated that the relations between the component series of the Index and the underlying business cycle pattern were not stable, since different weights for the Index were chosen for each sample.[17] This finding suggests that

[16] The indices of lagging and coincident indicators are also described in the *Handbook of Cyclical Indicators*.

[17] Alan J. Auerbach, "The Index of Leading Indicators; 'Measurement Without Theory,' Twenty-five Years Later," National Bureau of Economic Research, Working Paper No. 761.

FIGURE 5

NOT ALL SERIES ARE HELPFUL PREDICTORS

Component Series of the Index of Leading Indicators	Seasonally Adjusted Data	Nonseasonally Adjusted Data
Average workweek of production workers, manufacturing		
Layoff rate, manufacturing (inverted)		
New orders, consumer goods and materials, 1972 dollars		
Index of net business formation	not helpful in prediction	
Index of stock prices (Standard and Poor)	not helpful in prediction	
Contracts and orders, plant and equipment, 1972 dollars		
Building permits, private housing	not helpful in prediction	
Vendor performance		
Change in inventories on hand and on order, 1972 dollars	not helpful in prediction	not helpful in prediction
Percent change in sensitive prices (smoothed)	not helpful in prediction	
Percent change in total liquid assets (smoothed)	(not tested)	(not tested)
Money supply (M1), 1972 dollars	not helpful in prediction	

SOURCE: Salih N. Neftci, "Lead-Lag Relations, Exogeneity and Prediction of Economic Time Series," *Econometrica* 47, 1 (January 1979), pp. 101-113.

the relations between the individual series used to construct the Index and the underlying pattern of economic activity change over time.

When the weights are estimated over one sample period and the Index so constructed is employed to forecast over another sample period, however, the results are poor compared to the Bureau of Economic Analysis Index with equal weights. Even though the weights chosen by the Bureau of Economic Analysis don't seem to be the best in a statistical sense, no obviously superior set of weights has yet been found.

Consideration of how the component series and the weights for the Index of Leading

Indicators are chosen reveals some problems and puzzles, but not necessarily solutions and answers. Not all the component series really improve the forecasts when compared to forecasting with only the past history of Industrial Production. But this is only a problem when seasonally adjusted data is used. The weights, seemingly not chosen in the best way, haven't been improved on. Only more research can resolve these issues. On balance, the most important problem with the Index of Leading Indicators seems to be that it uses seasonally adjusted data.[18] But no index has yet been constructed with non-seasonally adjusted data.

WHERE DOES ALL THIS LEAD?

The Index of Leading Indicators, like other forecasting methods, has its drawbacks. The most important of these is its tendency to signal turning points falsely. Another problem is unreliable lead times. It would be easy to conclude that the difficulties with the Index are so serious that it should be discarded. But that would be too hasty. Good forecasters use a variety of techniques and information. The Index of Leading Indicators does forecast turning points, and it has a strong record when evaluated by the whole cycle approach. The Index is a useful summary of the outlook for the aggregate economy since it combines a great deal of information about diverse activities. Moreover, it's free.

While the Index of Leading Indicators has some problems, the general approach has proven useful. No new, improved, index is yet available, but progress in the spirit of the National Bureau's "measurement without theory" approach is being made toward indices with improved predictive abilities.[19]

[18]The government's method of deseasonalizing data has been criticized before. See, for example, W.S. Cleveland and G.C. Tiao, "Decomposition of Seasonal Time Series: A Model for the Census X-11 Program," *Journal of the American Statistical Association* 71 (1976), pp. 581-587.

[19]An example of such current work is Robert B. Litterman, "A Use of Index Models in Macroeconomic Forecasting," Federal Reserve Bank of Minneapolis, Staff Report 78. Also Stephen Beveridge and Charles R. Nelson, "A New Approach to Decomposition of Economic Time Series with Attention to Measurement of the 'Business Cycle'," *Journal of Monetary Economics* 7 (1981), pp. 151-174.

FEDERAL RESERVE BANK OF PHILADELPHIA
BUSINESS REVIEW CONTENTS 1982

BUSINESS REVIEW
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