Leading Indicators of Inflation

By Howard L. Roth

Some of the best economic news in recent years has come from price statistics. Consumer price inflation fell dramatically from double-digit rates in 1979 to less than 4 percent early in 1983. Inflation then remained moderate for the next three years before slowing even further when oil prices collapsed early this year.[1] The Consumer Price Index (CPI) actually declined in February through April of this year, registering the largest three-month decline since 1949.

Despite this good news, considerable uncertainty surrounds the outlook for inflation. On the one hand, continued lackluster economic growth suggests that inflation might remain moderate. On the other hand, there are a number of reasons why inflation might increase. The deflationary effects of falling oil prices have come to an end, the inflationary effects of the depreciating dollar could be just beginning, the growth of money, however defined, has been rapid, and the current expansion is entering a relatively advanced stage that in past expansions has been characterized by increasing inflation.

In view of the uncertain outlook for inflation, considerable interest has been generated lately in predicting turning points in inflation. This article assesses various leading indicators of inflation that have been developed in recent years. The article begins with a review of the behavior of consumer price inflation since 1948. It then turns to an examination of five leading indicators of consumer price inflation and provides information on what the indicators are predicting now. Most of the indicators are currently pointing upward. Confidence in this forecast, however, is weakened

[1] This inflation scenario is described by the Consumer Price Index. The Producer Price Index (PPI) and the GNP deflator give similar descriptions. This article focuses entirely on the CPI. Much of the concern about inflation relates to its impact on consumers. Prices paid by consumers are intentionally excluded from the PPI, and although consumer prices enter the GNP deflator, so do prices paid by government units and businesses. In addition, imports, which have become increasingly important in satisfying consumers' demands, are reflected in the CPI but not in the deflator. Another reason for choosing the CPI over the deflator is that the monthly CPI provides more observations on inflation than does the quarterly deflator. The specific CPI measure studied in this article is the CPI, All Urban.

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somewhat by the newness of the indicators and uncertainty about their ability to predict future turning points in inflation.

Behavior of inflation: 1948 to 1986

Every month the Bureau of Labor Statistics (BLS) announces two sets of CPI figures, the index for the preceding month and rates of change in the index over various periods. The index itself measures the cost of purchasing a basket of goods and services in that month relative to the cost of purchasing the same items in a past reference period. For example, the index was 328.2 in August 1986, compared with 100 in the base year of 1967. This means that consumers found the goods and services covered by the CPI to be 3.282 times as expensive in August as in 1967 as a whole.

The CPI inflation figures that attract the most attention every month are the rate of change in the index over the previous month and the rate of change from the same month a year ago. The CPI was 327.6 in July 1986 and 323.1 in August 1985. Thus, consumer prices increased 0.2 percent from July to August 1986, or at a compound annual rate of 2.2 percent. From August 1985 to August 1986, consumer prices rose 1.6 percent.[2]

The measure of consumer price inflation used in this article is a variant of these approaches. The month-to-month measure is rejected because it can be quite variable, obscuring some characteristics of inflation. For example, the CPI rose at an annual rate of 4 percent from December 1985 to January 1986 and then fell almost 5 percent from January to February. Measuring inflation from the same month a year earlier, as from August 1985 to August 1986, results in a less variable measure of inflation because it averages the monthly growth rates for the 12 intervening months. However, such averaging can also eliminate important characteristics and introduce spurious ones. The measure used in this article strikes a balance between these two approaches. Specifically, it measures growth of the CPI index for a given month from its average value in the preceding 12 months.[3] This measure is less variable than the month-to-month measure and yet does not alter characteristics of inflation important to this study.[4]

Chart 1 employs this measure to depict inflation from 1948 to 1986. Three general observations can be made from the chart. First, consumer prices rose over most of this period, with the average annual rate of inflation over the entire period being slightly higher than 4 percent. Second, the rate of inflation varied considerably, ranging from −3.1 percent in July 1949 to 15.2 percent in May 1980. Third, until the last few years, the rate of inflation appeared to have trended

[2] All figures have been adjusted for seasonal effects. Seasonal adjustment of data eliminates most of the effects of changes that normally occur at about the same time and in about the same magnitude every year. For example, price data may be affected by normal weather patterns, regular production and marketing cycles, or model changeovers. Seasonal effects are of no interest in a study of the cyclical properties of an economic process and may actually obscure underlying cyclical behavior. For these seasons, studies of the cyclical behavior of economic processes are generally conducted with seasonally adjusted data.

[3] The formula used to compute inflation is

$$INF(t) = [\{CPI(t)/[\sum_{i=1}^{12} CPI(t-i)/12]\}^{**}(12/6.5) - 1.0] \times 100$$

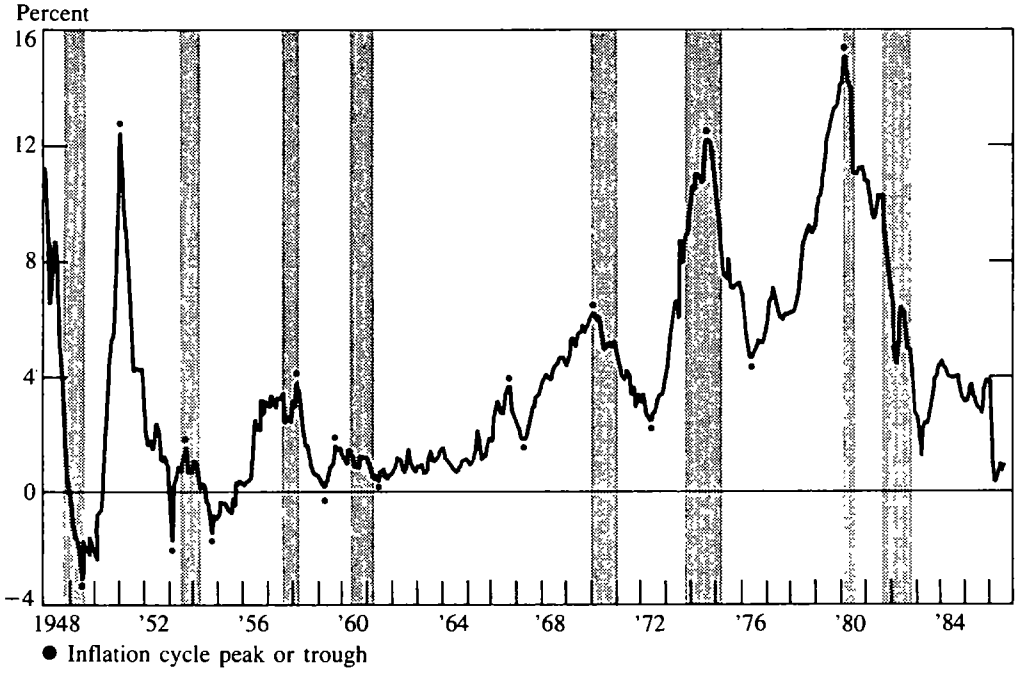
This measure is referred to as a six-month smoothed inflation rate. The "six-month" refers to the fact that the preceding 12 months are an average of six and a half months in the past. "Smoothed" refers to the use of the 12-month CPI average as a base for computing growth rather than the value of the CPI six months ago, a more variable number.

[4] This measure has been used in other inflation studies. See, for example, Geoffrey H. Moore and Stanley Kaish, "A New Inflation Barometer," *The Morgan Guaranty Survey*, July 1983; Geoffrey H. Moore, "Inflation Barometer: Rougher Weather Ahead," *The Morgan Guaranty Survey*, December 1983; Geoffrey H. Moore, "A Revised Leading Index of Inflation," Center for International Business Cycle Research, Graduate School of Business, Columbia University, February 1986, or Michael P. Niemira, "A Multiple Stage Decision Model for Forecasting Inflation," Paine Webber, July 1984.

CHART 1

Growth rate of Consumer Price Index, all urban

(Six-month smoothed rate, annualized)



upward. The average annual rate was 1.6 percent from January 1951 to December 1960, 2.9 percent from January 1961 to December 1970, and 8.1 percent from January 1971 to December 1980.

A closer examination of Chart 1 reveals that recessions slow inflation. In seven of the eight recessions shown as shaded areas in Chart 1, inflation was lower at the end of the recession than at the beginning. The brief 1957-58 recession was the exception. But it was a minor exception as inflation began a sharp decline before the 1958 recovery began. The behavior of inflation during the most recent recession was more typical. At the beginning of this recession in July 1981, the inflation rate was 10.6 percent. By the subsequent trough in November 1982, the rate had dropped to 4.3 percent.[5] Not only was inflation lower at the end of all but one recession, but in most cases, the rate of inflation continued to fall after business had started to recover. As the most recent example, inflation has continued to fall since the trough of the business cycle in November 1982.[6]

[5] Two studies of the behavior of inflation during economic slowdowns are Geoffrey H. Moore, "Recession Slows Inflation," reprinted in *Business Cycles, Inflation, and Forecasting*, Second Edition, Ballinger Publishing Company, Cambridge, MA, 1983, and Glenn H. Miller, Jr., "Slowdowns in Economic Activity and the Rate of Inflation," *Economic Review*, Federal Reserve Bank of Kansas City, September/October 1981, pp. 18-27.

[6] This description of inflation since November 1982 does not accord perfectly with Chart 1. The chart shows inflation rising between March 1983 and February 1984 and then steadily declining after February 1984. The 11-month upturn in inflation beginning in March 1983 most likely is a statistical artifact. The Bureau of Labor Statistics changed the way homeownership costs are computed in the CPI in January 1983. Other consumer price inflation measures, including an experimental CPI measure using the new methodology, show no upturn in inflation in 1983.

TABLE 1
Inflation turning points, 1948 to 1986

Trough		Peak		Change in Inflation During		Duration in months of	
Month	Inflation Rate*	Month	Inflation Rate	Expansion	Preceding Contraction	Expansion	Preceding Contraction
July 1949	−3.1	Feb. 1951	12.7	15.8	—	19	—
Jan. 1953	−1.6	Oct. 1953	1.8	3.4	−14.3	9	23
Oct. 1954	−1.2	Mar. 1958	4.0	5.2	−3.0	41	12
Apr. 1959	0.2	Oct. 1959	1.9	1.7	−3.8	6	13
June 1961	0.6	Oct. 1966	3.8	3.2	−1.3	64	20
May 1967	2.1	Feb. 1970	6.3	4.2	−1.7	33	7
June 1972	2.9	Sep. 1974	12.4	9.5	−3.4	27	28
June 1976	4.9	Feb. 1970	15.2	10.3	−7.5	45	21
Average				6.7	−5.0	30.5	17.7

*Six-month smoothed growth rate of CPI, all urban (annualized)

The chart also suggests that expansions fuel inflation. In five of the seven expansions since 1948, inflation was higher at the end of the expansion than at the beginning. The 1958-60 expansion and the recent expansion in 1981 were the two exceptions. However, the 1981 expansion was the shortest of the post-World War II expansions, which may help explain why inflation did not increase.

These regularities support the notion that inflation is related to the business cycle. Further support is seen in Table 1, which tabulates the inflation peaks and troughs marked in Chart 1. As shown in Table 1, expansionary phases of inflation cycles lasted 30.5 months, on average, during which the inflation rate rose an average of 6.7 percentage points. Contractionary phases of inflation cycles were shorter, on average, lasting 17.7 months. The rate of inflation declined 5.0 percentage points, on average, during these contractions.[7]

Five inflation indicators

As in predicting economic growth, anticipating turning points is the most difficult part of forecasting the course of inflation. In predicting growth of economic output, the difficulty of predicting turning points has led to a search for economic variables with turning points that correlate with turning points in the business cycle. Since the 1930s, the National Bureau of Economic

[7] The criteria used in specifying peaks and troughs were the size of the change in the rate of inflation and the length of time over which the change took place. Generally, a change of at least one and a half percentage points was required over a period of at least six months.

To be sure, identification of inflation troughs and peaks is somewhat arbitrary. The 1959 expansion and the 1967 contraction listed in Table 1 barely meet the criteria. And the rise in inflation in 1983 appears to be a statistical artifact and is not listed as an inflation expansion in Table 1 even though inflation increased almost 5 percentage points over an 11-month period.

Research (NBER) has identified numerous economic variables with turning points that either lead, coincide with, or lag turning points in the business cycle. The average number of hours worked by production or nonsupervisory manufacturing workers is an example of a leading indicator. In the early stages of a business recovery, businessmen usually increase the hours of their existing workers before hiring additional workers. Similarly, when business slackens, hours are cut before layoffs are made. The Department of Commerce takes the identification of indicator variables a step farther by combining the best of each category in composite indexes.

Interest in finding indicator variables for inflation has been a more recent development. The low and stable inflationary environment of the post-Korean War 1950s and the 1960s provided little incentive to find inflation indicators. But sharp increases in both the level and the variability of inflation in the 1970s focused the attention of economists on the inflationary process. Although no effort as comprehensive as the NBER business cycle indicator study has been undertaken, a number of leading indicators of inflation have been proposed, including two composite leading indexes.

Several characteristics are sought in choosing indicator variables, whether for the business cycle or inflation. First, the indicator should represent an important economic process and accurately measure it. In this respect, the price of an extensively used industrial commodity, such as crude oil, would be a better leading indicator of inflation than a commodity used relatively little, such as pine tar. Also a variable used as a leading indicator should not be subject to major revisions. Second, the indicator should bear a consistent relationship over time with movements and turns in the business cycle or inflation, as the case may be. Leads or lags should be fairly constant in length and anticipate or echo a high percentage of the turning points in the process being studied. Third, the indicator should not be dominated by irregular and noncyclical movements. A common fault of indicators is the presence of fluctuations of very short duration, or "noise," that tend to mask important cyclical movements. Fourth measurements of the indicator need to be promptly available and frequently reported. Because of their greater frequency, monthly statistics are preferred, other things equal, to quarterly statistics.

This article analyzes five leading indicators of inflation. They include two composite indexes—one developed by Geoffrey H. Moore of the Center for International Business Cycle Research at Columbia University and the other compiled by Michael Niemira of Paine Webber.[8] A third indicator, developed by John Morosani of Cyrus J. Lawrence Inc., is based on the ratio of the Federal Reserve's measure of industrial capacity utilization to its measure of the trade-weighted value of the dollar. A fourth indicator is the rate of increase of an index of spot prices for 18 industrial materials prices. This index is computed and published by the *Journal of Commerce*.[9] The

[8] Sources: Center for International Business Cycle Research Graduate School of Business, Columbia University, and Paine Webber. The two composite indexes have been constructed using the Department of Commerce's methodology for compiling the business cycle composite indexes.

[9] Sources: *Journal of Commerce*, Knight-Ridder, Inc. The 18 industrial materials are burlap, cotton, polyester, printcloth, scrap steel, copper scrap, aluminum, zinc, lead, tin, hides, rubber, tallow, plywood, corrugated boxes, red oak, benzene, and crude oil. The *Journal of Commerce* industrial materials price index was recently revised. The earlier index covered the prices of 15 industrial materials. In the revision, the prices of turpentine, linseed oil, and silk were deleted and the prices of crude oil, aluminum, plywood, red oak, benzene, and corrugated boxes were added. The most important addition in the current environment is crude oil. The original index was developed by J. Roger Wallace when he was associate editor and economist of the *Journal of Commerce*. The new index was compiled for the *Journal of Commerce* by the Center for International Business Cycle Research at Columbia University. For additional information on the revision of the *Journal of Commerce's* industrial materials price index, see the August 28, 1986 and September 2, 1986 editions of the *Journal of Commerce*.

fifth indicator is the rate of growth of the narrowly defined money supply, M1.[10]

The leading inflation index developed by Moore is a composite of five economic series: the percentage of the working age population that is employed; the growth rate of the industrial materials spot price index mentioned above; the growth of total business, consumer, and federal government debt outstanding; the growth rate of an index of import prices; and a Dun and Bradstreet compiled index of the consensus among businessmen regarding changes they expect in their selling prices.[11]

The first three components of the Moore index are intended to reflect the intensity of demand pressures in the labor, commodities, and capital markets, respectively. The percentage of the working age population that is employed has a direct bearing on how intensely employers have to compete for workers. When competition is high, wage inflation is likely to increase. And wage costs are usually reflected in the prices of products and services, though perhaps with some delay. The rate of increase in prices of industrial materials is usually influenced by changing economic conditions. The industrial materials included in the index are freely traded in open markets, and for that reason, their prices are sensitive to changing conditions in those markets. Furthermore, all the commodities in the index are widely used for further processing. Thus, changes in the prices of the index are likely to be reflected later in the prices of final goods. Growth in total debt generally reflects spending plans. New borrowing is often undertaken to finance the purchase of goods and services. Thus, more rapid growth of total debt might well be an early symptom of inflationary pressures stemming from increased demand for goods and services.

The two remaining components of Moore's composite index were incorporated early in 1986.[12] The growth rate of an index of import prices was included in recognition of the greater effect import prices have on consumer prices today. The Dun and Bradstreet index was added in recognition that businessmen should have an advantage in predicting where their prices are headed. The particular measure that was added is the percentage of surveyed businessmen that expect their prices to be higher in the coming quarter than in the corresponding quarter a year earlier.

The leading indicator of inflation developed by Michael Niemira is a composite of four economic series: vendor performance, the ratio of employment to population, the National Association of Purchasing Management's (NAPM) price survey index, and the Federal Reserve's trade-weighted dollar index. The vendor performance series measures the percentage of purchasing agents in the Greater Chicago area experiencing slower deliveries than a month earlier.[13] Slower deliveries often reflect a higher volume of business and,

[10] The inflation indicator properties of the pre-1980 measure of M1, which does not include other checkable deposits (OCD's), were also studied. The results for "Old M1" are not presented. The two measures of M1 had identical indicator properties until the mid-1970s because OCD's were negligible until then. Subsequently, the current M1 measure predicted inflation turning points marginably better than did Old M1.

[11] Sources: U.S. Department of Commerce, Bureau of Economic Analysis (percentage of working age population employed); *Journal of Commerce*, Knight-Ridder, Inc. (index of industrial materials prices); Board of Governors of the Federal Reserve System (growth of total debt); BLS (import prices); Dun and Bradstreet, Inc. (survey of businessmen regarding anticipated selling prices).

[12] See Geoffrey H. Moore, "A Revised Leading Index of Inflation," ... The Moore composite index was revised a second time in September 1986 to reflect changes in three of its components. The recently revised *Journal of Commerce* industrial materials price index replaces its predecessor in the Moore composite index. A BLS import price series that excludes crude oil replaces the earlier series, which included crude oil. And the growth rate of debt has been revised upward as a result of revisions in the mortgage debt of savings and loan associations.

[13] Source: Purchasing Management Association of Chicago.

Morosani Index

The Morosani Index is computed by first regressing CPI inflation on the 12-month lagged capacity utilization-dollar exchange rate ratio. The predicted values of the estimated equation are the values of the index. (Morosani uses the 12-month growth rate of the CPI as his inflation measure. The six-month smoothed rate was used in this study, however, to promote greater comparability with the other indicators. A check using the 12-month inflation measure showed no major differences.)

The OLS-estimated regression equation using data through May 1985 is

$$\underset{}{inf_t} = \underset{(-20.2)*}{-12.1} + \underset{(31.7)*}{24.7} \text{ (capacity utilization/dollar)}_{t-12}$$

t = 1968:1 to 1986:5
R^2 = 0.82
DW = 0.18

Because the explanatory variable is lagged 12 months, the estimated equation can be used to generate forecasts up to 12 months into the future.

With the announcement of new data each month, the equation is re-estimated and 12 new forecasts are generated.

*t-statistics in parentheses

therefore, can presage price increases. The NAPM price survey index summarizes recent price experiences and expectations of 250 purchasing managers concerning the prices they face.[14] In many instances, changes in input prices are later reflected in the prices of output. The trade-weighted value of the dollar summarizes in one number the individual exchange rates of the dollar against ten major foreign currencies.[15] The exchange rate of the dollar is a direct determinant of the cost of imports to domestic consumers as well as a constraint on the prices set by domestic producers of import-competing goods. When the dollar appreciates, as it did in the early 1980s, the prices of imports and of domestically-produced import-competing goods tend to grow more slowly, perhaps even declining. Thus, an appreciating dollar has a restraining effect on consumer price inflation. Conversely, a falling dollar can lead to higher inflation—the current concern.

The leading inflation indicator developed by John Morosani of Cyrus J. Lawrence Inc. is based on the ratio of the Federal Reserve's capacity utilization measure to the trade-weighted value of the dollar. (See the accompanying box for technical details.) This ratio is used in predicting the inflation rate 12 months in the future. The rate of capacity utilization is intended to capture the effect of demand pressures in the economy, and the trade-weighted value of the dollar is intended to measure the delayed effects of changes in the dollar's value on consumer price inflation.

[14] Source: National Association of Purchasing Managers.

[15] Source: Board of Governors of the Federal Reserve System.

CHART 2

CPI inflation and five leading indicators

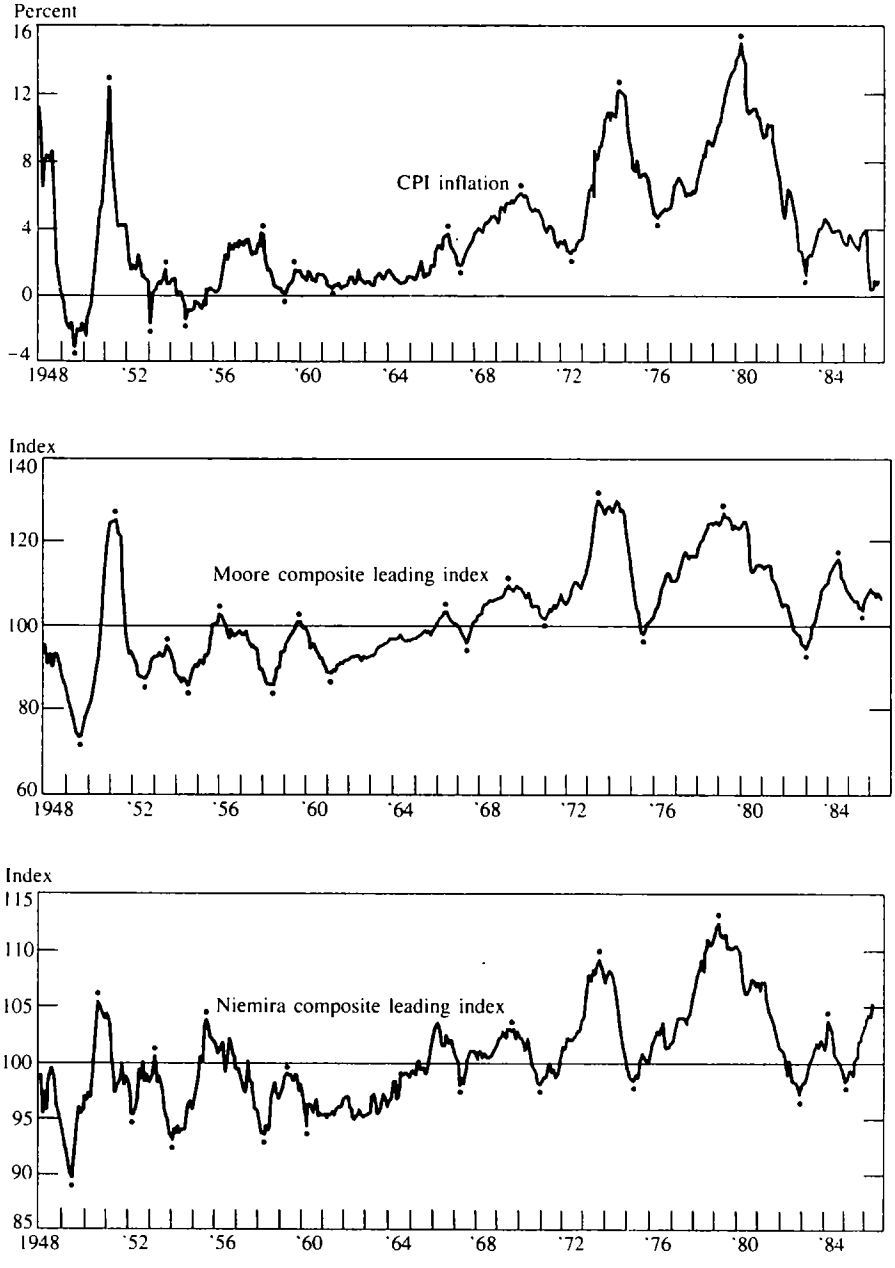
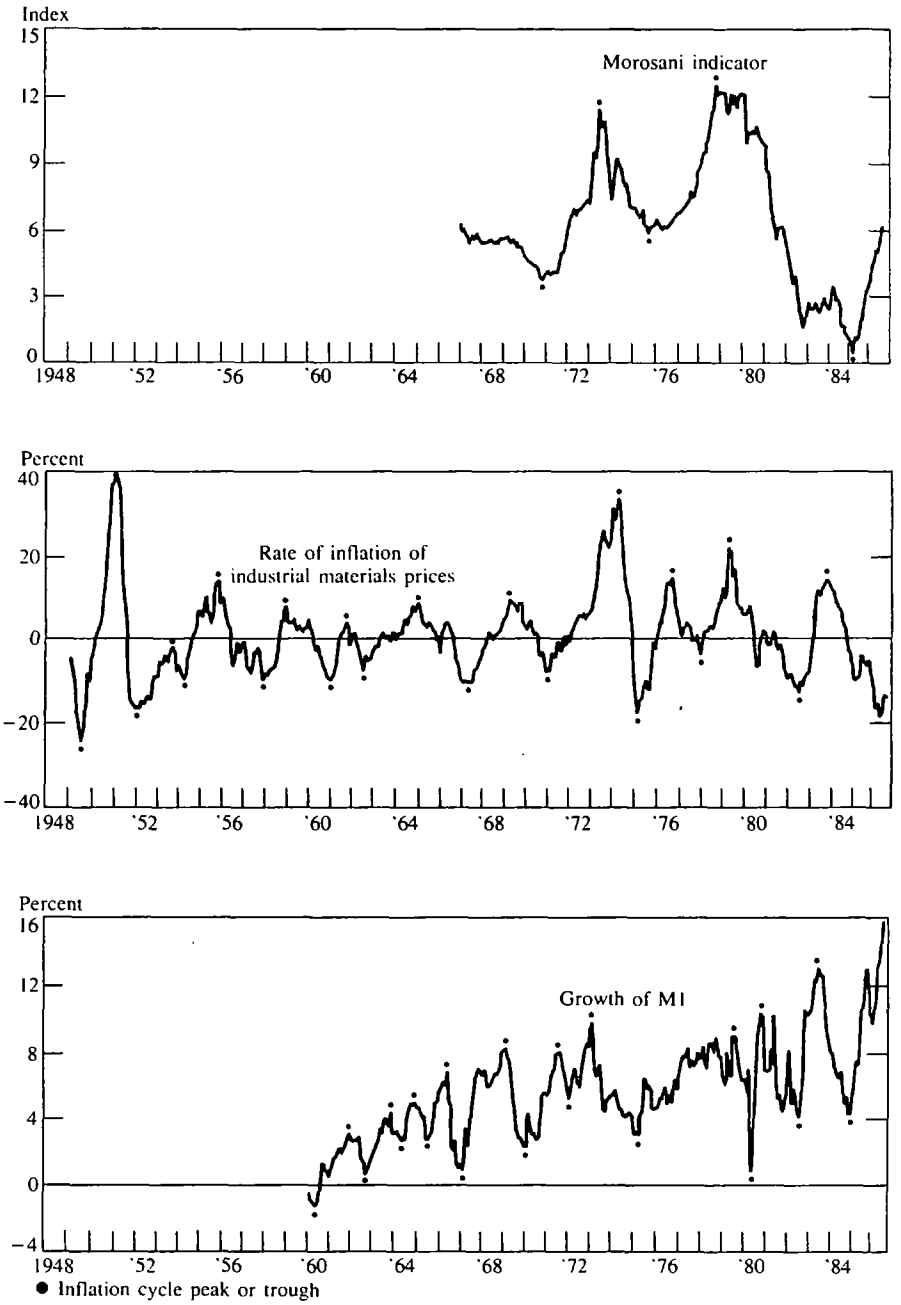


CHART 2 (continued)



Increases in capacity utilization and decreases in the trade-weighted value of the dollar push the Morosani indicator higher. Conversely, declines in capacity utilization and increases in the trade-weighted value of the dollar move the indicator lower.

The fourth inflation indicator is the *Journal of Commerce's* index of spot market prices for 18 industrial materials, the second component of Moore's composite index. The industrial materials price index was developed to give early signals of inflation or disinflation.

The remaining inflation indicator is the growth rate of M1. Reference to this measure has been made frequently in support of inflation predictions. To be sure, what is being predicted is typically a change in the average level of inflation, not a turning point. Nevertheless, M1 has been included in the study to see how well its growth rate anticipates turning points in inflation.

Chart 2 brings together the five leading inflation indicators and CPI inflation. The Moore, Niemira, and industrial materials indexes extend back to January 1948. Monthly data on M1 starts in January 1959. The Morosani index begins even later, in January 1967. Peaks and troughs in the series are marked. In general, the indicators and the CPI inflation measure show broadly similar fluctuations. Similarities between M1 growth and CPI inflation, though, are the most difficult to discern, particularly after 1979.

Performance of the indicators

How well do the five indicators perform? It is difficult to give a definitive answer to this question because the indicators are new and have not yet established a track record. Nonetheless, it is possible to provide some assessment by examining how closely turns in the indicators would have corresponded to past turns in inflation and how well the indicators would have predicted past turning points in inflation.

Correlation with inflation turning points

With respect to how closely turns in the indicators correspond to past turns in inflation, a perfect indicator would turn before each turn in inflation, lead inflation the same number of months every time, and turn only before turns in inflation. Table 2 documents how well the indicators meet these criteria.

The data in the upper half of Table 2 indicate how consistently the indicators turn before turns in inflation. For example, the Moore index turns one month before the July 1949 inflation trough. In fact, the Moore index and the other indicators almost always turn before inflation, as is evident from the predominance of minus signs. In addition, not one of the indicators misses an inflation turning point.

Data in the lower half of Table 2 show the average number of months that turns in the indicators lead or lag turns in inflation and the standard deviations of these leads and lags.[16] The average lead of the Moore composite index is 7.7 months, and the average lead of the Niemira composite index is 9.8 months. The other three inflation indicators turn earlier than the composites. The Morosani index leads CPI inflation an average of 14.8 months. But this average is based on only four observations. The average lead of the industrial materials index is about 12 months. M1 leads inflation by 13.4 months, on average. None of the indicators have constant leadtimes, as indicated by the standard deviations listed in Table 2. The Morosani indicator has the least variable

[16] The standard deviation of a series of numbers is a measure of the extent to which the numbers vary around their mean value. The mean of a data series x_t (t=1, ..., N) is defined as

$$\text{Mean} = \bar{x} = (1/N) \cdot \sum_{t=1}^{N} x_t$$

The standard deviation is defined as

$$\text{Standard Deviation} = \{[1/(N-1)] \cdot \sum_{t=1}^{N} (x_t - \bar{x})^2\}^{1/2}.$$

TABLE 2
Turning points of inflation indicators

Inflation Troughs (T) and Peaks (P)*	Number of Months that Indicator Turning Points Lead (−) or Lag (+) Inflation Turning Points				
	Moore	Niemira	Morosani	Industrial Materials Prices	M1
July 1949 (T)	−1	−1	NA	−1	NA
Feb. 1951 (P)	+1	−6	NA	−3	NA
Jan. 1953 (T)	−7	−10	NA	−14	NA
Oct. 1953 (P)	−3	−7	NA	−2	NA
Oct. 1954 (T)	−3	−9	NA	−8	NA
Mar. 1958 (P)	−27	−30	NA	−30	NA
Apr. 1959 (T)	−11	−12	NA	−17	NA
Oct. 1959 (P)	−2	−6	NA	−11	NA
June 1961 (T)	−4	−15	NA	−6	−14
Oct. 1966 (P)	−4	−7	NA	−23	−6
May 1967 (T)	0	−2	NA	−5	−4
Feb. 1970 (P)	−5	−6	NA	−11	−13
June 1972 (T)	−19	−18	−19	−18	−29
Sep. 1974 (P)	−15	−11	−14	−6	−20
June 1976 (T)	−11	−15	−9	−17	−14
Mar. 1980 (P)	−12	−2	−17	−12	−7
	Mean lead (−) or lag (+) in months				
All turning points	−7.7	−9.8	−14.8	−11.5	−13.4
Troughs	−7.0	−10.3	−14.0	−10.8	−15.3
Peaks	−8.4	−9.4	−15.5	−12.3	−11.5
	Standard deviation of leads and lags in months				
All turning points	7.4	7.1	3.8	7.8	7.7
Troughs	6.0	5.7	5.0	6.1	8.9
Peaks	8.6	8.1	1.5	9.1	5.6
	Number of extra turning points†				
	2	2	0	6	8

*Six-month smoothed growth rate of CPI, all urban (annualized)
†No corresponding turning points in the CPI growth rate. The Moore composite index has extra turning points in December 1982 (T) and June 1984 (P). The Niemira composite index has extra turning points in November 1982 (T) and March 1984 (P). The industrial materials prices index has extra turning points in September 1961 (P), July 1962 (T), July 1976 (P), September 1977 (T), June 1982 (T), and September 1983 (P). M1 has extra turning points in November 1961 (P), September 1962 (T), November 1964 (P), June 1965 (T), May 1980 (T), October 1980 (P), July 1982 (T), and May 1983 (P).
NA: Data not available

leadtime. But again, this statistic is based on only four observations. The variabilities of the leads of the other four indicators are broadly similar.

The bottom line of Table 2 reveals that the Morosani indicator has no "extra" turning points—turning points that do not correspond to turning points in CPI inflation.[17] The two composite indexes each have two extra turns, the industrial materials price index has six, and M1 has eight.

Predictions of inflation turning points

A second way of evaluating the inflation indicators is according to how well they can be used to generate early warning signals of cyclical swings in inflation. How this criterion differs from the criterion used in Table 2 can be illustrated by a hypothetical example. Suppose an inflation indicator has declined one month after having climbed steadily over the preceding year. Suppose further that inflation also has been increasing steadily, with no signs of moderating. Generally, a one-month decline in the indicator would not justify a warning that inflation is about to fall. One-month declines in indicators are often reversed the following month.

What would warrant a prediction of falling inflation, generally, is any behavior of the indicator that in the past has been associated with downturns in inflation. This behavior might be a number of consecutive monthly declines of the indicator when inflation has been increasing. Or it might be a critical percentage decline of the indicator. These are only two of many possible rules for determining when the behavior of the indicator justifies warning that inflation is about to fall. If, in fact, a warning signal is given and inflation actually falls, three events will have taken place—the indicator will have turned, the indicator will have given a warning signal that inflation is about to fall, and inflation will have fallen. In terms of these three events, the criterion used in the analysis underlying Table 2 was how well turns in the indicator correlate with turns in inflation. The criterion used in this section is how well the indicator signals turns in inflation.

In a sense, the second criterion is an extention of the first. The ability to signal cyclical swings in inflation depends on how closely the turning points of the indicator are correlated with turning points in inflation. But the ability to signal cyclical swings in inflation also depends on how strongly the indicator moves in anticipation of a cyclical swing in inflation and how well the conditions under which the indicator anticipates a turning point in inflation can be summarized by a rule for signaling turning points.

Why is a rule for signaling turning points needed? As in the hypothetical example, early warnings of cyclical swings in inflation must be given in practice without knowledge of future values of both inflation and the indicator. The rule compensates for this lack of knowledge about the future.

Of the five indicators, only Moore's index has a turning point rule specified for it. The rule is based on growth of the index, calculated according to the formula used to measure inflation in this study. A peak is signaled the first month growth falls below -1.0 percent. Similarly, a trough is signaled the first month growth exceeds 1.0 percent. As will be seen below, this rule allows the Moore index to signal all the inflation turn-

[17] Extra turning points are also a problem of the composite business cycle indicators. Efforts have been made to alleviate this problem in the case of composite index of leading business cycle indicators. See Saul H. Hymans, "On the Use of Leading Indicators to Predict Cyclical Turning Points," *Brookings Papers on Economic Activity*, February 1973, pp. 339-84, 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, March 1981, pp. 151-174, and Carl J. Palash and Lawrence J. Radecki, "Using Monetary and Financial Variables to Predict Cyclical Downturns," *Quarterly Review*, Federal Reserve Bank of New York, Summer 1985, pp. 36-45, and the references therein.

ing points in Table 1, although frequently signaling only after the fact.

Turning point rules were developed in this study for the other four indicators. The objective was to find rules that allow the indicators to signal past turning points accurately, the hope being that the rules will continue to work in the future. Developing good rules for some of the indicators was quite involved. Fortunately, this was not the case with the Niemira index. The rule developed for the Moore index works well for the Niemira index.

The rule developed for the Morosani index compares the predicted change in the rate of inflation in the next 12 months with the change in the rate of inflation in the preceding 12 months.[18] A trough is signaled the first month the predicted change in inflation in the next 12 months is positive, the change in the preceding 12 months is negative, and the difference between the two changes exceeds two percentage points. The peak signal is the mirror image of the trough signal.

The rule for the M1 indicator compares current growth of M1 with its average growth in the previous 12 months. A trough is signaled the first month that growth exceeds the average by at least two percentage points. A peak is signaled the first month M1 growth falls below the average by at least two percentage points.

The rule for the raw industrial materials index is also based on the difference between the growth of the index and its average growth in the previous 12 months. But prices of raw industrial materials can swing widely. For that reason, a trough is not signaled until the index exceeds the average by at least 2.5 percentage points for three consecutive months. A peak is not signaled until the index falls below the average by at least 2.5 percentage points for three consecutive months.

[18] The most recent data used in estimating the Morosani equation was from the period in which the predictions would have been made. (See box on page 9 for details.)

In signaling turns in inflation, a perfect indicator signals every turn in inflation, gives its signal the same number of months ahead or behind every time, and does not give false signals. Table 3 documents how well the indicators meet these criteria.

The data in the upper half of Table 3 indicate how successfully the indicators signal past turns in inflation. For example, the Moore index signals the July 1949 trough in inflation four months later, in November 1949. This signal only confirms a turn in inflation, as do almost half of the signals recorded in Table 3. But confirming signals can be useful. In practice, it takes time to determine whether a change in the rate of inflation is temporary or the beginning of a new phase. An indicator that signals at or soon after turning points in inflation can help make the distinction. A confirming signal is at least more informative than no signal. Missed signals are not a problem, however. The only miss is committed by the M1 index.

Data in the lower half of Table 3 report the average number of months of advanced warning given by the indicators and the variability of these warnings. The average warnings range from 2.8 months for the Moore composite index to ten months for the Morosani indicator. The Niemira composite index signals slightly earlier, on average, than the Moore index. The Moore index has the least variable leadtime, although no major differences were found in the variabilities of the indicators, as indicated by the standard deviations listed in Table 3.

The bottom line of Table 3 reveals that only the Morosani indicator succeeds in giving no false signals. The Moore composite index makes two false signals. The Niemira composite index and the M1 indicator each make four false signals. The industrial materials price index gives six false signals.

Of the five inflation indicators, the two composite indexes best meet the criteria underlying

TABLE 3
Turning point signals given by inflation indicators

Inflation Troughs (T) and Peaks (P)*	Number of Months that Indicator Turning Point Signals Lead (−) or Lag (+) Inflation Turning Points				
	Moore	Niemira	Morosani	Industrial Materials Prices	M1
July 1949 (T)	4	2	NA	NA	NA
Feb. 1951 (P)	4	2	NA	1	NA
Jan. 1953 (T)	−2	−6	NA	−5	NA
Oct. 1953 (P)	0	−3	NA	2	NA
Oct. 1954 (T)	0	−2	NA	−5	NA
Mar. 1958 (P)	−21	−25	NA	−26	NA
Apr. 1959 (T)	−7	−8	NA	−10	NA
Oct. 1959 (P)	3	3	NA	4	NA
June 1961 (T)	2	3	NA	−3	M
Oct. 1966 (P)	−1	2	NA	−16	−3
May 1967 (T)	3	4	NA	4	1
Feb. 1970 (P)	−2	0	−11	−4	−8
June 1972 (T)	−13	−6	−23	−10	−21
Sep. 1974 (P)	−3	−3	−8	−4	−13
June 1976 (T)	−5	−8	−4	−9	−12
Mar. 1980 (P)	−7	−7	−4	−7	0
	Mean lead (−) or lag (+) in months				
All turning points	−2.8	−3.3	−10.0	−5.9	−8.0
Troughs	−2.3	−2.6	−7.7	−5.4	−10.7
Peaks	−3.4	−3.9	−13.5	−6.3	−6.0
	Standard deviation of leads and lags in months				
All turning points	6.5	7.0	7.0	7.6	7.4
Troughs	5.4	4.7	2.9	4.6	9.0
Peaks	7.4	8.6	9.5	9.5	5.0
	Number of false signals†				
	2	4	0	6	4

*Six-month smoothed growth rate of CPI, all urban (annualized)
†Signaled turning point did not materialize. The Moore composite index gives false signals in March 1983 (T) and September 1984 (P). The Niemira composite index gives false signals in June 1962 (P), April 1963 (T), April 1983 (T), and August 1984 (P). The industrial material prices index gives false signals in March 1962 (P), April 1963 (T), October 1976 (P), June 1978 (T), December 1982 (T), and February 1984 (P). And M1 gives false signals in September 1980 (T), July 1981 (P), October 1982 (T) and November 1983 (P).
M: Indicator fails to signal turning point in CPI
NA: Data not available

Tables 2 and 3. Both composite indexes match every turn in inflation. Both composites make only two extra turns. Both signal every turning point in inflation. The Moore index gives two false signals and the Neimira index four. The Morosani indicator makes no errors, but its record is very short. The industrial materials price index and M1, on the other hand, are considerably less promising. Both the industrial materials price index and M1 make too many extra turns and give too many false signals. In addition, M1 fails to signal one inflation turning point.

Qualifications

Tables 2 and 3 might put the inflation indicators in too favorable a light. A few qualifications should be made. First, the indicators, except for M1, were specifically designed to anticipate past turning points in the rate of inflation. That they perform this task well should not be surprising. But this ability to predict past turning points in inflation does not ensure success in anticipating future turning points in inflation. The underlying economic processes that led to the correlations between the indicators and inflation could change. As cases in point, the Niemira composite leading inflation index has been revised once and the Moore composite index has been revised twice in the past two years to reflect the growing importance of imports on consumer price inflation. The composite indexes are new, and it is reasonable to expect that some initial refinement may be needed. But if they continue to need modifying every two or three years, the indexes will be of little use.

Second, a similar point can be made regarding turning point rules. These rules were designed to explain the past. Turning point rules are limited in number and complexity only by the imagination. With perseverance, a rule can be found to explain the past. But there is no guarantee that the rule will work well in the future.

The last two points are part of a more general criticism—that the indicator approach is really measurement without theory.[19] The root of this criticism is that the indicators do not emerge naturally from a rigorous theoretical model of the economy.[20] Rather, the variables used as indicators or as components of composite indexes simply make sense.[21] Without a theoretical model, it is difficult to explain or predict changes in the relationships between variables. This shortcoming can lead to problems. For example, suppose two economic variables have been highly correlated and that, as a result, one of the variables has been an excellent indicator of the other. The two variables need not be directly related. Their correlation could arise from them being related to a third variable. If a change in the economy resulted in the third variable being no longer related to either of the two original variables, the correlation observed between the two original variables might disappear.

Third, completely revised data was used in evaluating the indicators. In practice, much of the data is subject to revision. Reliance on preliminary data could degrade the performance of the indicators. An analysis of the indicators' performance based on originally published data is beyond the scope of this study, but the possibility cannot be dismissed that the results reported here are biased favorably by use of revised data.

[19] See, for example, Alan J. Auerbach, "The Index of Leading Indicators: 'Measurement Without Theory,' Thirty-Five Years Later," *The Review of Economics and Statistics*, November 1982, pp. 589-95.

[20] Much of applied macroeconomics is subject to this criticism, which probably says as much about the state of theoretical macroeconomics as it does about the practice of applied macroeconomics.

[21] The good performance of the Morosani index does not make sense in one respect. The index relies on the level rather than the growth rate of the trade-weighted value of the dollar. Intuitively, the growth rate of the dollar would be expected to be more closely correlated to inflation than is the level of the dollar.

TABLE 4
Behavior of the inflation indicators since the February 1984 peak in CPI inflation*

Indicator	Indicator Turning Points (all troughs)	Signals Given by Indicators (all troughs)
Moore	September 1985	November 1985
Niemira	February 1985	August 1985
Morosani	January 1985	February 1986
Industrial material prices	—	—
M1	October 1984	May 1985

*The February 1984 peak in CPI inflation was the most recent cyclical swing in inflation.

What are the inflation indicators saying now?

Considerable uncertainty surrounds the current outlook for inflation. The steady decline in the dollar's value since early 1985 and the dramatic fall in oil prices in early 1986 are the most frequently cited events when current inflation is analyzed and predictions for 1987 are made. The fall in oil prices had almost an immediate effect, driving consumer price inflation on a month-to-month basis below zero for three consecutive months early this year. The effect of falling oil prices appears to have run its course, however. The effect of the decline in the dollar, on the other hand, has been limited so far, manifesting itself primarily in increases in the prices of some manufactured imports. The questions asked most often are, will the fall in the dollar become the main influence on consumer price inflation and, if it does, when will it increase inflation and how much?

Most of the inflation indicators analyzed in this article point toward higher inflation. As shown in Table 4, four of the five indicators reached troughs in either late 1984 or 1985. Only the industrial materials price index has not turned upward yet. Table 4 also shows that all of the indicators except the industrial materials price index have signaled an upturn in inflation in the past two years. The Morosani indicator was the most recent to signal an upturn, in February 1986.

Differences in how the indicators are affected by oil prices and the dollar's exchange value explain why the two composite indexes and the Morosani indicator are pointing toward higher inflation while the industrial materials price index is not. The fall in oil prices beginning late last year has kept the industrial materials price index from turning up.[22] Because this index is a component of the Moore composite index, falling oil prices also have had a moderating influence on the Moore index. But the falling dollar has more than offset the effect of falling oil prices on the Moore index by pushing up another component of the Moore index—prices of imports excluding crude oil. The falling dollar also is clearly respon-

[22] The earlier index, which did not include crude oil, turned up in December 1984.

TABLE 5
Predictions of inflation

	R^2	Inflation Prediction: Date	Inflation Prediction: Rate
Moore: $\hat{inf} = -22.8 + 0.261$*(Moore Index)$_{-7}$ (−29.4) (34.9)	0.73	Feb. 1987	5.2%
Niemira: $\hat{inf} = -71.4 + 0.750$*(Niemira Index)$_{-9}$ (36.6) (38.7)	0.77	Feb. 1987	7.7
Morosani: $\hat{inf} = -12.05 + 24.75$*(cap util/dollar)$_{-12}$ (−20.2) (31.7)	0.82	Aug. 1987	6.1
Industrial Materials: $\hat{inf} = 3.97 + .170$*(growth in ind. material price index)$_{-11}$ (26.1) (11.3)	0.23	July 1987	1.7
M1: $\hat{inf} = 1.85 + 0.612$*(growth in M1)$_{-12}$ (4.4) (9.11)	0.21	Aug. 1987	11.5

Definitions: $\hat{inf}$ = predicated CPI inflation
cap util = industrial capacity utilization rate, Federal Reserve
dollar = trade-weighted exchange value of the dollar, Federal Reserve
Ind. material price index = *Journal of Commerce* index of 18 industrial materials prices

Notes: Figures in parentheses are t-statistics.
The lags chosen for the indicators are the average number of months the indicators turn before CPI inflation (see Table 2).

sible for the increase in the Morosani indicator. The only other variable entering this indicator is industrial capacity utilization. Capacity utilization has gradually fallen for the past few years, having an opposite but much smaller effect on the Morosani indicator than has the decline of the dollar. The dollar also directly enters the Niemira composite index, and the fall in the dollar is the primary reason this index is predicting an upturn in inflation.

Four of the five indicators have reached troughs in the past two years and have signaled rising inflation, but concern about an upturn in inflation should be tempered for two reasons. First, the indicators are new. Their predictive abilities have not been demonstrated in practice. Second, the indicators are not independent of each other. The value of the dollar figures prominently in three of them. The price of oil is important in at least two. Thus, the troughs reached by the four indicators are probably not four independent pieces of evidence that inflation will soon reach a trough.

Numerical forecasts of inflation are more difficult to obtain from the indicators. Only the Morosani indicator gives a direct numerical forecast of inflation. In August 1986, this indicator was predicting consumer price inflation of 6.1 percent by August 1987, an increase of almost five percentage points. Although the other four

indicators are not designed to provide numerical forecasts of inflation, rough indications can be obtained by referring to the past correlations between the indicators and consumer price inflation. These indications have been obtained through regression techniques, and the resulting equations are given in Table 5. The predictions range from the industrial materials price index's forecast of 1.7 percent in July 1987 to the M1 indicator's prediction of 11.5 percent by August 1987. The M1 and industrial materials prices equations have very little explanatory power, however, and their predictions ought to be discounted. The average prediction of the other three indicators is 6 to 6.5 percent consumer price inflation early in 1987.

Conclusion

Five leading indicators of inflation have been examined in this article. Two are composite indexes patterned after the composite leading indicator of the business cycle. The other three are simpler. The indicators, particularly the composite indexes, anticipate past turning points quite well. The growth rate of M1 turns more frequently than consumer price inflation, however, and is, therefore, too prone to predict inflation turning points. Rules for signaling inflation turning points based on the behavior of the indicators were also analyzed. A rule was found that allowed each indicator to signal past turning points in inflation with at least some degree of success.

Most of the indicators currently point toward higher inflation. Four of five have reached troughs in the last two years and have signaled an upturn in inflation. These predictions are cause for concern. The concern should be tempered, however, by awareness that the indicators are new. Their success in explaining past turning points in inflation should come as no surprise. The indicators, except for M1, were specifically designed to predict past turning points in inflation. Their ability to predict future turning points in inflation remains to be seen.