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Looking Ahead: Leading Indexes For Pennsylvania and New Jersey

Theodore M. Crone and Kevin J. Babyak**

Business planners and policymakers regularly look for any sign of a change in the direction of the overall economy. Prudent budget directors will reduce their revenue projections when they see indications of a slowdown in the economy. Likewise, prudent business managers will take steps to curtail their inventories. In these attempts to anticipate general business conditions, people look for signals about the economy.

One signal of the future course of the national economy is the traditional composite index of leading indicators, now published by the Conference Board but maintained for many years by the U.S. Department of Commerce. Recently, the National Bureau of Economic Research (NBER) began publishing an alternative leading index, developed as part of its project on cyclical indicators. Both these indexes are

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meant to foreshadow the direction of the national economy six to nine months ahead.[1]

Many policymakers and business persons, however, are interested not only in the course of the national economy but also in the course of their region's economy. Since 1994 the Federal Reserve Bank of Philadelphia has published monthly indexes of coincident indicators for the three states in the Third Federal Reserve District (see the 1994 article by Crone). These indexes reveal that state recessions do not necessarily coincide with national recessions. Therefore, a natural complement to the coincident indexes would be a set of leading indexes for the states. This article introduces leading indexes for the two largest states in the District—Pennsylvania and New Jersey—based on the methodology of the NBER's new alternative index for the nation. They are the first state indexes to be developed using this methodology.[2]

LEADING INDEXES OF THE NATIONAL ECONOMY

The origins of the current leading indexes for the nation go back to the late 1930s when Wesley Mitchell and Arthur Burns drew up a list of 71 statistical series that they considered to be reliable indicators of economic recoveries. The list was later extended to include leading indicators of recessions. Lists of coincident and lagging indicators were developed as well. These lists were periodically revised, and over time, the individual indicators were combined to construct composite indexes intended to summarize the information in the individual indicators and give an overall assessment of the economy. Both the identification of individual indicators and the development of composite indexes have been part of a broader effort to explain business cycles, which Burns and Mitchell described as "a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle. . . .; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles . . . [that exhibit swings in economic activity of similar] amplitudes."

From a List of Indicators to a Composite Index. The early development of composite indexes was based on the notion that there is a set of indicators that reflects the current state of the economy, a set that reflects the future state of the economy, and a set that reflects past economic activity. Once researchers identified and categorized individual cyclical indicators as coincident, leading, or lagging, the next step was to combine at least some of those indicators into single composite indexes. Since business cycles are defined as broad-based contractions and expansions, combinations of indicators or composite indexes are generally better at tracking the cycles than any single indicator (see the article by Geoffrey Moore). But which indicators should be included in each composite index? And should they all be given the same weight in forming the composite index?[3]

[1]The index of leading indicators formerly maintained by the Department of Commerce has been published by the Conference Board since late 1995. We will refer to it as the traditional leading index.

[2]In the late 1970s and early 1980s, the Federal Reserve Bank of Philadelphia published a leading index for the Philadelphia region using the Commerce Department's methodology (see Anthony Rufolo's article).

[3]To help answer these questions Geoffrey Moore and Julius Shiskin developed an explicit scoring system to gauge the value of the individual series as indicators of the business cycle. They considered such factors as how large a portion of the economy is reflected in the series, how much

The components of the traditional composite index of leading indicators and the weights assigned to them have changed over the years. Currently, the index is constructed from 11 components (Table 1). As in the case of the coincident and lagging indexes, changes in the leading index are calculated as a weighted average of the monthly changes in each of the components. The current weights for the monthly changes in the components of the index are primarily designed to keep the more volatile series from dominating month-to-month movements in the index.[4]

How well does this leading index lead? A leading index can be evaluated either by how well it predicts turning points in the business cycle or by how well it predicts actual changes in some economic indicator at all points in the cycle (see Gary Gorton's article). The most frequent use of the traditional leading index, however, has been to predict turning points in the business cycle, especially economic downturns or recessions.

Several different rules of thumb have been applied to the leading index to determine whether it is signaling a recession. As Gorton points out, these rules of thumb are inherently arbitrary, but the most common rule is that three successive declines in the index forecast a re-

TABLE 1

Components of the Traditional Leading Index

- Average weekly hours of production workers in manufacturing
- Average weekly initial claims for unemployment insurance
- Manufacturers new orders in constant dollars for consumer goods and materials industries
- Index of vendor performance
- Contracts and orders for plant and equipment in constant dollars
- Index of new private housing units authorized by local building permits
- Manufacturers unfilled orders for durable goods in constant dollars
- Sensitive materials prices
- Index of stock prices, S&P 500 common stocks
- Money supply (M2) in constant dollars
- Index of consumer expectations compiled by the University of Michigan Research Center

the series fluctuates with the cycle, how large and how frequent revisions to the series are, and how promptly the data for the series are available. Moore and Shiskin used their scores not only to draw up short and long lists of indicators but also to weight the indicators in constructing composite indexes.

[4]A standardized change is calculated for each component by dividing this month's change in the series by the average size of monthly changes over a historical period. For example, between 1978 and 1989 the average absolute percentage change in hours worked by production workers in manufacturing was 0.42. If the actual change in the most recent month was only 0.21, or one-half the historical average, the standardized change would be 0.5. The monthly change in the composite index is a weighted average of these "standardized changes" in the components. The weight is adjusted so that a 1 percent change (or one unit change) in each of the components results in a 1 percent change in the composite index. The current formulas for calculating the index can be found in the article by George Green and Barry Beckman.

cession within the next nine months. By this rule the traditional index has successfully predicted eight of the nine U.S. recessions since 1948, with leads of two to eight months.[5] But it has also given seven false signals. Once the economy is in a recession, the traditional leading index has generally been slow to signal a recovery using the popular three-month rule. Only three times in the last nine recessions has the index recorded three successive increases before the official beginning of the recovery.[6]

The record of the traditional leading index has not been perfect, but it has been helpful in predicting recessions. Questions are frequently raised, however, about how the index is constructed. A major issue is how the weights for the components are determined (see Vance Martin's article). While the current weights adjust for the volatility of the various components, they do not reflect differences in how broadly the indicators represent the economy or of how consistent they have been in leading recessions or recoveries. Also, as their names suggest, the index of *leading* indicators ought to lead the index of *coincident* indicators. And although the same methodology is used to construct the traditional coincident and leading indexes, no statistical technique is employed to ensure that the leading index actually "leads" the coincident index (see the article by Green and Beckman).

A Forecasting Approach to a Leading Index. In the late 1980s under the auspices of the NBER, James Stock and Mark Watson developed an alternative leading index that attempts to respond to some of the questions raised about the traditional index (see the 1994 article by Crone). In essence, their leading index is a statistical forecast of future economic conditions. The weights assigned to the various components of the index are not set arbitrarily but are determined by how well each component helps predict future conditions.

As a first step in their effort to develop alternative measures of the business cycle, Stock and Watson developed a *new index of coincident indicators* for the economy. With one slight modification this index includes the same series as the traditional one. The major difference between the two lies in the method by which they are constructed. Rather than use some average of the monthly changes in the individual coincident indicators, Stock and Watson use a modern time-series technique known as dynamic factor analysis to estimate what they term the "unobserved state of the economy." This estimated "state of the economy" is their alternative coincident index, and the implicit weights for the individual components are determined in the process of estimating their model. In practice, the historical pattern of Stock and Watson's new coincident index differs little from the pattern of the traditional coincident index. Both tend to reach their peaks and troughs at or very near the NBER Dating Committee's official peaks and troughs of U.S. business cycles. But Stock and Watson's coincident index provides the basis for their leading index.

Stock and Watson's *new leading index* differs from its traditional counterpart in more ways than their coincident index does. First, the list of individual indicators Stock and Watson use to construct their leading index varies substantially from the traditional list (Table 2). Their leading index is constructed from their coincident index and seven other indicators, only two of which appear in the list of 11 leading indicators used to construct the traditional index.

More important than the differences in the lists of individual leading indicators is the difference in Stock and Watson's methodology.

[5]The failure was for the 1990-91 recession. Three declines in the leading index did occur between May and July 1989, one year before the onset of the 1990-91 recession. But we do not consider this to be a true recession signal, since the index later recorded three successive increases before the recession actually began.

[6]In four other cases the leading index registered its second successive increase in the month the recession ended.

TABLE 2

Variables Used to Construct Stock and Watson's Leading Index

- Stock and Watson's Coincident Index
- Index of new private housing units authorized by local building permits*
- Manufacturers unfilled orders for durable goods in constant dollars*
- Part-time work in nonagricultural industries because of lack of full-time work
- Trade weighted nominal exchange rate between the U.S. dollar and the currencies of the U.K., West Germany, France, Italy, and Japan
- Yield on 10-year Treasury bonds
- Spread between the yields on 10-year Treasury bonds and one-year Treasury notes.
- Spread between the interest rates on six-month commercial paper and six-month Treasury bills

*Also in the list of indicators for the traditional leading index.

Rather than constructing a leading index from some average change in the individual indicators, Stock and Watson tie their leading index more closely to their coincident index. If the coincident index truly reflects the state of the economy, a good forecast of the change in the coincident index should make a good leading index. Therefore, Stock and Watson use past changes in their coincident index as well as a number of other variables that have historically led the business cycle to forecast the change in the coincident index over the next six months. This forecasted six-month change in the coincident index becomes their leading index. To produce the forecast they use a common time-series technique called vector autoregression, or VAR (see *The Basics of VAR Forecasts*). The effect of each indicator on the composite leading index is statistically determined in the process of estimating the forecast.

How well does this new index forecast recessions? Stock and Watson's leading index is available only from 1960. The U.S. economy experienced a recession that year and has suffered five others since then. How well did this new index signal the past five recessions? Since Stock and Watson's leading index is a forecasted change in economic activity, a negative value of their index is analogous to a decline in the traditional index. If we apply the rule of three consecutive negatives to Stock and Watson's leading index, it forecasts four of the five U.S. recessions since the end of 1960 with leads of two to six months. Like the traditional index, Stock and Watson's would not have forecast the 1990-91 recession using the rule of three consecutive negatives.[7] But the Stock and Watson leading index would have resulted in only one false recession signal since 1960 while the traditional

[7]Stock and Watson do not consider any absolute number of negatives in their leading index as a recession signal. Rather, they estimate a separate probability of being in recession in six months based on the components of their coincident and leading indexes. But their recession probability index also failed to forecast the 1990-91 recession. The estimated probability of recession did not exceed 10 percent in the nine months prior to that recession. In the nine months prior to each of the four previous recessions, the estimated probability reached 77 percent or higher.

The Basics of VAR Forecasts

Vector autoregression (VAR) forecasts are based on the notion that in properly chosen sets (vectors) of economic variables there are fundamental patterns among the variables (see the 1992 article by Crone). These fundamental patterns can sometimes be obscured by occasional deviations, and the purpose of the VAR system is to uncover the basic pattern by estimating a system of equations in which each variable is related to past values of itself and all the other variables in the system. In a simple two-variable model of housing starts and mortgage interest rates, for example, the two equations to be estimated would be

$$Starts_t = a_0 + a_1\, Starts_{t-1} + a_2\, Starts_{t-2} \ldots + b_1\, Rates_{t-1} + b_2\, Rates_{t-2} \ldots + e_{St}$$
$$Rates_t = g_0 + g_1\, Rates_{t-1} + g_2\, Rates_{t-2} \ldots + h_1\, Starts_{t-1} + h_2\, Starts_{t-2} \ldots + e_{Rt}$$

Once the coefficients **a, b, g,** and **h** have been estimated from historical data, forecasts can be generated by successively calculating values for starts and rates one period ahead.

Of course, the quality of the forecast will depend on choosing the proper variables for estimating a stable underlying pattern. One cannot, however, increase the number of variables or the number of lags on the variables arbitrarily in the hope of increasing the accuracy of the forecasts. Trying to estimate too many coefficients with a limited amount of historical data will cause the occasional past deviations from the fundamental pattern to be incorporated into the estimates of the coefficients. Forecasts from such an estimated model will reflect past one-time deviations as well as the true fundamental pattern. Most model builders overcome this difficulty by limiting the number of variables and lags included in the system based on their prior understanding of how certain variables affect others in the economy. For a more technical discussion of VAR models, see Thomas Sargent.

index produced six false signals since then. Thus, over the period for which it is available, the Stock and Watson index foreshadows the same number of recessions as the traditional index but produces considerably fewer false signals (see Figures 1 and 2). Like the traditional index, Stock and Watson's leading index is less helpful in predicting recoveries than in predicting recessions. Using a rule of three consecutive increases, Stock and Watson's index would have predicted two of the last five national recoveries.

LEADING INDEXES FOR THE STATES

Since we have previously constructed coincident or current economic activity indexes for Pennsylvania and New Jersey, we can use Stock and Watson's methodology to construct leading indexes for those two states.[8] Like Stock and Watson's national leading index, our state indexes are forecasts of the change in the state's current activity index. We chose a nine-month forecast to produce an index with a reasonable lead time.[9] In other words, our leading index is

[8]We followed Stock and Watson's methodology in constructing the current economic activity indexes for the states. For a description of the methodology and a list of the variables used to construct the coincident indexes, see the 1994 article by Crone. We also constructed a coincident index for Delaware, but we were not successful in constructing a leading index for that state because we found no set of variables to adequately predict the state's coincident index. There is more month-to-month variability in Delaware's coincident index than in the indexes for Pennsylvania and New Jersey, so changes in Delaware's coincident index are more difficult to forecast.

[9]We also experimented with a six-month forecast, but the nine-month horizon produced a slightly better lead time for some recessions without introducing any more false signals. The longer the forecast horizon, the longer is the potential lead time. The advantage of a longer lead time, however, must be weighed against the disadvantage of a less accurate forecast.

FIGURE 1

Traditional Leading Index

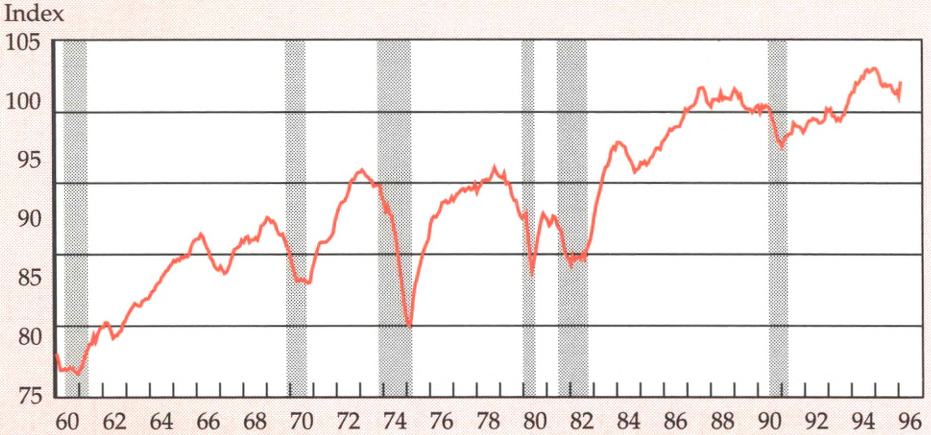
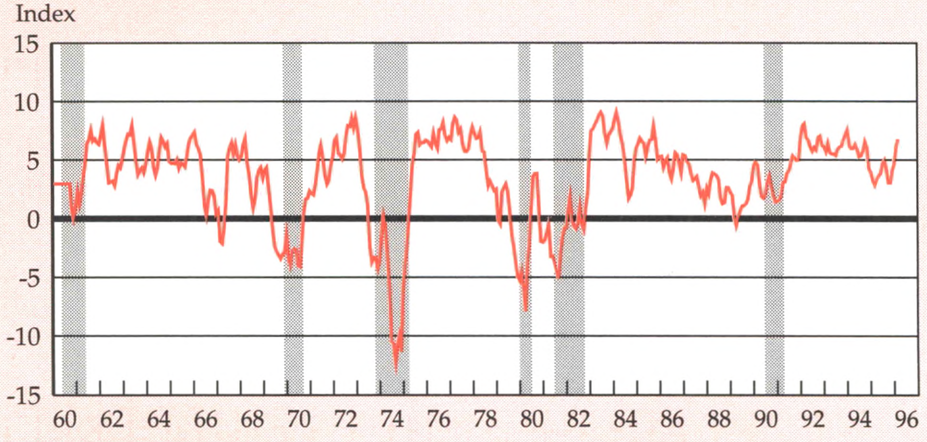


FIGURE 2

Stock and Watson Leading Index



Note: Shaded areas represent national recessions.

a forecast of the total change in the coincident index over the next nine months. Among the variables used in the traditional index or in Stock and Watson's index, only three are available at the state level—average hours worked in manufacturing, housing permits, and initial unemployment claims. Our basic model for the leading indexes includes past changes in housing permits and initial unemployment claims for the states plus past changes in the coincident index.[10] It does not include average hours worked as a separate variable because this variable is a component of the current activity indexes for Pennsylvania and New Jersey and past changes in these indexes are already included in the models for the leading indexes.

We expanded these basic models by adding some interest-rate and regional variables that improved the accuracy of the forecasts without diminishing their ability to signal recessions or without increasing the number of false signals. We found that adding the spread between the six-month commercial-paper rate and the six-month Treasury-bill rate improved our basic forecast model for New Jersey.[11] For Pennsylvania, the forecast was improved by adding the spread between the yield on 10-year Treasury bonds and one-year Treasury notes.

[10]Because of the high month-to-month variability in the data on housing permits, we smoothed the data by taking a six-month moving average.

[11]Improvement in the forecast was measured by the reduction in the average root mean squared error of the forecast for the nine-month-ahead change in the state's economic activity index.

From the Philadelphia Fed's Business Outlook Survey of manufacturers we also have some regional variables that correspond to components of the national leading indexes, namely, new orders, unfilled orders, and delivery time (vendor performance).[12] Neither the regional variable for new orders nor the one for unfilled orders improved the performance of the leading indexes for the states. But the Pennsylvania model was improved by adding the diffusion index for delivery time from the Philadelphia Fed's survey. This diffusion index is the difference between the percentage of respondents reporting an increase in delivery time and the percentage reporting a decrease. (For a complete list of variables in the state models, see Table 3.)

Figures 3 and 4 present the leading indexes for Pennsylvania and New Jersey from January 1973 to the present.[13] Our leading indexes

[12]The firms in this survey are located in eastern Pennsylvania, southern New Jersey, and Delaware.

[13]Because some of the data were not available prior to 1972 and our models used a number of lags in the data, we were not able to construct leading indexes for the states prior to 1973.

TABLE 3
Variables Used to Construct Leading Indexes for the States

Pennsylvania	New Jersey
The Philadelphia Fed's Economic Activity Index for Pennsylvania	The Philadelphia Fed's Economic Activity Index for New Jersey
Housing units authorized by local building permits	Housing units authorized by local building permits
State initial unemployment claims	State initial unemployment claims
Spread between the yields on 10-year Treasury bonds and one-year Treasury notes	Spread between the rates on six-month commercial paper and six-month Treasury bills
Diffusion index for vendor delivery time from the Philadelphia Fed's Business Outlook Survey	

are the predicted nine-month growth rates for each state's current activity index based on these final models (see Appendix). Any positive value of the state index is a prediction of a cumulative increase in activity over the next nine months; any negative value is a predic-

FIGURE 3
Pennsylvania Leading Index

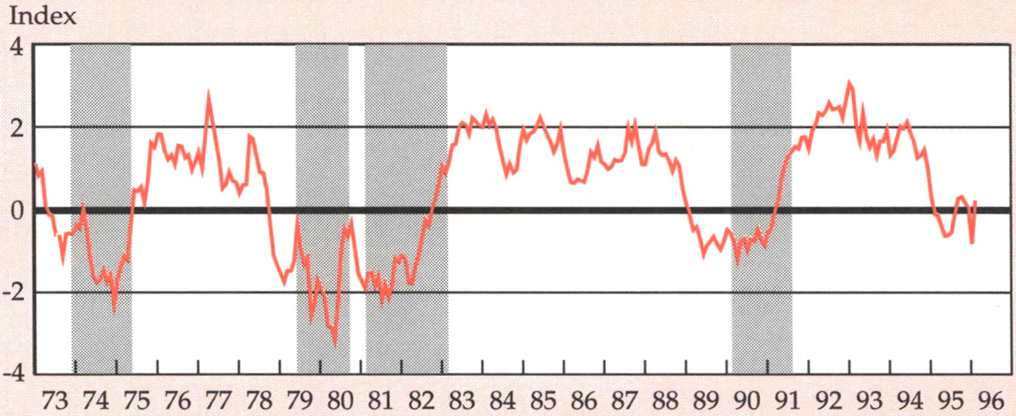
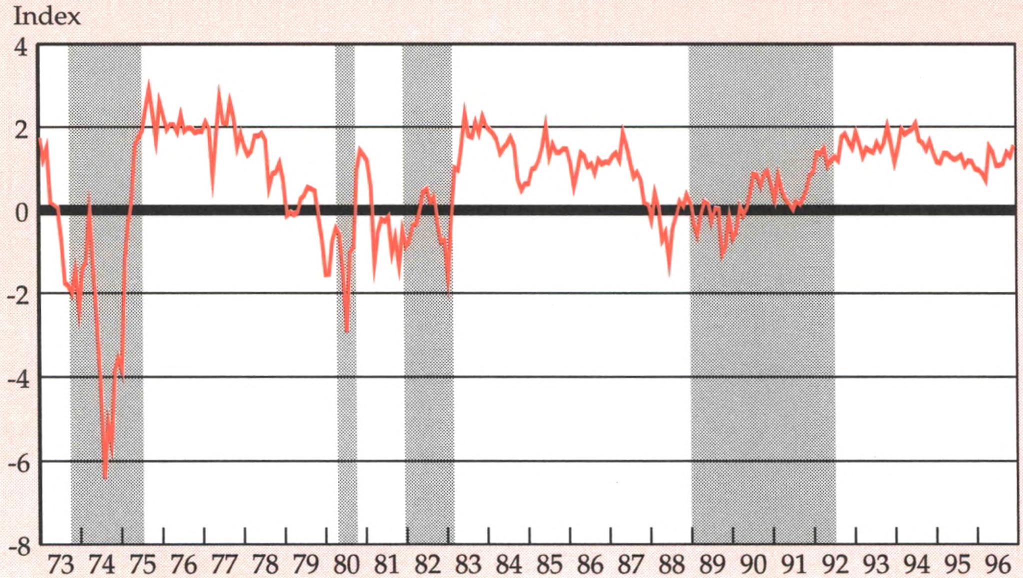


FIGURE 4
New Jersey Leading Index



Shaded areas represent state recessions.

tion of a cumulative decrease in activity.

How Well Have These State Indexes Performed? The rationale for developing leading indexes for the states is based on the notion that recessions in the states do not necessarily coincide with national recessions. Using the current economic activity index developed in 1994, we identified dates for four recessions in Pennsylvania and New Jersey between 1973 and 1994.[14] How well would the leading indexes for the two states have forecast those recessions?

If we use the rule that three successive negative readings of the index signal a recession, Pennsylvania's leading index has predicted all four of the state recessions since 1973, with leads of 5 months or more. The index also gave a false signal last year when it was negative for seven consecutive months. Pennsylvania's economy was very weak in 1995, but it did not suffer a recession.

New Jersey's leading index has also predicted all four of that state's recessions since 1973, with leads of one to seven months. New Jersey's index has given two false recession signals, one at the beginning of 1979 and one at the end of 1987. Both of these false signals occurred a little more than a year before the onset of the next recession. Thus, in the last 23 years, the new leading indexes for the states would have predicted all four recessions in Pennsylvania and New Jersey. In addition, the Pennsylvania index would have given one false signal, and the New Jersey index two. The record of the state indexes is only slightly less accurate than the record of the national Stock and Watson index, which would have given no false signals since 1973 but would have missed calling the most recent recession. Like the national indexes, these state indexes are not as reliable in signaling the end of recessions. Using the three-month rule Pennsylvania's leading index would have predicted recovery from two of the state's four recessions since 1973; New Jersey's index would have predicted recovery from only one of four.

At the end of 1995 the economies of both Pennsylvania and New Jersey were growing at a slower rate than the national average. A record-breaking snow storm in January 1996 reduced economic activity at the beginning of the year. New Jersey's leading index remained positive through the period, forecasting no recession this year. Pennsylvania's index was negative in January 1996 but turned positive again in February; so it too is not signaling a recession this year.

CONCLUSION

Although they do not have a perfect record, leading indexes of the national economy have been helpful in foreshadowing turning points, especially economic downturns. The limited data available at the state and regional level and their greater volatility make it more difficult to construct leading indexes for the states. Despite these difficulties, we have been able to construct leading indexes for Pennsylvania and New Jersey. These indexes have been rather successful in predicting downturns in the state economies over the past 23 years. Because there have been few business cycles over that time, however, a longer history will be necessary before we can make a full evaluation of these leading indexes for Pennsylvania and New Jersey.

[14]State recessions are dated from the peak to the trough of the state's current activity index in any business cycle. A decline in the index was recognized as a recession only if the cumulative decline was at least four times the average absolute monthly change in the index. Using these criteria, we marked with bars the state recessions in Figures 3 and 4. With two exceptions these recession dates are within three months of the cyclical peaks and troughs of employment in each of the two states.

Appendix
Model Specifications for the State Indexes

Like Stock and Watson we used vector autoregression models to construct our leading indexes for the states. The Pennsylvania model contained five equations, and the New Jersey model, four. All the variables except the diffusion indexes and the interest rate spreads are expressed in log difference form, i.e., $\Delta \ln X_t = \ln X_t - \ln X_{t-1}$. We applied some of the same restrictions that Stock and Watson used in their model. For example, the equation for each variable except the one for the changes in the state's economic activity index contained only one lag of itself and one lag of each of the other variables. Also, the equation for the change in the state's economic activity index contained four lags of the change in that index and a varying number of lags on the other variables. We used a commonly accepted statistical procedure to determine the number of lags for these other variables (see Akaike).

We show the resulting equations forecasting the change in the economic activity index for Pennsylvania and New Jersey.

Pennsylvania

$$\Delta lnPAI = \alpha + \sum_{j=1}^{4} \beta_j (\Delta lnPAI)_{t-j}$$
$$+\gamma_1 \Delta lnPermits_{t-1}$$
$$+\sum_{k=1}^{3} \delta_k (\Delta lnClaims)_{t-k}$$
$$+\sum_{m=1}^{3} \zeta_m (\Delta Delivery)_{t-m}$$
$$+\sum_{p=1}^{3} \eta_p (\Delta Spread10)_{t-p}$$

New Jersey

$$\Delta lnNJI = \alpha + \sum_{j=1}^{4} \beta_j (\Delta lnNJI)_{t-j}$$
$$+\gamma_1 \Delta lnPermits_{t-1}$$
$$+\sum_{k=1}^{6} \delta_k (\Delta lnClaims)_{t-k}$$
$$+\sum_{p=1}^{5} \vartheta_p (\Delta Spread6)_{t-p}$$

where:

- ΔlnPAI = log difference of the Pennsylvania current economic activity index, i.e., $\Delta lnPAI_t = lnPAI_t - lnPAI_{t-1}$
- ΔlnNJI = log difference of the New Jersey current economic activity index
- Δlnpermits = log difference of the six-month moving average of state housing permits
- Δlnclaims = log difference of state initial unemployment claims
- Δdelivery = change in the diffusion index for delivery time from the Federal Reserve Bank of Philadelphia's Business Outlook Survey of manufacturers
- Δspread10 = change in the spread between the yields on 10-year Treasury bonds and one-year Treasury bills
- Δspread6 = change in the spread between the interest rates on six-month commercial paper and six-month Treasury bills.

Since our leading index is the forecasted nine-month change in each state's coincident index, we follow Stock and Watson in using the R^2 between the forecasted nine-month change and the actual nine-month change as a measure of the "goodness of fit" for the model. For Pennsylvania this R^2 is 0.48, and for New Jersey it is 0.42.

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Inflation Forecasts: How Good Are They?

*Dean Croushore**

Forecasts of inflation are important because they affect many economic decisions. Investors need good inflation forecasts, since the returns to stocks and bonds depend on what happens to inflation. Businesses need inflation forecasts to price their goods and plan production. Homeowners' decisions about refinancing mortgage loans also depend on what they think will happen to inflation.

In the early 1980s, economists tested the inflation forecasts in surveys taken over the previous 20 years and found that the forecasts systematically underpredicted inflation. But economic theory suggests that this shouldn't happen. To some extent, forecasters' livelihoods depend on how well they forecast, so they have a strong incentive to avoid such systematic mistakes. Faced with evidence that forecasters make systematic errors, economists suggested that either those who surveyed the forecasters weren't collecting the proper data or forecasters were irrational in their beliefs about infla-

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tion. As a result, many economists stopped paying attention to the forecast surveys.

If we look at the data on actual inflation and the forecasts of inflation, the problem with the forecasts is clear. In the mid-1970s, and again in the late 1970s, inflation increased dramatically, rising to much higher levels than were forecast. But that doesn't mean that the forecasters weren't doing the best they could using the available information. Major increases in oil prices because of political events in the Middle East made the job of accurately forecasting inflation impossible. When oil prices rose, inflation rose sharply as well. Given that no one anticipated these huge increases in oil prices, it isn't surprising that the inflation forecasts underpredicted inflation. Another problem for forecasters was that, before 1973-74, they had never faced such a large increase in oil prices, so they didn't know how inflation would respond.

So economists may have been too rash in abandoning the surveys of forecasters. The key question is this: does adding data from the 1980s and early 1990s suggest that the forecasts are better than when we just looked at data from the 1970s and before? The answer is yes: the forecasts are much better when you look at the entire period through 1994. One interpretation is simply that the sharp rise in oil prices caused a period of inflation underprediction; inflation forecasts are generally good otherwise. And it's understandable that forecasters facing such a huge economic shock weren't sure what would happen.

But the forecasts aren't perfect. Forecasters don't seem to account properly for changes in monetary policy. When inflation is increasing and the Federal Reserve raises short-term interest rates, the forecasts suggest that inflation will stop rising much more quickly than it actually does. Systematic errors such as these suggest that while inflation forecasts are correct on average, forecasters are inefficient in their use of information about monetary policy. These errors could arise because forecasters don't do their jobs well, because the economy is too complicated and changes too frequently, because it takes time to learn about changes in the economy, or because monetary policy isn't fully credible.

FORECASTS SHOULD BE UNBIASED

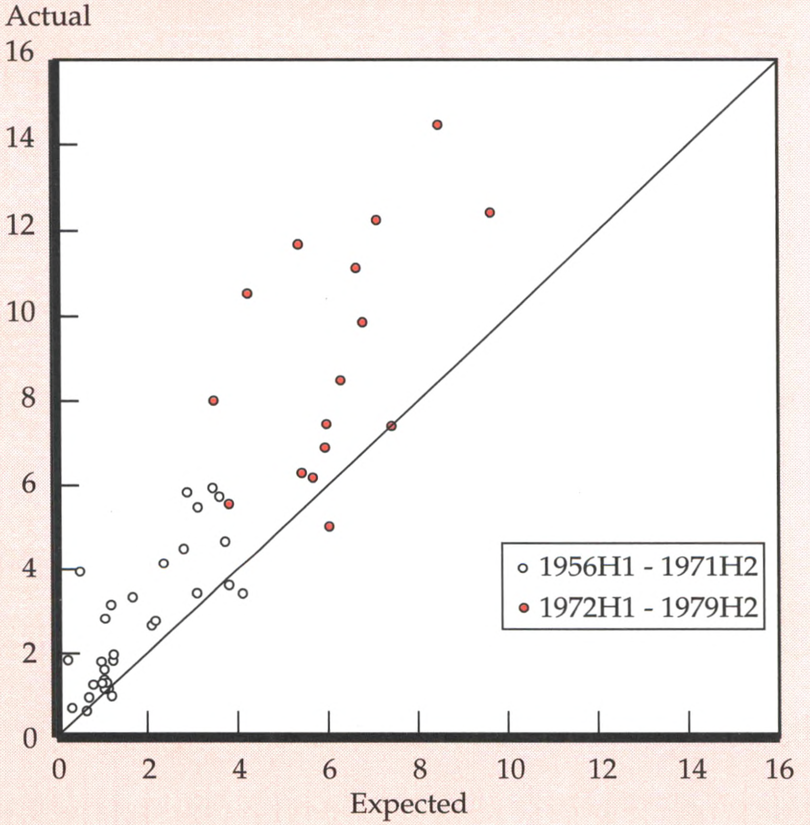
The economic theory of *rational expectations* implies that forecasts for inflation should meet two criteria: (1) they must be *unbiased*, that is, forecast errors (actual inflation minus the forecast) must average out to zero over time; and (2) they must be *efficient*, that is, forecasters must use all the relevant information at their disposal in forming forecasts.

Forecasts are unbiased if, when you look at the data on inflation and on inflation forecasts over a long period, positive and negative errors cancel each other out. But a look at actual inflation compared with expected inflation (as estimated from the Livingston Survey of economists from 1956 through 1979) shows a problem (Figure 1).[1] If the inflation forecasts are correct on average, they should be located symmetrically around the 45-degree line drawn in the figure. As you can see, the points tend to be above that line—actual inflation has usually been higher than expected inflation. These forecasts are biased because they show a systematic underprediction of inflation.

Many formal statistical studies of the data available in the early 1980s also suggested that forecasts were biased.[2] This discovery, with statistical support behind it, persuaded economists

[1]The Livingston Survey, which collects economists' forecasts of inflation and other economic variables twice a year, has been in existence since 1946. For more information on the Livingston Survey, which is conducted by the Federal Reserve Bank of Philadelphia, see the article by Herb Taylor. John Carlson discusses some statistical problems in using the survey. The figure shows the mean forecasts of CPI inflation over the 14 months following each survey, compared with actual inflation over those 14 months.

FIGURE 1
Actual and Expected Inflation
Livingston Survey 1956H1 to 1979H2



supply their forecasts, and they made their forecasts anonymously. An alternative view was that the people being surveyed weren't very good at forecasting inflation because they had no reason to be good at doing so; their livelihoods didn't depend on their inflation forecasts. As one participant suggested, the benefits of working on a joke for the speech he was about to give were greater than the benefits from a slight refinement in his inflation forecast.

that there must be something wrong with surveys of inflation expectations. Some economists believed that people didn't have a strong enough incentive to respond accurately to the surveys, because they weren't being paid to

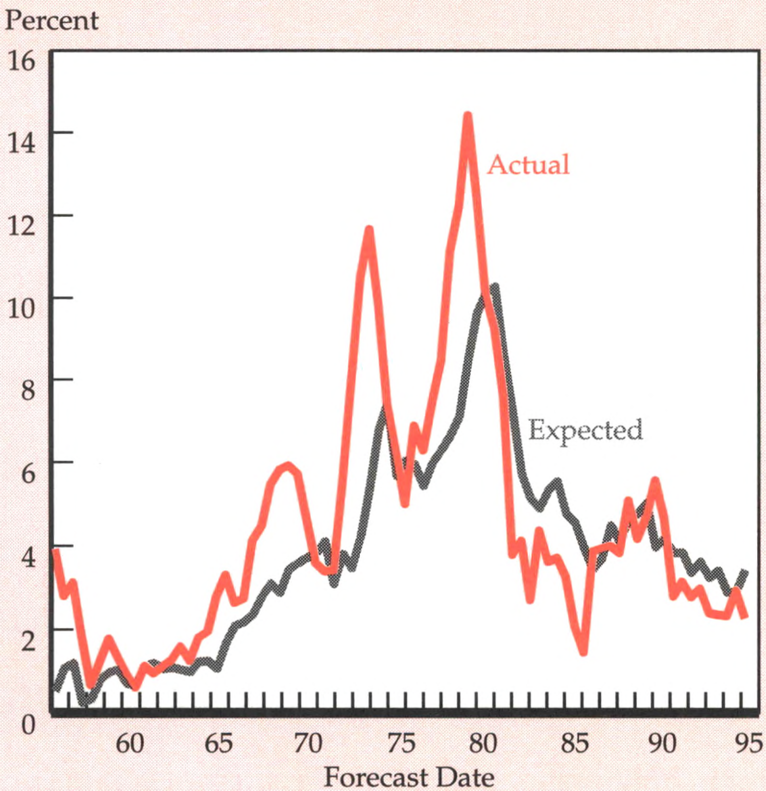
INFLATION AND THE OIL SHOCK

Economists had become interested in testing people's expectations about inflation at the worst possible time. In 1973 and 1974, the price of oil rose dramatically on world markets in response to a sharp reduction in supply from the Arabian peninsula, catching everyone by surprise. As a result, inflation in the United States and many other countries rose sharply, and the forecasts of inflation looked very bad (Figure 2).[3] The oil-price

[2]These studies include those by Stephen Figlewski and Paul Wachtel; Edward Gramlich; Eugene Fama and Michael Gibbons; and Michael Bryan and William Gavin. For a review of the issues and the statistical results, see the article by G.S. Maddala. Technically, a biased forecast isn't necessarily worse than an unbiased forecast, if the bias is small and if the biased forecast has smaller errors, on average. But the bias found in these studies was quite large.

[3]As before, the data in this figure are the mean responses from the Livingston Survey for the 14-month-ahead forecast of CPI inflation.

FIGURE 2
Actual and Expected Inflation
Livingston Survey



Note: "Expected" is the inflation forecast for the year following the forecast date; "Actual" is the actual inflation rate over that period.

shock of 1973-74 was followed by another one in 1978-79, which is also apparent in the figure.

The two oil-price shocks were unexpected. But compounding the problem was the fact that people didn't know how the economy would respond. Would the oil price increases cause a recession in the United States? Would inflation rise permanently or temporarily and by how much? How would monetary policy respond? We know now that the sharp increases in oil prices led directly to a large increase in inflation, but at the time, no one knew what would happen.[4] Since these were the first episodes of their kind in U.S. history, it isn't surprising that the forecasters didn't do a very good job in forming inflation expectations.

FORECASTS LOOK BETTER TODAY

If we add the inflation data since 1980 to the chart, the forecasts look much better (Figure 3). There appears to have been some overprediction of inflation in the early 1980s and again in the early 1990s, but these errors are much smaller than the errors in the 1970s.[5]

Formal statistical tests on the

[4]CPI inflation rose from just over 3 percent in 1972 to almost 9 percent in 1973 and over 12 percent in 1974. In the second oil shock, inflation rose from just under 7 percent in 1977 to 9 percent in 1978, then to about 13 percent in 1979 and 1980.

[5]The error in a forecast is defined as the actual inflation rate over the period minus the forecast of the inflation rate over the period. If forecasts are good, forecast errors should be fairly small, and the plotted points should be close to the 45-degree line in the figure.

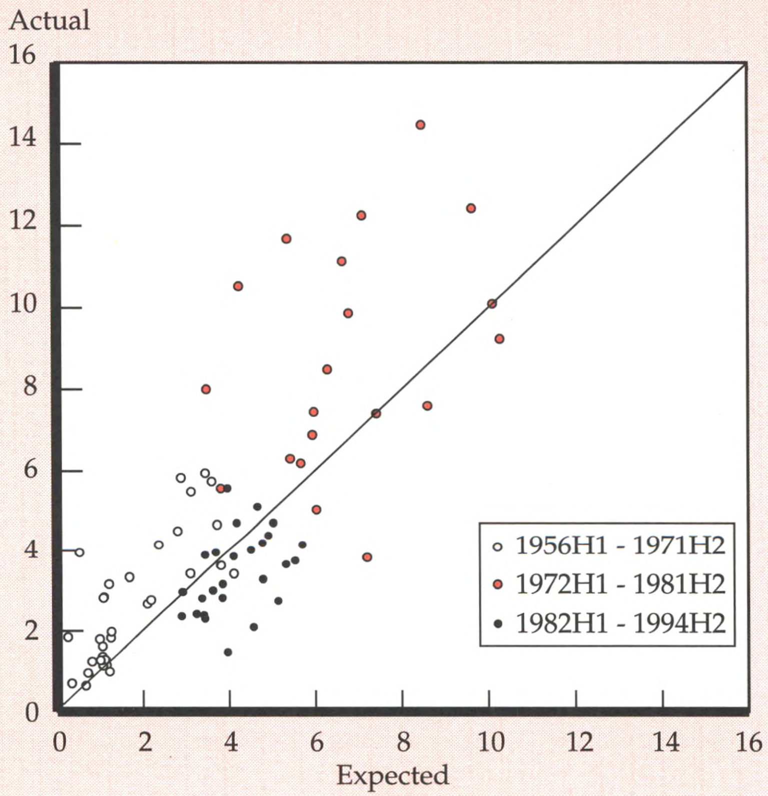
data, which are identical to the ones economists performed in the early 1980s, show much-improved performance.[6] The forecasts no longer show any bias. In the figure, the points are fairly symmetric around the 45-degree line.

What's more, this result holds up when we look at data from other surveys of forecasts or data other than the CPI inflation rate. We've done the same statistical tests using the Survey of Professional Forecasters (Figure 4) and the University of Michigan Survey of Consumers (Figure 5).[7] The expected inflation variable in the figure for the Survey of Professional Forecasters is the mean of the survey participants' forecasts of the GNP implicit price deflator (GDP deflator after 1991) over the next year, which is compared to actual inflation over the next year; for the Michigan survey it is the mean of the survey participants' forecasts of the CPI inflation rate over the next year, which is compared to actual inflation over the next year. Though these surveys differ in the types of people responding to the survey and the type of inflation variable being forecast, there is no apparent bias in the figures, a finding supported by formal statistical tests.

FIGURE 3

Actual and Expected Inflation

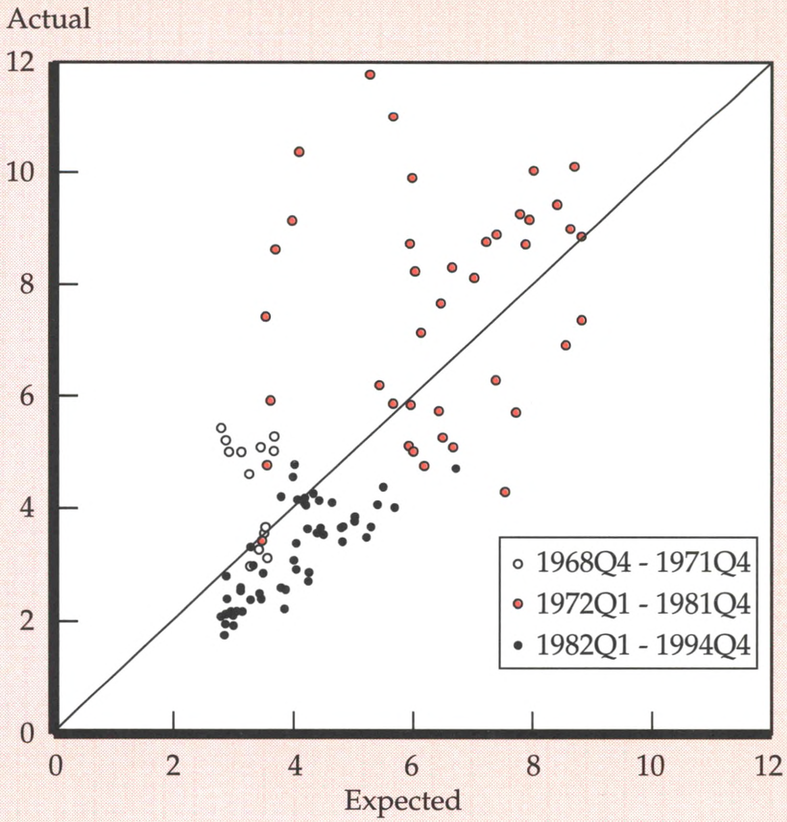
Livingston Survey 1956H1 to 1994H2



[6]In this analysis, we add data from the 1980s and 1990s to the original data from the 1950s through the 1970s. A similar figure for just the 1980s and 1990s shows a very impressive forecast pattern, with very small differences between actual and expected inflation. The formal results, which are based on regression analysis, are available from the author upon request.

[7]See my 1993 article for a detailed description of the Survey of Professional Forecasters, which began in 1968. See the article by Nicholas Noble and Windsor Fields for more details on the University of Michigan Survey of Consumers, which, in 1969, began to collect inflation forecasts once a quarter.

FIGURE 4
Actual and Expected Inflation
Survey of Professional Forecasters 1968Q4 to 1994Q4



biased, there is some evidence that they are *inefficient*. The term inefficient applies to forecasts that could be improved by using additional information. That is, forecasters could have done a better job at forecasting if they had used all the data available to them in the right way. My research with Larry Ball of Johns Hopkins University has found that forecasters do not use information about monetary policy in the best way possible.[8] Our research suggests that when inflation is rising, leading the Federal Reserve to tighten monetary policy, forecasters underestimate the degree to which inflation continues to rise even after the Fed has taken action. Forecasters thus seem to assume that tight monetary policy will have a more immediate impact on inflation than is actually the case.

In our research, we examine the correlation between the inflation forecast error (that is, the

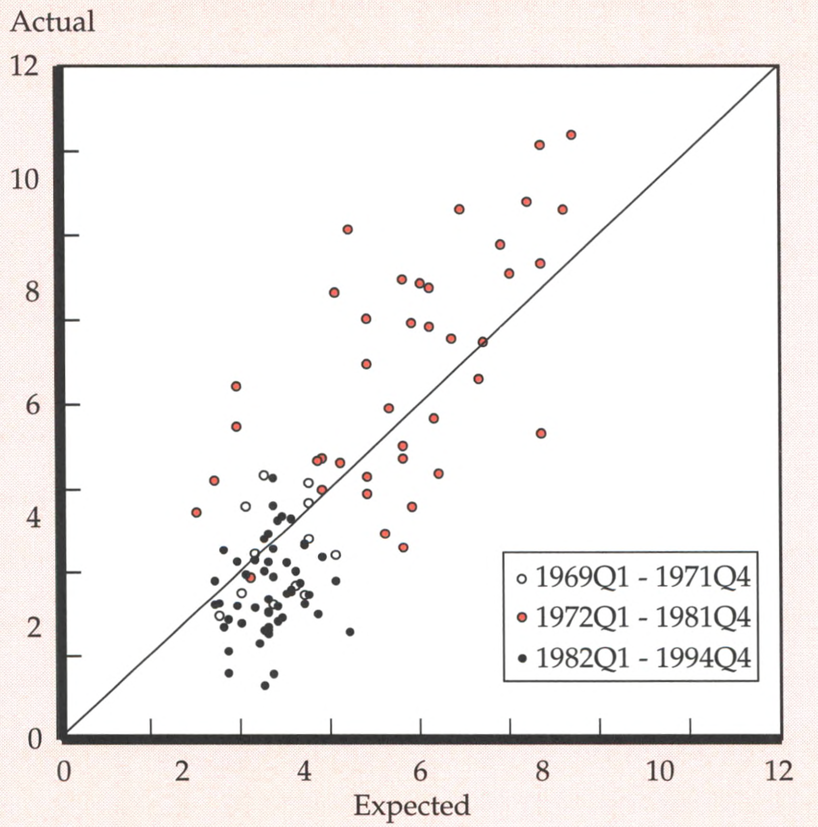
So it appears that the bias found in earlier studies of the surveys of inflation forecasts was largely due to the oil-price shocks in the 1970s. Those shocks made all forecasts of inflation look bad. Still, these forecasts may have been the best possible forecasts of inflation at the time; people should realize that unpredictable shocks sometimes occur.

BUT FORECASTS MAY STILL BE INEFFICIENT

Even though the forecasts appear to be un-

[8]Detailed results can be found in our 1995 working paper. Frederick Joutz, as well as John Schroeter and Scott Smith, also found that forecasters don't use information about monetary policy efficiently.

FIGURE 5
Actual and Expected Inflation
Michigan Survey 1969Q1 to 1994Q4



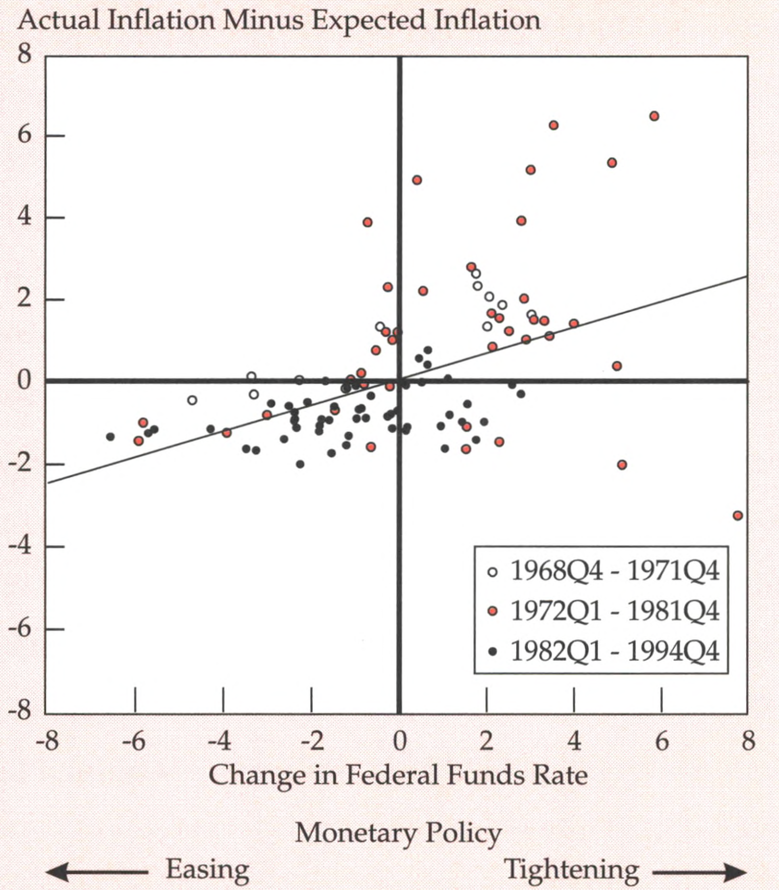
tionship, which can be seen in a plot of the data (Figure 6). In this figure, we've shown the inflation forecast error from the Survey of Professional Forecasters plotted against the change in the federal funds rate. You can see that there is a positive relationship between the two—when monetary policy is tightening, actual inflation tends to be higher than expected inflation. And when monetary policy is easing, actual inflation tends to be less than expected inflation.

The solid line shown in the figure is the line through the points of the figure that fits the data best. As shown by the line, an increase of one percentage point in the federal funds rate over the past year is associated with an increase in the forecast error of 0.32 percentage point, on average.

Further investigation of this result shows that the forecasters' errors lie in the timing of the response of inflation to monetary policy, not in the magnitude. That is, the forecasters are right about the size of the effect that tighter monetary policy has in reducing inflation, but their forecasts suggest that inflation will respond to monetary policy quickly. In fact, it

actual inflation rate over the next year minus the expected inflation rate) and the change in the federal funds rate (our measure of monetary policy) over the past year. If the forecasters are efficient in using information about monetary policy, there should be no relationship between the forecast error and the annual change in the federal funds rate; otherwise the forecasters should have used the relationship between the forecast error and the change in the federal funds rate to produce an improved forecast. But our formal statistical tests show a positive rela-

FIGURE 6
Inflation Forecast Errors and Monetary Policy
Survey of Professional Forecasters 1968Q4 to 1994Q4



takes longer for monetary policy to work than the forecasters think.

An improved inflation forecast can be devised by using the information from Figure 6. To get a new inflation forecast, take the average survey forecast for inflation (in the GDP deflator) over the coming year and add to it an amount equal to 0.32 times the change in the federal funds rate over the past year. Following this procedure over the last six years of the period we study would have lowered forecast errors roughly 20 percent.[9] For example, after the federal funds rate declined 2.4 percentage points in 1992, the forecasters predicted inflation in the GDP deflator of 2.87 percent, but a better forecast could have been made by predicting inflation of 2.87 - (2.4 x .32), or 2.10 percent. Actual inflation for the GDP deflator turned out to be 2.13 percent, so the modified forecast would have been much better.

This relationship between inflation forecast errors and past changes in monetary policy also appears when we use the Livingston Survey or the University of Michigan Survey of Consum-

[9]Technically, the root mean squared forecast error is 17 percent lower, while the mean absolute error is 24 percent lower. The root mean squared forecast error is found by taking the square of the forecast error at each date, calculating the average of these squared values, and taking the square root. The mean absolute error is found by taking the average of the absolute values of the forecast errors.

ers as the basis for expected inflation. This suggests that forecasters could use information about monetary policy to make better forecasts. In particular, forecasters would need to make sure that their inflation forecasts reflected the proper timing of changes in inflation caused by recent movements in monetary policy.

EXPLAINING FORECAST INEFFICIENCY

Why do inflation forecasts suffer from inefficiency? Don't forecasters have the incentive to provide optimal forecasts? If so, how can forecast errors be persistently related to monetary policy measures? You might think that if forecasters continually made mistakes in their inflation forecasts, they would realize they were doing so and would correct those errors. So the real question is: why don't forecasters make adjustments so that they produce not only better forecasts but also ones that are efficient with respect to monetary policy? There are a number of possible explanations for why forecast errors may persist, but no convincing explanations for why the forecasts are inefficient in the first place.

One possible explanation for the failure of forecasters to improve their forecasts is simply that forecasters don't do their jobs well. That is, they must not have enough incentive to form completely rational expectations of inflation, perhaps because their inflation forecasts aren't that important to them. It's possible that, except for the few forecasters whose forecasts of inflation are used by traders to buy and sell bonds and thus have a lot of money riding on them, the forecasters in the survey may not care about inflation very much. If their forecasts are wrong, it doesn't hurt them.

Another possible explanation for why forecast errors may persist is that the macroeconomy is very complicated, and no one has a complete understanding of how it works. The Phillips curve (which relates inflation to the unemployment rate) was thought to be a great model of inflation until the 1970s, when it failed miserably. Nobody knew ahead of time that the oil-price shocks in the 1970s would raise inflation so much. And the most popular theoretical models of the economy today seem far too abstract to use in forecasting. As a result, it isn't surprising that forecasting inflation is difficult.

Related to our lack of understanding of exactly how the economy works is the fact that it takes time for economists to learn about changes in the economy. They don't see trends emerging right away; it takes time for the data to come in and for economists to realize that the relationship between economic variables has changed. For example, in the late 1980s, the Federal Reserve developed a model of inflation called P* (pronounced P-star), which related the money supply (measured by M2) to the price level for the GNP deflator. But the changes in the demand for money that occurred in the early 1990s altered the relationship between M2 and inflation. As a result, the model no longer provided good forecasts. For example, it predicted a large reduction in inflation in the 1993-95 period, but inflation didn't decline nearly as much as predicted.

Another possible explanation for the inefficiency of inflation forecasts concerns the credibility of monetary policy. In the early 1980s, people had doubts about how serious the Federal Reserve was about fighting inflation. They thought the Fed might allow inflation to drift upward, rather than keeping inflation at 4 percent or less. That may be why forecasters persistently overpredicted inflation in the mid-1980s. So, clearly some degree of inefficiency in forecasting inflation may be due to uncertainties about monetary policy.

Credibility may also have played a role in the early 1990s. Again, forecasters kept predicting a rise in CPI inflation from about 3 percent to about 3.5 percent. The overprediction was small, but it persisted for several years. This persistence may have resulted from a combination of doubts about the Fed's commitment to low inflation and the lack of a good macroeconomic model of inflation, since monetary aggregates (M1, M2, M3) seemed to have lost their predictive power.

While these explanations may help us understand why forecasters have difficulty in forecasting inflation and perhaps also why they don't adjust their forecasts to better use the information about monetary policy, they don't tell us why the forecast errors are systematically related to monetary policy in the first place.

CONCLUSION

Surveys of inflation forecasts have had a bad reputation. Based on statistical tests in the early 1980s, economists had doubts about how accurate the forecasts were. But that was largely the effect of the oil-price shocks in the 1970s. If we look at the data today, the forecasts look much better. Nonetheless, there appears to be some inefficiency in the forecasts with respect to their relationship to monetary policy.

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