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

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]

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.

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

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.

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

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

---

[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
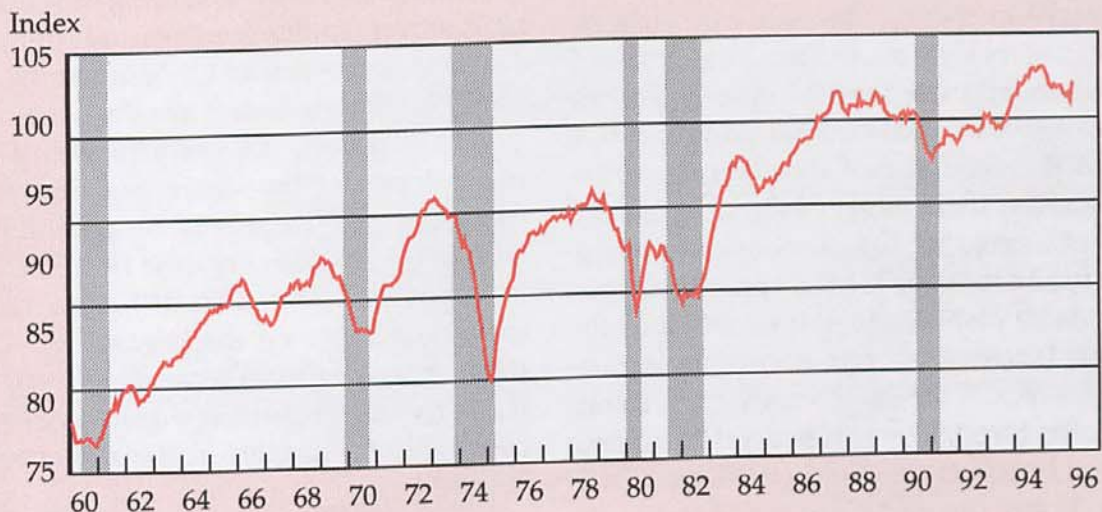
FIGURE 2
Stock and Watson Leading Index
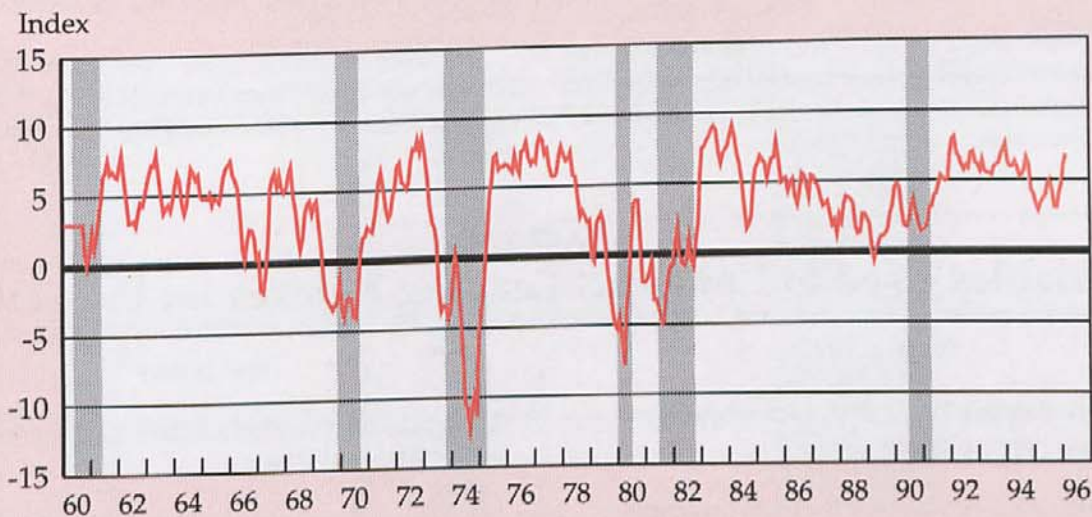
Note: Shaded areas represent national recessions.

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 coinci-

dent 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 posi- tive 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
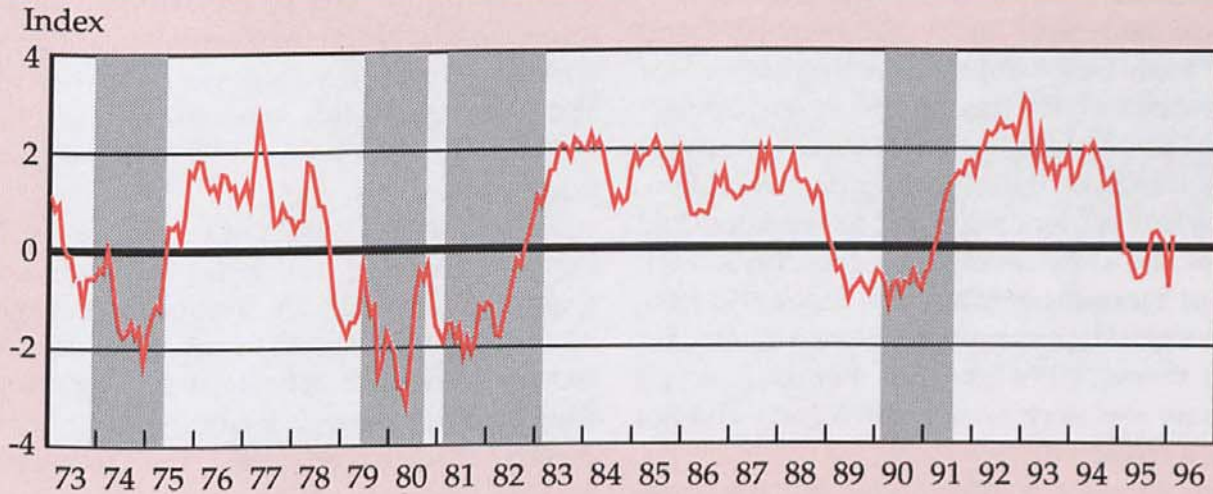
FIGURE 4
New Jersey Leading Index
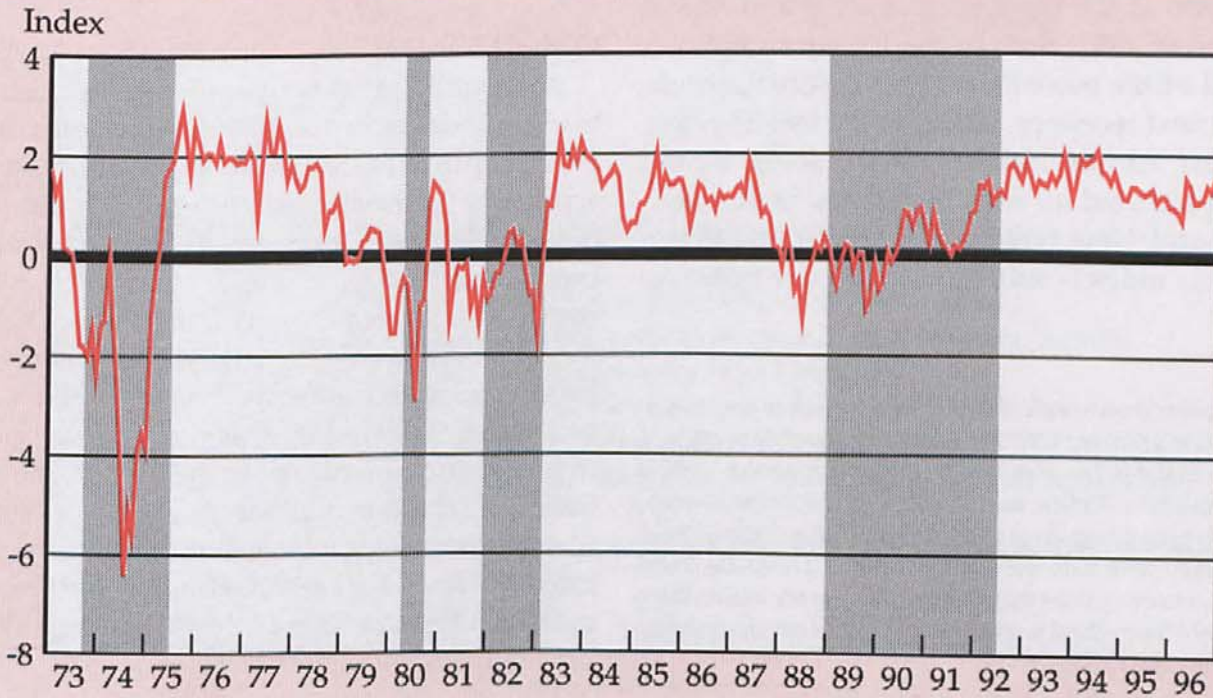
Shaded areas represent state recessions.

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 sig-

---

[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.

nal, 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.

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., $\Delta lnX_t = lnX_t - lnX_{t-1}$. 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.

<table>
<tr><td align="center">Pennsylvania</td><td align="center">New Jersey</td></tr>
</table>

$$\Delta lnPAI = \alpha + \sum_{j=1}^{4} \beta_j (\Delta lnPAI)_{t-j} \qquad\qquad \Delta lnNJI = \alpha + \sum_{j=1}^{4} \beta_j (\Delta lnNJI)_{t-j}$$

$$+\gamma_1 \Delta lnPermits_{t-1} \qquad\qquad\qquad +\gamma_1 \Delta lnPermits_{t-1}$$

$$+\sum_{k=1}^{3} \delta_k (\Delta lnClaims)_{t-k} \qquad\qquad +\sum_{k=1}^{6} \delta_k (\Delta lnClaims)_{t-k}$$

$$+\sum_{m=1}^{3} \zeta_m (\Delta Delivery)_{t-m} \qquad\qquad +\sum_{p=1}^{5} \vartheta_p (\Delta Spread6)_{t-p}$$

$$+\sum_{p=1}^{3} \eta_p (\Delta Spread10)_{t-p}$$

where:

$\Delta lnPAI$	= log difference of the Pennsylvania current economic activity index, i.e., $\Delta lnPAI_t = lnPAI_t - lnPAI_{t-1}$
$\Delta lnNJI$	= log difference of the New Jersey current economic activity index
$\Delta lnpermits$	= log difference of the six-month moving average of state housing permits
$\Delta lnclaims$	= log difference of state initial unemployment claims
$\Delta delivery$	= change in the diffusion index for delivery time from the Federal Reserve Bank of Philadelphia's Business Outlook Survey of manufacturers
$\Delta spread10$	= change in the spread between the yields on 10-year Treasury bonds and one-year Treasury bills
$\Delta spread6$	= 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.

REFERENCES

Akaike, Hirotugu. "Likelihood of a Model and Information Criteria," *Journal of Econometrics*, 16 (1981), pp. 3-14.

Burns, Arthur F., and Wesley C. Mitchell. *Measuring Business Cycles*. New York: National Bureau of Economic Research, 1946.

Crone, Theodore M. "A Slow Recovery in the Third District," Federal Reserve Bank of Philadelphia *Business Review* (July/August 1992).

Crone, Theodore M. "New Indexes Track the State of the States," Federal Reserve Bank of Philadelphia *Business Review* (January/February 1994).

Gorton, Gary. "Forecasting with the Index of Leading Indicators," Federal Reserve Bank of Philadelphia *Business Review* (November/December 1982).

Green, George R., and Barry A. Beckman. "Business Cycle Indicators: Upcoming Revision of the Composite Indexes," *Survey of Current Business* (October 1993).

Martin, Vance L. "Derivation of a Leading Index for the United States Using Kalman Filters," *Review of Economics and Statistics*, 72 (1990) pp. 657-63.

Mitchell, Wesley C., and Arthur Burns. "Statistical Indicators of Cyclical Revivals," New York: *NBER Bulletin* No. 69, 1938.

Moore, Geoffrey H. *Statistical Indicators of Cyclical Revivals and Recessions*. Occasional Paper 31. NY: National Bureau of Economic Research, 1950.

Moore, Geoffrey H., and Julius Shiskin. *Indicators of Business Expansions and Contractions*. NY: National Bureau of Economic Research, 1967.

Rufolo, Anthony M. "An Index of Leading Indicators for the Philadelphia Region," Federal Reserve Bank of Philadelphia *Business Review* (March/April 1979).

Sargent, Thomas J. "Estimating Vector Autoregressions Using Methods Not Based on Explicit Economic Theories," Federal Reserve Bank of Minneapolis *Quarterly Review* (Summer 1979).

Stock, James H., and Mark W. Watson. "New Indexes of Coincident and Leading Economic Indicators," *NBER Macroeconomics Annual* (1989), pp. 351-94.

Stock, James H., and Mark W. Watson. "A Probability Model of the Coincident Economic Indicators," in Geoffrey Moore and K. Lahiri, eds., *The Leading Economic Indicators: New Approaches and Forecasting Records*. New York: Cambridge University Press, 1990.