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Leading Economic Indexes for New York State and New Jersey

- New indexes of leading economic indicators, presented in this article, can help predict the future course of economic activity in New York State and New Jersey.
- The leading indexes provide a basis for constructing separate indexes that estimate the probability of a recession or expansion occurring in the states within a nine-month period.
- The historical performance of the leading indexes suggests that they effectively summarize information about future economic trends beyond that offered by other indicators. The recession and expansion indexes prove particularly reliable in forecasting cyclical changes in state economic activity.

Despite the unusual length of the current expansion, few economists are ready to repudiate the business cycle. In particular, imbalances in the U.S. economy may develop rather quickly and result in either a slowdown or actual contraction in economic activity. The pattern of recurrent transitions between periods of economic expansion and contraction is of practical interest to consumers, businesses, and the government. In advance of a likely contraction, households may want to defer spending, businesses may seek to adjust product lines, and policymakers may need time to change plans and budgets. Moreover, in the midst of a lengthy contraction, retailers would like advance notice of an upturn in order to increase inventories before demand revives.

The empirical regularities that characterize the U.S. business cycle have been the subject of considerable economic research. Arthur Burns and Wesley Mitchell are among the pioneers who provided a systematic study of these features. An outcome of their research was the identification of coincident and leading indicators of economic activity. These indicators provide the basis for the development of coincident and leading indexes—composite measures intended to gauge the current level of economic activity and predict its future course. Macroeconomists, however, have expressed concern about the methodology used to construct the indexes. Because the

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business cycle lacks a precise definition, the approach is largely judgmental and the indexes do not have well-defined statistical properties. In addition, movements in the indexes do not lend themselves to a straightforward interpretation. Although the indexes may be easy to understand at a conceptual level, it is not entirely clear what they are actually measuring.

In a series of papers, Stock and Watson (1989, 1991, 1993) attempt to provide a formal analysis of coincident and leading indexes for the United States. Incorporating the idea that the U.S. business cycle represents broad-based contractions and expansions in economic activity, the authors develop a model that estimates a common unobserved factor across a set of coincident indicators. This common factor is assumed to represent the shared influence of "the state of the economy" on the indicators, and is identified as the coincident index. Because the leading index is designed to predict changes in "the state of the economy," Stock and Watson define the leading index as the forecasted growth in the coincident index.

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If national business cycles mirrored those at the state level, then the indexes discussed above might be sufficient for summarizing and forecasting regional economic activity. However, economic fluctuations at the national level are not reflected evenly throughout the fifty states. During the 1980s and 1990s, the nation's recessions and expansions were characterized as bicoastal, led by the "rust belt," and, later still, led by the revitalized "industrial heartland." Different regions of the country clearly led and lagged changes in the nation's economy. Moreover, while single variables are often used as shorthand measures for gauging the current level or future course of state economic activity, they may be too narrow in scope or released too late to serve as a useful guide.[1]

This article describes a method by which we may more accurately predict regional economic activity. Specifically, we develop an index of leading economic indicators (LEI) for New York State and for New Jersey over the 1972-99 period. We extend our earlier work (Orr, Rich, and Rosen 1999), which uses the dynamic factor model of Stock and Watson (1989, 1991) to estimate an index of coincident economic indicators (CEI) for each state and to date each state's business cycles. We define the LEI as the forecasted growth in each state's CEI over a nine-month horizon. The forecasts are constructed using a single-equation model, where the set of leading indicators includes the national index of leading economic indicators and an interest rate spread as well as state-level changes in the CEI and housing permits.

We then develop a recession index and an expansion index for New York State and for New Jersey. The indexes estimate the probability of a recession or expansion in each state over the next nine months. To construct the indexes, we define recessionary and expansionary patterns in terms of future growth sequences in the CEI. We then calculate the indexes by using simulation techniques—Monte Carlo methods—to evaluate the likelihood of observing the recessionary and expansionary patterns.

We find that the movements of our recession and expansion indexes show a close relationship with the behavior of our LEI for New York State and New Jersey. The indexes therefore allow us to extend the informational content of our LEI by estimating the probability of an upcoming cyclical change in each state's economic activity.

In the next section, we provide a brief history and description of state indexes of leading economic indicators. We then discuss the construction of our leading indexes for New York State and New Jersey and provide details on the methodology used to estimate our recession and expansion indexes. Finally, we present the empirical results and examine the within-sample and out-of-sample performance of the indexes.

Existing State Indexes of Leading Economic Indicators

Although a national index of leading economic indicators has been developed to signal future turning points in aggregate economic activity, similar indexes at the state level are not widely available. In addition to the indexes developed in this article, leading indexes are regularly reported for only three states—New Jersey, Pennsylvania, and Texas.[2]

A key factor constraining the evaluation of leading indexes at the state level is that, unlike the nation, states do not have formally designated business cycles.[3] Therefore, an index of coincident economic indicators for each state is usually constructed prior to the development of an index of leading economic indicators.[4] Peaks and troughs in the coincident index can then be used to date state business cycles.[5] Monthly coincident and leading indexes for Texas were developed in 1988 and refined in 1990 (Phillips 1988, 1990). Since 1994, the Federal Reserve Bank of Philadelphia has published monthly indexes of coincident economic indicators for Pennsylvania and New Jersey and introduced an index of leading economic indicators for the two states in 1996 (Crone 1994; Crone and Babyak 1996).[6]

Important issues in the construction of a leading index include the selection of variables and the method of combining the variables into a single composite measure. For Texas, the index of leading economic indicators is constructed as a weighted average of leading variables. A variable is included in the leading index if changes in its past values (of at least two months) are highly correlated with current changes in the coincident index. The resulting leading index contains a total of nine variables, six of which are: two state counterparts to variables entering the national index of leading economic indicators (average weekly hours worked in manufacturing and initial claims for unemployment insurance); two variables that point to the future performance of the oil industry (new well permits and real oil prices); an indicator of international competitiveness (a Texas trade-weighted value of the dollar); and the national index of leading economic indicators.[7] Three other state variables are included: a state help-wanted index, real retail sales, and an index of the real stock prices of Texas-based companies. Each variable is assigned a weight that emphasizes the cyclical timing of the series. This procedure is similar to the one used by the U.S. Department of Commerce in assigning weights to the variables entering the national index of leading economic indicators.

Although a national index of leading economic indicators has been developed to signal future turning points in aggregate economic activity, similar indexes at the state level are not widely available.

For Pennsylvania and New Jersey, Crone and Babyak (1996) adopt a forecasting approach, similar to the one used by Stock and Watson (1989), to construct an index of leading economic indicators. The leading index for each state is a forecast of the change in its coincident index over the next nine months. For Pennsylvania, the forecasting equation includes four state variables: the number of new housing permits, initial claims for unemployment insurance, an index of local vendor delivery time, and lagged values of the coincident index; and an interest rate spread measuring the difference between the rates on ten-year Treasury bonds and one-year Treasury bills. Similar variables are used in the construction of the New Jersey LEI, except that the vendor delivery index is excluded and the interest rate spread measures the difference between the rates on six-month commercial paper and six-month Treasury bills. The weight of each variable in the leading index is determined by its estimated coefficient in the forecasting equation.

For the purpose of forecasting recessions and expansions, a procedure must be established that translates movements in the leading index into a signal about future turning points in economic activity. Crone and Babyak (1996) adopt a rule of thumb in which three consecutive negative (positive) readings of the leading index signal an upcoming recession (expansion).[8] Based on that rule, the indexes for Pennsylvania and New Jersey have done reasonably well in forecasting recessions, although not as well in forecasting expansions.[9]

Phillips (1990) uses an alternative approach that converts the current reading of the Texas LEI into the probability of a recession or expansion. The probability is computed by calculating the likelihood that the current reading of the LEI would occur during a recession or expansion and then modifying the value based on the probability for the previous period. A probability greater than 90 percent is taken as a strong signal of an impending recession or expansion.[10]

Indexes of Future Economic Activity for New York State and New Jersey

This section describes the construction of the indexes of leading economic indicators for New York State and New Jersey as well as the recession and expansion indexes. We begin by specifying a model that links the LEI to near-term growth in the coincident index for each state. The analysis then turns to a discussion of the use of the LEI to forecast recessions and expansions. To motivate the design of the recession and expansion indexes, we initially examine a popular rule of thumb that uses the behavior of the LEI to signal future recessions and expansions. To improve upon its features and performance, we propose a slight modification to this rule. We argue that one advantage of our modification is an increased lead time in generating a recession or expansion signal. More importantly, however, our modification provides the basis for the construction of the recession index and expansion index, which estimate, respectively, the probability of a future recession or expansion. Unlike conventional rules of thumb, the indexes are defined over a continuous probability range.

It is worth noting that we rely on different definitions of recessions and expansions for two aspects of the analysis. In the absence of a timely and fully reliable indicator of future recessions and expansions at the state level, we generate forecasts of these events by defining them on an *ex ante* basis in terms of future growth sequences in the coincident index. However, we date state business cycles, and hence evaluate the performance of the recession/expansion forecasts, by identifying peaks and troughs in the coincident index on an *ex post* basis. Although our approach might suggest some inconsistency, it parallels the approach often taken at the national level. For example, the NBER's dating of recessions normally occurs some time after a turning point has been realized.[11] In addition, the lack of a timely and fully reliable indicator of future recessions and expansions at the national level typically requires the adoption of some definition of recessions and expansions for forecasting purposes.[12]

The Leading Economic Index

Following the analyses of Stock and Watson (1989) and Crone and Babyak (1996), the indexes of leading economic indicators for New York State and New Jersey are forecasts of the change in the state's index of coincident economic indicators. Chart 1 extends the work of Orr, Rich, and Rosen (1999) and plots the CEI for each state, where the indexes are constructed using the methodology developed in Stock and Watson (1989, 1991) and the shading indicates state recessions.[13] As discussed in Orr, Rich, and Rosen, the cycles for New York State and New Jersey are broadly similar to those at the national level, although there are marked differences across some episodes with regard to timing, duration, and magnitude.

To construct the LEI, we select the nine-month forecasting horizon adopted in Crone and Babyak (1996) and specify the following regression equation:

(1) $$\Delta C_t^{t+9} = X_t \beta + \varepsilon_{t,9} ,$$

where ΔC_t^{t+9} is the (annualized) growth in the CEI between month t and month t+9, X_t is a set of leading variables available in month t used to forecast ΔC_t^{t+9}, β denotes the coefficients relating the leading variables to future growth in the CEI, and $\varepsilon_{t,9}$ is a mean-zero error term.[14]

By its definition, the LEI can be recovered from the estimation of equation 1 as:

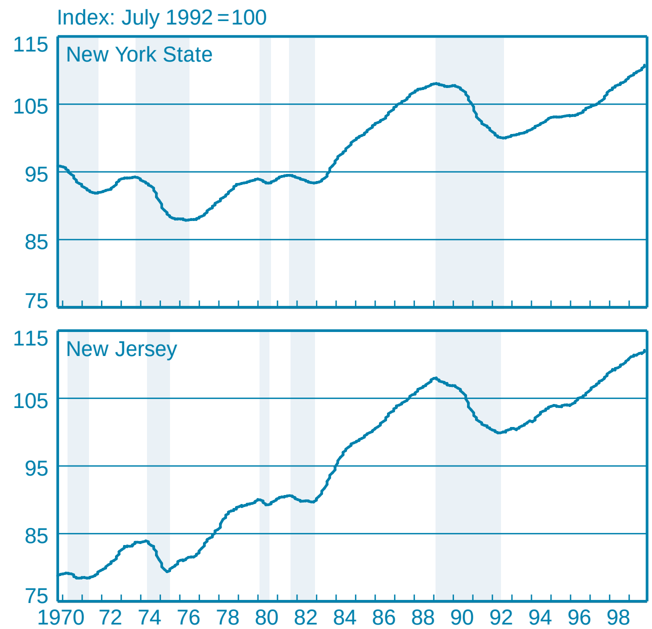
(2) $$\Delta \hat{C}_t^{t+9} = X_t \hat{\beta} ,$$

where $\Delta \hat{C}_t^{t+9}$ is the predicted nine-month growth rate in the CEI in month t and $\hat{\beta}$ denotes the estimated coefficients of the model.

Before turning our attention to the issue of forecasting recessions and expansions, there are two points about the leading index and our methodology that merit discussion. First, the single-equation approach contrasts with Stock and Watson (1989) and Crone and Babyak (1996), who use a vector autoregression (VAR) model to construct the leading index.[15] An advantage of our framework is that it is tractable and very easy to interpret. Specifically, it allows us to consider a direct relationship between the quantity of interest ($\Delta \hat{C}_t^{t+9}$) and observed values of the leading variables, rather than relying on a sequence of forecasted values that must be derived in a recursive manner. In addition, equation 1 involves the estimation of a relatively small number of parameters compared with a VAR system. This is consistent with the principle of parsimony and helps reduce the risk of overfitting the data.

Second, there is a technical issue that arises from the use of overlapping data in equation 1. Specifically, the forecasting horizon of the CEI exceeds the sampling interval of the data. Consequently, the error term in equation 1 is not precluded from displaying autocorrelation. Although this feature of the data does not invalidate the use of conventional techniques to estimate the parameters of equation 1, the standard errors need to be calculated using methods designed to account for autocorrelation of the disturbance terms.[16]

Chart 1
Indexes of Coincident Economic Indicators
October 1969–November 1999



Source: Authors' calculations.

Note: The shading indicates state recessions as determined by the authors.

The Recession and Expansion Indexes

The central reason for developing a leading index is to obtain a series capable of providing a reliable signal about recessions and expansions. It is important to note that by itself, a leading index conveys only qualitative information about the future course of fluctuations in economic activity. That is, its design is primarily intended to generate turning points that precede those associated with the business cycle. From a quantitative perspective, however, a leading index does not offer a probabilistic forecast of recessions and expansions.

Researchers have attempted to provide a more formal link between leading indexes and the incidence of recessions and expansions in the economy. While a review of the literature is beyond the scope of this article, it is instructive to examine what might be considered the two most divergent approaches.

We derive measures indicating the likelihood of a recession or expansion in a state—the recession and expansion indexes—by using simulation techniques to estimate the probability of observing the [recessionary and expansionary] growth patterns.

One approach is to specify a rule of thumb that uses movements in a leading index to forecast recessions and expansions. Crone and Babyak (1996) adopt this procedure in their work on leading indexes for Pennsylvania and New Jersey. The authors define the leading index as the forecasted nine-month growth rate in the coincident index, and apply their rule of thumb to the behavior of the leading index over three consecutive months. In particular, the rule generates a recession (expansion) signal if the economy is currently in an expansion (recession) and there are three consecutive declines (increases) in the leading index. An advantage of this approach is that it is very easy to implement. A potential drawback is that the rule is arbitrary and implicitly associates forecasts of recessions and expansions with probabilities that are restricted to being either 0 or 1. That is, the rule does not allow a "partial" recession (or expansion) signal to be issued.

The approach of Stock and Watson (1989, 1993) represents the other extreme. Stock and Watson define recessions and expansions in terms of particular sequences of one-month growth rates in the coincident index and then generate forecasts of recessions and expansions by evaluating the likelihood of observing the sequences over a six-month horizon. An attractive feature of the framework is that it offers a statistical model to construct probabilistic statements about future recessions and expansions. Its main disadvantage is that the model is quite sophisticated and not easily amenable to predicting recessions and expansions over alternative horizons.[17]

Our approach to forecasting recessions and expansions for New York State and New Jersey essentially combines the approaches of Stock and Watson (1989, 1993) and Crone and Babyak (1996). Specifically, we draw upon the work of Stock and Watson by defining recessions and expansions in terms of future growth patterns in the CEI. In addition, we derive measures indicating the likelihood of a recession or expansion in a state—the recession and expansion indexes—by using simulation techniques to estimate the probability of observing the growth patterns. In contrast to Stock and Watson, however, we employ simpler definitions for the recessionary and expansionary patterns based on a rule-of-thumb formulation. Because of these considerations, our approach can be interpreted as a "probabilistic rule of thumb."[18]

To motivate our modeling strategy, we begin by examining the rule of thumb used by Crone and Babyak to signal a recession or expansion:

$$(3)\ (\Delta\hat{C}_t^{t+9}<0 \textit{ and } \Delta\hat{C}_{t+1}^{t+10}<0 \textit{ and } \Delta\hat{C}_{t+2}^{t+11}<0)\ \textit{[recession signal]}$$

$$(\Delta\hat{C}_t^{t+9}>0 \textit{ and } \Delta\hat{C}_{t+1}^{t+10}>0 \textit{ and } \Delta\hat{C}_{t+2}^{t+11}>0)\ \textit{[expansion signal]},$$

where $\Delta\hat{C}_{t+i}^{t+i+9}$ denotes the forecasted growth rate in the CEI between month $t+i$ and month $t+i+9$ using information available through month $t+i$.

As an alternative to equation 3 and its reliance on three consecutive readings of a (nine-month) leading index, we will initially consider a rule that uses readings of forecasted growth in the CEI over three adjacent horizons to signal a recession or expansion:

$$(4)\ (\Delta\hat{C}_t^{t+7}<0 \textit{ and } \Delta\hat{C}_t^{t+8}<0 \textit{ and } \Delta\hat{C}_t^{t+9}<0)\ \textit{[recession signal]}$$

$$(\Delta\hat{C}_t^{t+7}>0 \textit{ and } \Delta\hat{C}_t^{t+8}>0 \textit{ and } \Delta\hat{C}_t^{t+9}>0)\ \textit{[expansion signal]},$$

where $\Delta\hat{C}_t^{t+i}$ denotes the forecasted growth rate in the CEI between month t and month $t+i$ using information available through month t. Because the leading index is linked to predicted growth in the CEI, equation 4 can be interpreted as a rule of thumb that uses concurrent declines (increases) in a seven-, eight-, and nine-month LEI to predict future recessions (expansions).

The key differences between equations 3 and 4 concern the dating of the information sets used for forecasting and the immediacy with which a recession or expansion signal can be generated. If $\Delta\hat{C}_t^{t+9}<0$ ($\Delta\hat{C}_t^{t+9}>0$), then the rule in equation 3 not only requires two additional periods to pass before a signal can be issued in period t+2, but also stipulates that the signal partly relies on forecasts constructed during the previous two periods. In contrast, the rule in equation 4 allows an immediate signal to be issued in period t because it depends only on currently available information. An advantage of the formulation in equation 4 is that it can improve the lead time in signaling a transition from one phase of the business cycle to the other, although it might be more susceptible to generating false signals.

If our interest was restricted to predicting recessions and expansions based on the rules of thumb in equations 3 and 4, then the remainder of the analysis might be concerned simply with evaluating the rules' relative performance. However, both equations are unattractive because they imply a discrete probability pattern for recessions and expansions that admits only values of 0 or 1. Moreover, the signal (and probability) of a recession or expansion depends only on the *sign* of the forecasted growth rates in the CEI and not on the *magnitude*.

In an attempt to remedy both of these shortcomings, we develop a formal statistical model to forecast recessions and expansions. Following Stock and Watson (1989, 1993), we define recessionary and expansionary patterns in terms of a sequence of growth rates in the CEI. In particular, we extend equation 4 and adopt the following definitions:

$$(5)\ (\Delta C_t^{t+7} < 0 \text{ and } \Delta C_t^{t+8} < 0 \text{ and } \Delta C_t^{t+9} < 0)\ \textit{[recessionary pattern]}$$

$$(\Delta C_t^{t+7} > 0 \text{ and } \Delta C_t^{t+8} > 0 \text{ and } \Delta C_t^{t+9} > 0)\ \textit{[expansionary pattern]},$$

where ΔC_t^{t+i} denotes the actual rate of growth in the CEI between month t and month $t+i$.[19]

For the purpose of forecasting recessions and expansions, equation 5 is void of any operational content because it is expressed in terms of *future* growth rates in the CEI. However, if we view the sequences in the equation as realizations from a stochastic process, then we can use the associated probabilities as the basis for drawing inferences about the likelihood of a recession or expansion. Borrowing from the terminology of Stock and Watson (1989, 1993), we define the recession index (R_t) and expansion index (E_t) in month t as:

$$(6)\quad R_t = Pr\,[(\Delta C_t^{t+7} < 0 \text{ and } \Delta C_t^{t+8} < 0 \text{ and } \Delta C_t^{t+9} < 0) | I_t]$$

$$E_t = Pr\,[(\Delta C_t^{t+7} > 0 \text{ and } \Delta C_t^{t+8} > 0 \text{ and } \Delta C_t^{t+9} > 0) | I_t],$$

where R_t and E_t denote, respectively, the probability of a recession and expansion within the next nine months, conditional on available information through month t (I_t).

We complete the statistical model by augmenting the previous specification for the nine-month growth rate in the CEI in equation 1 to include the processes governing the movements in the CEI over a seven- and eight-month horizon:

$$(7)\quad \Delta C_t^{t+7} = X_{1t}\beta_1 + \varepsilon_{t,7}$$

$$\Delta C_t^{t+8} = X_{2t}\beta_2 + \varepsilon_{t,8}$$

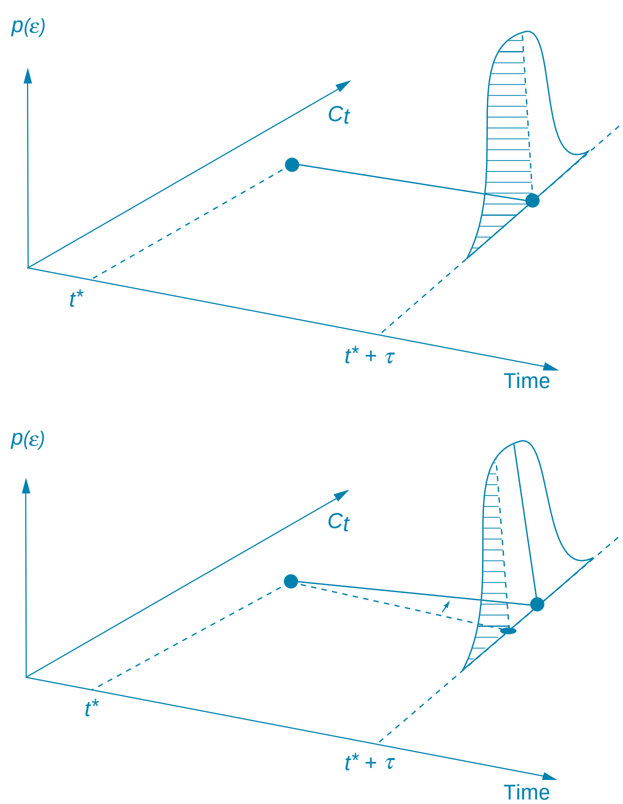
$$\Delta C_t^{t+9} = X_{3t}\beta_3 + \varepsilon_{t,9},$$

where X_{it} is a set of leading variables in the ith equation available in month t, β_i refers to the coefficients in the ith equation, and $\varepsilon_{t,j}$ is a mean-zero error term associated with the j-month-ahead growth rate in C_t. Our technical appendix describes the specification of the system in equation 7 for New York State and New Jersey and provides details on the calculation of the recession and expansion indexes in equation 6.[20]

With regard to forecasting recessions and expansions, the key aspect of our approach is that it depends on the processes governing the deterministic growth component of the CEI *and* the random disturbance term.[21] As such, our statistical model takes into account forecasting uncertainty and incorporates gradations of forecasted growth rates into the formulation of the recession and expansion indexes.

The top panel of Chart 2 makes this point visually by depicting a hypothetical situation in which the CEI is expected to remain constant (zero growth rate) over the near term. For

Chart 2
Calculating the Recession Index



the purpose of illustration, we will assume that a rule of thumb and our recession (and expansion) index depend only on the behavior of the CEI over a singular horizon.[22]

A rule of thumb based solely on the sign of the forecasted growth in the CEI between period t^* and period $t^* + \tau$ would not generate a recession signal and would implicitly assign a value of zero to the likelihood of a future recession. In contrast, our approach would recognize that there is an equal likelihood of positive and negative growth rates for the CEI and would assign a probability of 50 percent (indicated by the shaded area) to a future recession. The bottom panel of the chart then illustrates how the recession signal from a rule of thumb would be invariant to higher (positive) predicted growth in the CEI, while the value of our recession index would decline because of the lower probability of observing negative growth in the CEI.[23]

Our statistical model takes into account forecasting uncertainty and incorporates gradations of forecasted growth rates into the formulation of the recession and expansion indexes.

Empirical Results

The construction of the indexes for New York State and New Jersey requires the selection of a set of leading indicators. Our list includes both state-level and national variables. The state-level data consist of past changes in the coincident index and housing permits.[24] The use of lagged growth rates of the coincident index is intended to capture inertial effects—persistence—in the series. We augment these explanatory variables by including past changes in the national index of leading economic indicators and an interest rate spread—the difference between the yields on ten-year Treasury bonds and one-year Treasury bills. Our data appendix provides further details on the leading indicators.

It is worth noting that the results indicate that the interest rate spread contains additional forecasting power for state economic activity despite the inclusion of financial market indicators in the national leading index.[25] This evidence documenting an independent role for the interest rate spread as a regional indicator may reflect the critical importance of the finance, insurance, and real estate (FIRE) industry to the economies of New York State and New Jersey. For example, the FIRE industry's shares of both employment and earnings in the region are much larger than they are in the national economy. In addition, Kuttner and Sbordone (1997) provide evidence that shocks to employment growth in the FIRE sectors of New York State and New Jersey have significant effects on overall employment growth in the region.

Within-Sample Performance of the Leading Index

In estimating the leading indexes for New York State and New Jersey, it is important to recognize the existence of publication lags in variables and the implication for model specification. We follow the conventional practice of assuming a one-month delay in the release of the coincident index for each state.[26] As a consequence, there is also a one-month delay in the release of the leading index. That is, the LEI released at the end of February would correspond to the forecasted growth in the CEI from January to September, conditional on information available through February. To help clarify the notation, we define the lags of each leading indicator relative to the current information set. For the LEI released at the end of February, the contemporaneous value (zero lag) of the coincident index, housing permits, and the national index of leading economic indicators would reflect observations through January, while the contemporaneous value of the interest rate spread would be for February. The use of the most currently available data results in a more timely measure of economic activity.

Because of the large number of possible specifications for equation 1, we applied various testing procedures to help with model selection. The specifications were evaluated based on their within-sample as well as out-of-sample performance.[27] We also examined the specifications to determine if the estimated coefficients generally displayed the "correct" sign. While the rankings based on the various criteria were not always in complete agreement, they were broadly consistent.

Our results from estimating equation 1 for New York State and New Jersey over the sample period February 1972 to November 1999 appear, respectively, in Tables 1 and 2. The leading indexes for each state appear in Charts 3 and 4, where the series are plotted based on the dating of the LEI series and the shading represents state recessions.[28] As shown by the values of the adjusted R^2 measure, the models fit the data quite well and are able to explain approximately 75 percent and 63 percent of the total variation in the nine-month CEI growth rates for New York State and New Jersey, respectively.

Table 1

Estimated Leading Economic Index Model for New York State

$$\Delta C_t^{t+9} = \alpha_0 + \sum_{i=0}^{n_1} \beta_i \Delta C_{t-i-9}^{t-i} + \sum_{i=0}^{n_2} \delta_i \Delta Permits_{t-i} + \psi_0 (Spread_t) + \sum_{i=0}^{n_3} \gamma_i \Delta LEI_{t-i}^{National} + \varepsilon_{t,9},$$

where:

$\Delta C_t^{t+9} = (1200/9)*[1n(C_{t+9}/C_t)]$ = nine-month growth in the index of coincident economic indicators (CEI),

$\Delta C_{t-i-9}^{t-i} = (1200/9)*[1n(C_{t-i}/C_{t-i-9})]$,

$\Delta Permits_t = (1200/9)*[1n(Permits_t / Permits_{t-9})]$ = nine-month growth in housing permits,

$Spread_t = (1/3)\sum_{i=0}^{2}[Yield_{t-i}^{Ten-year\ Treasury\ bond} - Yield_{t-i}^{One-year\ Treasury\ bill}]$,

$\Delta LEI_t^{National} = (1200)*[1n(LEI_t^{National}/LEI_{t-1}^{National})]$ = one-month growth in the national index of leading economic indicators (LEI).

Sample Period: February 1972-November 1999		$\bar{R}^2 = 0.749$	DOF = 326
Parameter	Coefficient	Standard Error	t-Statistic
α_0	-0.1318	0.1686	0.7817
β_0	1.5787	0.3653	4.3216***
β_1	-0.9379	0.3563	2.6326***
δ_0	0.0022	0.0016	1.3163
δ_3	0.0025	0.0017	1.4649
δ_6	0.0039	0.0014	2.7966***
ψ_0	0.2618	0.0688	3.8034***
γ_0	0.2425	0.0412	5.8904***

New York State	Recession Lead(+)/Lag(-)			Expansion Lead(+)/Lag(-)	
Business Cycle Peak	Conventional Rule of Thumb	Modified Rule of Thumb	Business Cycle Trough	Conventional Rule of Thumb	Modified Rule of Thumb
October 1973	+2 months	+4 months	June 1976	+4 months	+6 months
February 1980	+5 months	+7 months	August 1980	0 months	+2 months
August 1981	+0 months	+2 months	November 1982	0 months	+2 months
February 1989	-3 months	-1 month	July 1992	-4 months	-2 months
False signals	August-September 1992	August-September 1992 January 1996	False signals	March 1989	March 1989

Source: Authors' calculations.

Notes: In the top panel, all growth rates are calculated on an annual percentage basis. Standard errors are calculated using the Newey-West (1987) estimator and allow for a moving-average (8) process for the regression residuals. DOF is degrees of freedom.

In the bottom panel, the identification of peaks and troughs in the state business cycles is based upon the coincident index derived using a full-sample smoother ($C_{t|T}$). State recessions (expansions) are dated from one month after a peak (trough) to the trough (peak) of the state's coincident economic activity index in any business cycle. For the conventional rule of thumb, three consecutive declines (increases) in the nine-month index forecast are used to signal a recession (expansion) within the next nine months. For the modified rule of thumb, a simultaneous decline (increase) in the seven-, eight-, and nine-month index forecast is used to signal a recession (expansion) within the next nine months. A lead/lag value of zero months indicates that the signal coincided with the beginning of a recession/expansion.

*** Significant at the 1 percent level.

Table 2

Estimated Leading Economic Index Model for New Jersey

$$\Delta C_t^{t+9} = \alpha_0 + \sum_{i=0}^{n_1} \beta_i \Delta C_{t-i-9}^{t-i} + \sum_{i=0}^{n_2} \delta_i \Delta Permits_{t-i} + \psi_0 (Spread_t) + \sum_{i=0}^{n_3} \gamma_i LEI_{t-i}^{National} + \varepsilon_{t,9},$$

where:

$\Delta C_t^{t+9} = (1200/9)*[1n(C_{t+9}/C_t)]$ = nine-month growth in the index of coincident economic indicators (CEI),

$C_{t-i-9}^{t-i} (1200/9)*[1n(C_{t-i}/C_{t-i-9})]$,

$\Delta Permits_t = (1200/9)*[1n(Permits_t/Permits_{t-9})]$ = nine-month growth in housing permits,

$Spread_t = (1/3) \sum_{i=0}^{2} [Yield_{t-i}^{Ten-year\ Treasury\ bond} - Yield_{t-i}^{One-year\ Treasury\ bill}]$,

$\Delta LEI_t^{National} = (1200)*[1n(LEI_t^{National}/LEI_{t-1}^{National})]$ = one-month growth in the national index of leading economic indicators (LEI).

Sample Period: February 1972-November 1999 — $\bar{R}^2 = 0.626$ — DOF = 325

Parameter	Coefficient	Standard Error	*t*-Statistic
α_0	0.2693	0.3052	0.8823
β_0	0.5598	0.2917	1.9191*
β_1	-0.8696	0.3337	2.6063***
β_2	0.7066	0.2542	2.7795***
δ_0	0.0078	0.0032	2.4665**
δ_3	0.0041	0.0018	2.2355**
δ_6	0.0029	0.0018	1.6320
ψ_0	0.3436	0.1163	2.9536***
γ_0	0.2696	0.0723	3.7269***

New Jersey	Recession Lead(+)/Lag(-)			Expansion Lead(+)/Lag(-)	
Business Cycle Peak	Conventional Rule of Thumb	Modified Rule of Thumb	Business Cycle Trough	Conventional Rule of Thumb	Modified Rule of Thumb
May 1974	+4 months	+6 months	June 1975	0 months	+1 month
February 1980	+5 months	+7 months	July 1980	-1 month	+1 month
September 1981	-1 month	+1 month	November 1982	+4 months	+6 months
February 1989	-4 months	0 months	May 1992	+6 months	+7 months
False signals	—	—	False signals	January 1990	September 1989 December 1989 January 1990 March 1990

Source: Authors' calculations.

Notes: In the top panel, all growth rates are calculated on an annual percentage basis. Standard errors are calculated using the Newey-West (1987) estimator and allow for a moving-average (8) process for the regression residuals. DOF is degrees of freedom.

In the bottom panel, the identification of peaks and troughs in the state business cycles is based upon the coincident index derived using a full-sample smoother ($C_{t|T}$). State recessions (expansions) are dated from one month after a peak (trough) to the trough (peak) of the state's coincident economic activity index in any business cycle. For the conventional rule of thumb, three consecutive declines (increases) in the nine-month index forecast are used to signal a recession (expansion) within the next nine months. For the modified rule of thumb, a simultaneous decline (increase) in the seven-, eight-, and nine-month index forecast is used to signal a recession (expansion) within the next nine months. A lead/lag value of zero months indicates that the signal coincided with the beginning of a recession/expansion.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

The results also confirm the presence of inertia in the growth pattern of the CEI, as evident by the quantitative and statistical significance of its past changes.

It is also important to note that the other leading variables generally are significant and always display the anticipated sign. In particular, a decline in the growth of housing permits, a narrowing of the yield spread, and lower growth in the national index of leading economic indicators are taken as harbingers of a slowing in state economic activity. Because the month-to-month movements in the national index of leading economic indicators can be somewhat noisy, we elected to smooth the series using a filter suggested by Stock and Watson (1989) to improve the model's forecasting performance.[29]

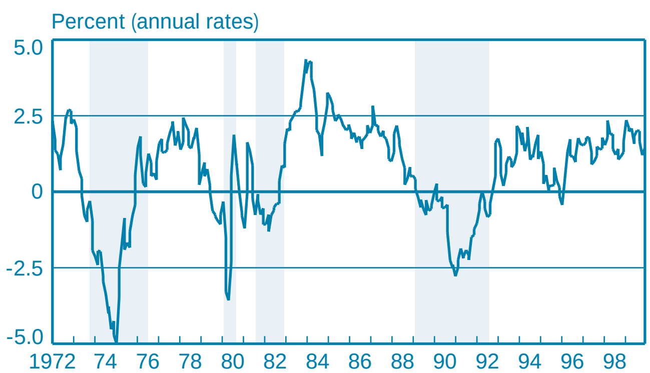
Although the New York State LEI and New Jersey LEI are expressed in terms of (annualized) growth rates rather than levels, we can nevertheless examine Charts 3 and 4 and conduct an informal and preliminary evaluation of the indexes. Specifically, if the index is providing a timely and useful signal of transitional shifts in business cycle phases, then we should observe negative (positive) growth preceding the onset of a recession (expansion).

The indexes for New York State and New Jersey generally display this feature, although there is considerable variation in the timing both within and across the states. Our inspection reveals that the indexes turned negative well in advance of the impending recessions in the mid-1970s and in 1980. Interestingly, both indexes are characterized by a fluctuating pattern prior to the 1981 recession in which they first turn negative, then increase above zero before turning negative again. In addition, each index showed an upturn prior to the start of the expansions in the mid-1970s and during the 1980s.

Chart 3

New York State Index of Leading Economic Indicators

Nine-Month CEI Forecast: January 1972–November 1999



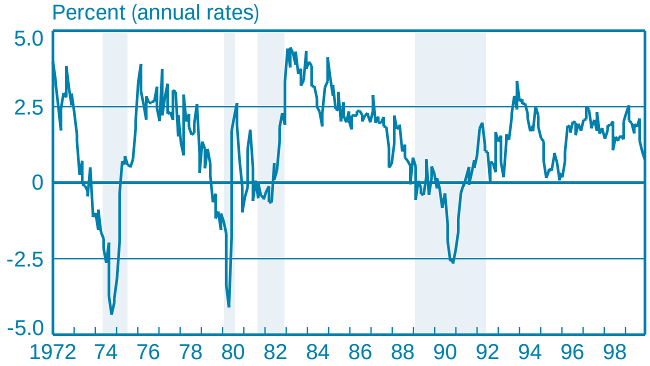
Source: Authors' calculations.

Notes: CEI is index of coincident economic indicators. The shading indicates state recessions as determined by the authors.

Chart 4

New Jersey Index of Leading Economic Indicators

Nine-Month CEI Forecast: January 1972–November 1999



Source: Authors' calculations.

Notes: CEI is index of coincident economic indicators. The shading indicates state recessions as determined by the authors.

However, the downturn in the LEI for both states was subsequent to the onset of the recessions in 1989.[30] With regard to their recent behavior, the series have displayed a similar pattern and were characterized by very slow growth during the mid-1990s.

To gain further insight into the behavior of the LEI, we can consider an historical decomposition to isolate each indicator's contribution to the index. The historical decomposition is based on the following relationship:

$$\Delta \hat{C}_t^{t+9} = \Delta \bar{C}_t^{t+9} + (X_t - \bar{X})\hat{\beta}, \qquad (8)$$

which expresses the LEI as the mean nine-month growth rate in the CEI ($\Delta \bar{C}_t^{t+9}$) plus the sum of the contributions from each indicator. Charts 5 and 6 plot the (mean-adjusted) LEI and its historical decomposition for New York State and New Jersey. For convenience, we accumulate the effects from all lagged terms when calculating the total contribution of a series.[31] A positive (negative) value for a series indicates that the variable is contributing to greater than (less than) trend growth in the leading index.

As shown, each of the series makes a contribution to the total. The largest historical contributions are from past changes in the coincident index and the national index of leading economic indicators. While the contributions from the yield spread and housing permits are smaller in scope, both variables have the desirable property of displaying downturns/upturns that precede those associated with state business cycles. Also, it appears that housing permits contribute more to the LEI for New Jersey than for New York State.

Before turning our attention to the recession and expansion indexes, it is instructive to examine the properties of the recessionary and expansionary patterns that underlie their construction. To shed light on this issue, we explore the consequences of forecasting recessions and expansions based on the rules of thumb discussed earlier. The conventional rule of thumb described in equation 3 is given by:

$$(\Delta\hat{C}_t^{t+9} < 0 \text{ and } \Delta\hat{C}_{t+1}^{t+10} < 0 \text{ and } \Delta\hat{C}_{t+2}^{t+11} < 0) \text{ [recession signal]}$$

$$(\Delta\hat{C}_t^{t+9} > 0 \text{ and } \Delta\hat{C}_{t+1}^{t+10} > 0 \text{ and } \Delta\hat{C}_{t+2}^{t+11} > 0) \text{ [expansion signal]}.$$

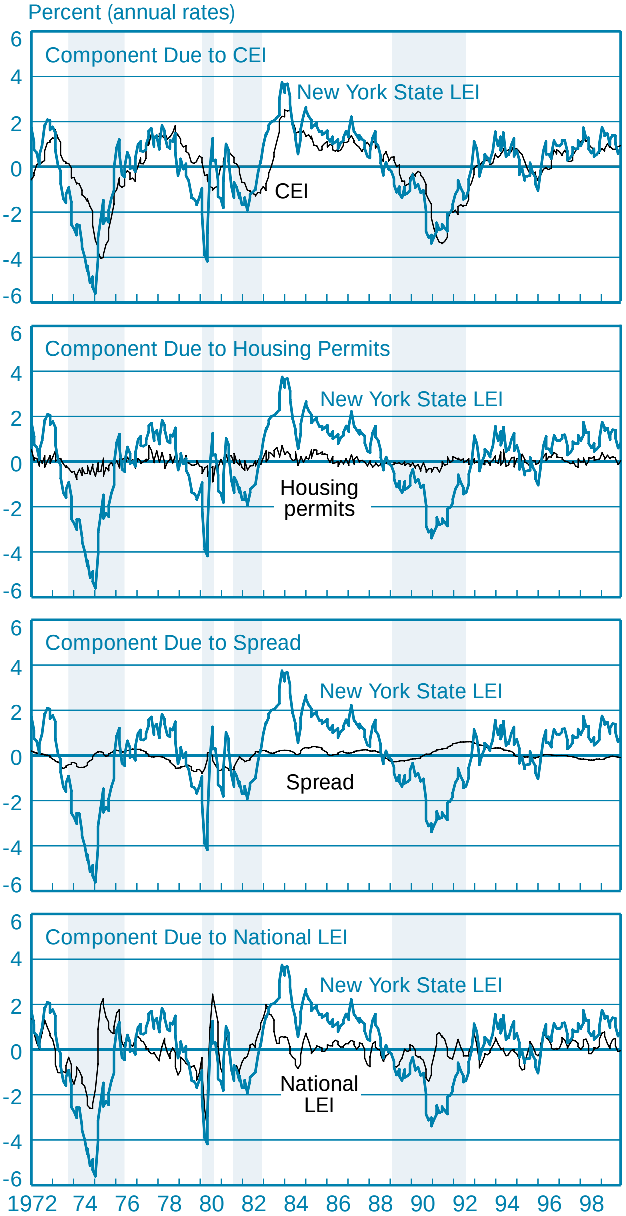
As an alternative, we propose the following modified rule of thumb in equation 4:

$$(\Delta\hat{C}_t^{t+7} < 0 \text{ and } \Delta\hat{C}_t^{t+8} < 0 \text{ and } \Delta\hat{C}_t^{t+9} < 0) \text{ [recession signal]}$$

$$(\Delta\hat{C}_t^{t+7} > 0 \text{ and } \Delta\hat{C}_t^{t+8} > 0 \text{ and } \Delta\hat{C}_t^{t+9} > 0) \text{ [expansion signal]}.$$

Chart 5

Historical Decomposition of the New York State LEI

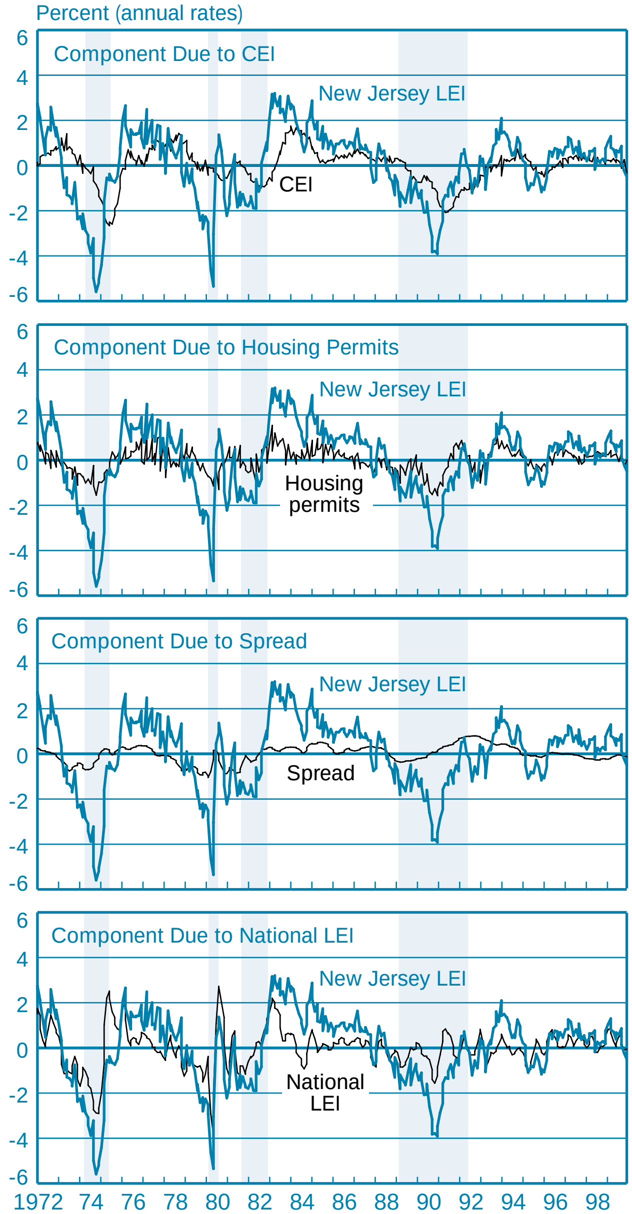


Source: Authors' calculations.

Notes: LEI is index of leading economic indicators; CEI is index of coincident economic indicators. The shading indicates state recessions as determined by the authors.

Chart 6

Historical Decomposition of the New Jersey LEI



Source: Authors' calculations.

Notes: LEI is index of leading economic indicators; CEI is index of coincident economic indicators. The shading indicates state recessions as determined by the authors.

Tables 1 and 2 also compare the forecasting performance of these competing rules of thumb. An initial examination of the results indicates that both rules ultimately signaled every recession and expansion over the sample period. In those instances where they failed to provide a leading signal, the rules nevertheless generated an accurate, albeit lagging, signal of an expansion or recession. The traditional rule of thumb was only able to provide an accurate leading signal for half of the recessions and expansions across New York State and New Jersey. With regard to the modified rule, it provided an accurate leading signal of three of the four recessions in New York State as well as three of the four expansions.[32] For New Jersey, the modified rule provided an accurate leading signal of three of the four recessions and all four expansions. The results for predicting expansions based on the modified rule seem particularly noteworthy in light of the previous lack of success at the state level.

The findings also seem to confirm our earlier suspicion about the properties of the two rules. The modified rule generates an earlier signal of recessions and expansions, where the lead time of equation 4 typically exceeds that of equation 3 by two months. These results are not particularly surprising given differences in the formulation of the rules and in the dating of information sets. These same considerations would also seem to account for the modified rule being slightly more susceptible to issuing false signals, although this feature seems to be principally limited to the case of forecasting the recovery in New Jersey in early 1990.

Within-Sample Performance of the Recession and Expansion Indexes

The recession and expansion indexes for New York State and New Jersey are plotted, respectively, in Charts 7 and 8, where the shading again indicates state recessions.[33] In the charts, the movements in the indexes closely correspond with the behavior of the LEI. Our recession (expansion) index typically rises prior to the advent of a contractionary (recovery) phase in state economic activity. In addition, most of the probabilities are close to either zero or one, suggesting that the indexes are arriving at a fairly strong conclusion about future changes in the direction of economic activity.

Although we do not attempt to provide a formal evaluation of the indexes and their ability to anticipate turning points, a reasonable metric to judge their performance might be based on whether the indexes indicate if the economy is more likely to be in a recession ($R_t > 0.5$) or an expansion ($E_t > 0.5$) within the next nine months. Based on this measure, the indexes generate slightly better lead times than those reported in Tables 1 and 2 for the modified rule of thumb, with no discernible change in the incidence of false signals. Taken together, these findings offer additional support for the reasonableness, reliability, and accuracy of the indexes.

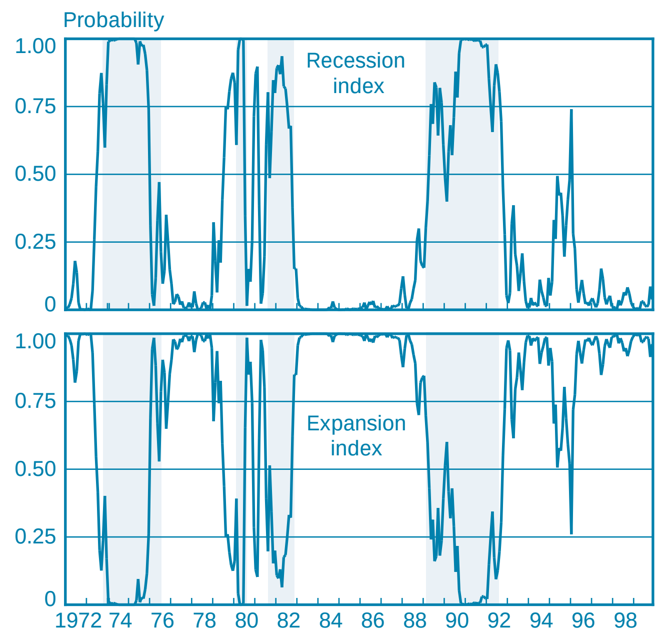
Our recession (expansion) index typically rises prior to the advent of a contractionary (recovery) phase in state economic activity.

As previously discussed, the indexes offer a potential advantage over a rule of thumb by allowing for a continuous probability range and thereby provide additional information about the strength of a signal. There are several instances where this feature seems to be particularly useful in analyzing cyclical behavior in the two states. For example, the 1981 recession in New York State, unlike that of the nation, was sufficiently mild and brief that some regional analysts temper the term

Chart 7

New York State Recession and Expansion Indexes

January 1972–November 1999



Source: Authors' calculations.

Note: The shading indicates state recessions as determined by the authors.

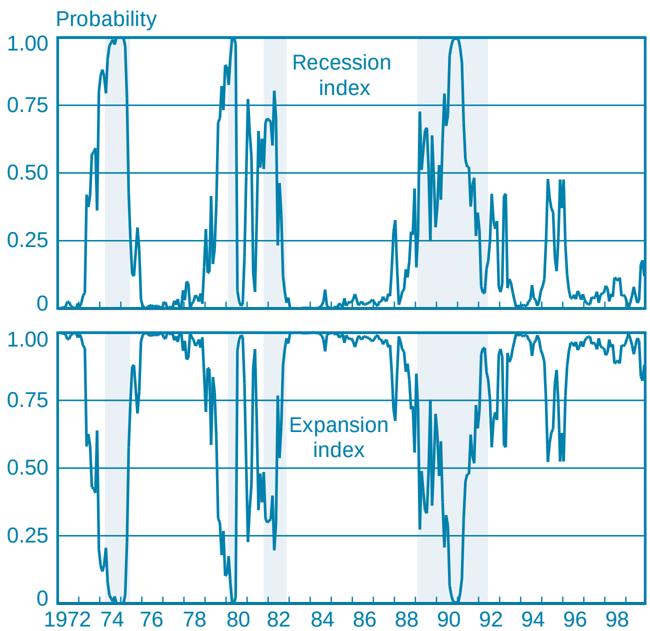
recession. This fact may explain the lack of lead time evident in the recession index for this episode. In addition, the upturn in late 1982 for New York State began very slowly before evolving into a “boom” period. In contrast, the expansion index seems to have reached a much firmer conclusion about the impending upturn.

The importance of this issue, however, seems to be most evident when considering economic developments of the mid-1990s. At the beginning of 1995, there was a pronounced slowdown of growth in the economies of New York State and New Jersey (as well as in economic activity at the national level). The recession indexes for both states seem to have anticipated this slowing correctly and display a marked and persistent rise during 1995. While a subsequent recession did not occur, there is good reason to believe that the likelihood of a recession increased during 1995. The use of a rule of thumb based only on the sign of forecasted growth rates, however, leads to a very different characterization of this period. In contrast to the indexes, both rules of thumb essentially remained silent during this period and would have provided little warning of a possible contraction in state economic activity.

Chart 8

New Jersey Recession and Expansion Indexes

January 1972–November 1999



Source: Authors’ calculations.

Note: The shading indicates state recessions as determined by the authors.

Data Revisions and the Out-of-Sample Performance of the LEI Models

Two important considerations underlie the previous results. First, our indexes are constructed using models estimated over the full sample period. Second, we employ final data and do not undertake the analysis by reproducing the data that would have been available each month. In the case of real-time forecasting, however, neither of these scenarios would be relevant. For example, information arrives sequentially over a sample period. In addition, initial data releases typically are preliminary and are subject to periodic revisions. As a consequence, the within-sample results may overstate the actual forecasting performance of the indexes.

To address this concern, we now examine the out-of-sample performance of the LEI models for New York State and New Jersey. Specifically, we construct alternative LEI series for each state based on a consideration of real-time forecasting issues and then compare the series with the LEI from the within-sample analysis. Because the real-time forecasting capability of the LEI models seems to be of particular interest around turning points, we focus on the December 1986-December 1994 period. This episode provides a two-year window on either side of the cyclical peak in early 1989 and the cyclical trough in mid-1992 that occurred in each state.[34]

The construction of the alternative LEI series can be described as follows. To simulate the sequential arrival of information, we adopt an expanding sample estimation procedure. To incorporate into the analysis data revisions for the leading variables, we focus on the coincident index and substitute preliminary payroll employment data in place of the final data as one of its components. This choice is motivated by the historical decomposition in Charts 5 and 6, which suggests that past changes in the coincident index are a major contributor to the LEI, as well as our previous work (Orr, Rich, and Rosen 1999), which indicates that payroll employment is the most important component of the coincident index. To conduct the out-of-sample exercise, we estimate the LEI model for each state using the real-time analogue of the coincident index along with the other leading variables, generate a nine-month-ahead forecast, add an additional month’s worth of data, and repeat the exercise.[35]

With regard to the expanding estimation procedure, it is important to recognize the nature of the restrictions that the horizon of the LEI places on the information and model estimates available to a forecaster in a real-time setting. Because we are interested in the nine-month growth rate of the CEI, the most current observation of this variable in period *t* would be

ΔC_{t-9}^{t}. From equation 1, this implies the following regression model:

$$\Delta C_{t-9}^{t} = X_{t-9|t}\beta_{t-9} + \varepsilon_{t-9,9}, \quad (9)$$

where $X_{t-9|t}$ is a set of leading variables through month t-9 that are available in period t for the estimation of equation 9.

We can then construct a forecast of the growth in the CEI between month t and month t+9 according to the following expression:

$$\Delta \hat{C}_{t}^{t+9} = X_{t}\hat{\beta}_{t-9}, \quad (10)$$

where $\Delta \hat{C}_{t}^{t+9}$ denotes the forecasted growth rate in the CEI between month t and month t+9, X_t is the corresponding value of the leading variables updated through month t, and β_{t-9} denotes the estimated coefficients of equation 9.

The LEI series based on the out-of-sample forecasts differs principally from its within-sample counterpart in equation 2 in terms of the model estimates. Specifically, the LEI series in equation 9 is derived from a two-step procedure that initially uses the variables $X_{t-9|t}$ as regressors to estimate the model, and then uses the variables X_t for forecasting purposes.[36] In contrast, the within-sample LEI series allows the variables X_t to serve as both the regressors and forecasting variables in the model.

The construction of the real-time analogue for the coincident index requires a timing convention for the mixture of preliminary and final payroll employment data as well as a choice of weights for the coincident indicators. Because preliminary values will correspond to the most recent observations of a time series, we assume that the data on payroll employment for a current year are preliminary and that those for the preceding years are final.[37] Following this timing convention, we can create a real-time payroll employment series for each year extending from 1986 through 1994. We can then combine the real-time payroll employment series with the other coincident indicators using the component weights from the estimation of the original coincident index model.

The outcome of this procedure is a real-time coincident index series for each year from 1986 through 1994 that can be used as a leading variable for forecasting purposes. The real-time coincident index series has the feature of incorporating preliminary payroll employment in the current year and final data in previous years. In each subsequent year, the index series would reflect not only the preliminary data for the current year, but would also incorporate the shift from preliminary payroll employment to final data for the preceding year.

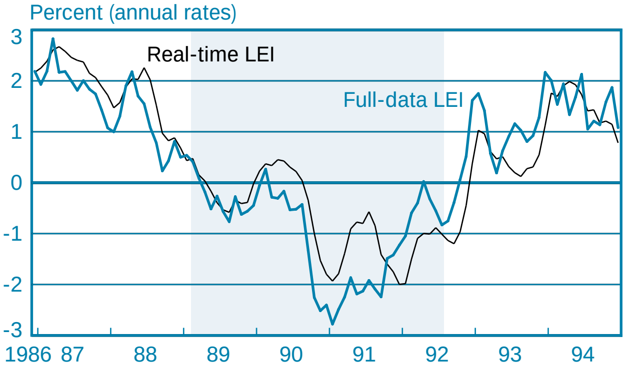
The out-of-sample forecasting performance of the LEI models for New York State and New Jersey is examined, respectively, in Charts 9 and 10. The charts illustrate the real-time LEI series from 1986 through 1994, where the LEI from the within-sample analysis is plotted again for convenience. Our principal focus is on comparing the real-time LEI series with the within-sample counterpart.[38]

As shown, the real-time LEI series appear to track closely the within-sample LEI. The indexes for New York State behave quite similarly throughout the entire episode. For New Jersey, the indexes again display similar behavior at the onset as well as during most of the 1989-92 state recession. Admittedly, there

Chart 9

New York State Real-Time LEI

December 1986–December 1994



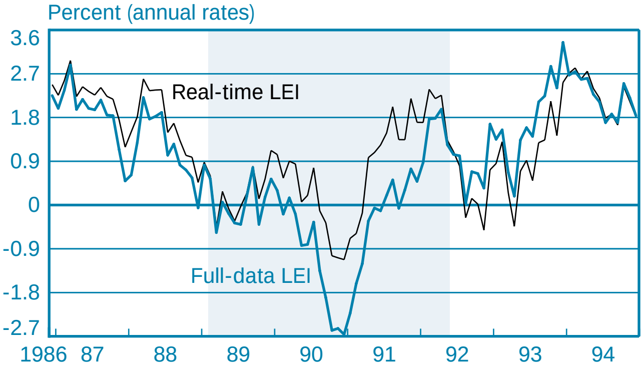
Source: Authors' calculations.

Notes: LEI is index of leading economic indicators. The shading indicates a state recession as determined by the authors.

Chart 10

New Jersey Real-Time LEI

December 1986–December 1994



Source: Authors' calculations.

Notes: LEI is index of leading economic indicators. The shading indicates a state recession as determined by the authors.

are some differences in the series during the initial phase of the subsequent recovery. Taken together, however, the evidence in Charts 9 and 10 suggests that the use of final data does not severely overstate the forecasting performance of the LEI models for New York State and New Jersey.

Conclusion

In this article, we constructed indexes of leading economic indicators for New York State and New Jersey over the 1972-99 period. The indexes are nine-month-ahead forecasts of the indexes of coincident economic indicators developed for each state in Orr, Rich, and Rosen (1999). In order to refine our forecast of future recessions and expansions, we then outlined a methodology for the construction of a recession and expansion index. These indexes provide an alternative to conventional rules of thumb by allowing the likelihood of a recession and expansion to be defined over a continuous probability range.

The historical performance of our leading indexes of future economic activity suggests that the information they convey about the timing and likelihood of a recession or expansion is quite useful and represents an improvement over the information offered by other indicators. Our results also suggest that the recession and expansion indexes provide a reliable signal of future economic turning points in New York State and New Jersey. Furthermore, the movements of our recession and expansion indexes display a close relationship with the behavior of our indexes of leading economic indicators. Accordingly, the recession and expansion indexes allow us to extend the informational content of the leading indexes by estimating the probability of an upcoming cyclical change in state economic activity.

Technical Appendix

This appendix describes the Monte Carlo procedure used to compute the recession index and expansion index for New York State and New Jersey. The recession (expansion) index is an estimate of the probability that the state economy will be in a recession (expansion) within nine months. The procedure can be described as follows.

The starting point for the analysis is the construction of a state-level index of coincident economic indicators (CEI). This series is denoted by C_t and is obtained from the estimation of a single index model developed by Stock and Watson (1989, 1991). The model is given by:

$$\text{(A1)} \qquad \Delta Y_t = \alpha + \gamma(L)\Delta C_t + \mu_t$$
$$D(L)\mu_t = \varepsilon_t$$
$$\phi(L)\Delta C_t = \delta + \eta_t,$$

where Y_t is an (n x 1) vector of coincident variables, Δ denotes the one-period change in a variable, ε_t and η_t are serially uncorrelated disturbance terms with a diagonal covariance matrix, L is the lag operator, and $\phi(L)$, $\gamma(L)$, and (L) are, respectively, scalar, vector, and matrix lag polynomials. Because the coincident variables are assumed to be measured in either levels or log levels, the vector ΔY_t can be interpreted as differences or growth rates in the coincident variables.

Stock and Watson provide details on additional identifying restrictions and estimation of the system (equation A1) using a Kalman filter. Following Orr, Rich, and Rosen (1999), the coincident economic indicators for New York State and New Jersey are based on these four series: the monthly growth in nonfarm payroll employment, actual (and forecasted) quarterly growth in real earnings (wages and salaries), the unemployment rate, and average weekly hours worked in the manufacturing sector.

Our interest in forecasting recessions and expansions rests with the recession index and expansion index previously defined in equation 6 in the text as:

$$\text{(A2)} \quad R_t = Pr\,[(\Delta C_t^{t+7} < 0 \text{ and } \Delta C_t^{t+8} < 0 \text{ and } \Delta C_t^{t+9} < 0) | I_t]$$
$$E_t = Pr\,[(\Delta C_t^{t+7} > 0 \text{ and } \Delta C_t^{t+8} > 0 \text{ and } \Delta C_t^{t+9} > 0) | I_t],$$

where R_t and E_t denote, respectively, the probability of a recession and expansion in the state's economy within the next nine months, conditional on information through month t.

To evaluate the expressions in equation A2, we consider the following three-equation system previously defined in equation 7 in the text:

$$\text{(A3)} \qquad \Delta C_t^{t+7} = X_{1t}\beta_1 + \varepsilon_{t,7}$$
$$\Delta C_t^{t+8} = X_{2t}\beta_2 + \varepsilon_{t,8}$$
$$\Delta C_t^{t+9} = X_{3t}\beta_3 + \varepsilon_{t,9},$$

where ΔC_t^{t+i} is the growth rate of the CEI between month t and month $t+i$, X_{it} denotes the vector of leading variables in the ith equation of the system available in month t, β_i is the coefficient vector of the ith equation, and $\varepsilon_t = [\varepsilon_{t,7}, \varepsilon_{t,8}, \varepsilon_{t,9}]'$ denotes the (3 x 1) vector of disturbance terms in the system. It is assumed that the disturbance vector ε_t has mean zero with covariance matrix $E\,[\varepsilon_t \varepsilon_t'] = \Sigma$ for all t.

Let $\hat{\beta} = (\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3)$ denote the estimated parameters of the three-equation system (equation A3) and let $\hat{\Sigma}$ denote the estimated variance-covariance matrix of the observed forecast errors $(\hat{\varepsilon}_1, \hat{\varepsilon}_2, \ldots, \hat{\varepsilon}_{T-9}) \equiv [(\hat{\varepsilon}_{1,7}, \hat{\varepsilon}_{1,8}, \hat{\varepsilon}_{1,9}), (\hat{\varepsilon}_{2,7}, \hat{\varepsilon}_{2,8}, \hat{\varepsilon}_{2,9}), \ldots, (\hat{\varepsilon}_{T-9,7}, \hat{\varepsilon}_{T-9,8}, \hat{\varepsilon}_{T-9,9})]$. To construct the recession index in period τ, we begin with the point forecasts of the seven-, eight-, and nine-month growth rate in the CEI, which are given, respectively, by:

$$\text{(A4)} \qquad \Delta\hat{C}_\tau^{\tau+7} = X_{1\tau}\hat{\beta}_1$$
$$\Delta\hat{C}_\tau^{\tau+8} = X_{2\tau}\hat{\beta}_2$$
$$\Delta\hat{C}_\tau^{\tau+9} = X_{3\tau}\hat{\beta}_3.$$

Next, we use simulation techniques—Monte Carlo methods—to generate a sample of artificial observations for the seven-, eight-, and nine-month growth rates of the CEI, which we denote by $[\Delta\tilde{C}_\tau^{\tau+7}, \Delta\tilde{C}_\tau^{\tau+8}, \Delta\tilde{C}_\tau^{\tau+9}]$. The set of observations for the artificial sample is generated by randomly drawing an observation from $\hat{\Sigma}$ and then adding the realization $[\tilde{\varepsilon}_\tau^{\tau+7}(1), \tilde{\varepsilon}_\tau^{\tau+8}(1), \tilde{\varepsilon}_\tau^{\tau+9}(1)]$ to the actual point forecasts based on the historical data from equation A4:

$$\text{(A5)} \qquad \Delta\tilde{C}_\tau^{\tau+7}(1) = X_{1\tau}\hat{\beta}_1 + \tilde{\varepsilon}_\tau^{\tau+7}(1)$$
$$\Delta\tilde{C}_\tau^{\tau+8}(1) = X_{2\tau}\hat{\beta}_2 + \tilde{\varepsilon}_\tau^{\tau+8}(1)$$
$$\Delta\tilde{C}_\tau^{\tau+9}(1) = X_{3\tau}\hat{\beta}_3 + \tilde{\varepsilon}_\tau^{\tau+9}(1).$$

A full sample of artificial data for month τ is then constructed by repeating this process N times:

(A6) $$[(\Delta\tilde{C}_{\tau}^{\tau+7}(1), \Delta\tilde{C}_{\tau}^{\tau+8}(1), \Delta\tilde{C}_{\tau}^{\tau+9}(1)), \ldots, (\Delta\tilde{C}_{\tau}^{\tau+7}(N), \Delta\tilde{C}_{\tau}^{\tau+8}(N), \Delta\tilde{C}_{\tau}^{\tau+9}(N))].$$

We select $N = 1{,}000$ replications to generate the full sample of artificial data for a given month τ.

The generation of the full sample of artificial data relies on an estimate of the variance-covariance matrix ($\hat{\Sigma}$) of the disturbance terms of the system. Because of the overlapping nature of the forecasts, the off-diagonal elements of the matrix $\hat{\Sigma}$ are not expected to equal zero. For the Monte Carlo analysis, the random draws used to construct the artificial data are taken from a multivariate normal distribution.

Once a full sample of artificial data for month τ is generated, we can count the number of times the recessionary pattern occurs in equation A6:

(A7) $$R_{\tau}^{i} = 1 \; if \; (\Delta\tilde{C}_{\tau}^{\tau+7}(i) < 0 \; and \; \Delta\tilde{C}_{\tau}^{\tau+8}(i) < 0 \; and \; \Delta\tilde{C}_{\tau}^{\tau+9}(i) < 0)$$
$$R_{\tau}^{i} = 0 \; otherwise.$$

Similarly, we can count the number of times the expansionary pattern occurs in equation A6:

(A8) $$E_{\tau}^{i} = 1 \; if \; (\Delta\tilde{C}_{\tau}^{\tau+7}(i) > 0 \; and \; \Delta\tilde{C}_{\tau}^{\tau+8}(i) > 0 \; and \; \Delta\tilde{C}_{\tau}^{\tau+9}(i) > 0)$$
$$E_{\tau}^{i} = 0 \; otherwise.$$

As discussed in endnote 20, the definitions of the recessionary and expansionary patterns in equation 5 are not collectively exhaustive. Because of the dichotomous nature of recessions and expansions, however, we will exclude the indeterminate growth sequences from our subsequent calculations. Accordingly, we compute an estimate of the recession index in month τ as the ratio of the count in equation A7 to the total count from equations A7 and A8:

(A9) $$R_{\tau} = Pr\,[(\Delta C_{\tau}^{\tau+7} < 0 \; and \; \Delta C_{\tau}^{\tau+8} < 0 \; and \; \Delta C_{\tau}^{\tau+9} < 0) | I_{\tau}] = \frac{\left(\sum_{i=1}^{N} R_{\tau}^{i}\right)}{\left(\sum_{i=1}^{N} R_{\tau}^{i} + \sum_{i=1}^{N} E_{\tau}^{i}\right)}.$$

The expansion index in month τ is then given by:

(A10) $$E_{\tau} = 1 - R_{\tau}.$$

The recession or expansion index can then be obtained for each time period in the historical sample by selecting the relevant point forecasts of the seven-, eight-, and nine-month growth forecasts of the CEI and repeating the procedure outlined above for $\tau = 1, 2, \ldots, T$.

The specification of the three-equation system for New York State is given by:

(A11) $$\Delta C_t^{t+7} = \alpha_0 + \sum_{i=0}^{3} \beta_i \Delta C_{t-i-7}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread_t) + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,7}$$
$$\Delta C_t^{t+8} = \alpha_0 + \sum_{i=0}^{2} \beta_i \Delta C_{t-i-8}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread_t) + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,8}$$
$$\Delta C_t^{t+9} = \alpha_0 + \sum_{i=0}^{1} \beta_i \Delta C_{t-i-9}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread_t) + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,9}.$$

The specification of the three-equation system for New Jersey is given by:

(A12) $$\Delta C_t^{t+7} = \alpha_0 + \sum_{i=0}^{3} \beta_i \Delta C_{t-i-7}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread)_t + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,7}$$
$$\Delta C_t^{t+8} = \alpha_0 + \sum_{i=0}^{3} \beta_i \Delta C_{t-i-8}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread)_t + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,8}$$
$$\Delta C_t^{t+9} = \alpha_0 + \sum_{i=0}^{2} \beta_i \Delta C_{t-i-9}^{t-i} + \delta_0 \Delta Permits_t + \delta_3 \Delta Permits_{t-3} + \delta_6 \Delta Permits_{t-6} + \psi_0(Spread)_t + \gamma_0 \Delta LEI_t^{National} + \varepsilon_{t,9}.$$

Data Appendix

Leading Variables

Interest Rate Spread (Percent per Annum)

Interest rates:
- One-year constant maturity securities
- Ten-year constant maturity securities

Source: Board of Governors of the Federal Reserve System.

Composite Index of Leading Economic Indicators

Average weekly hours, manufacturing
Average weekly initial claims for unemployment insurance
Manufacturers' new orders, consumer goods, and materials
Vendor performance, slower diffusion index
Manufacturers' new orders, nondefense capital goods
Building permits, new private housing units
Stock prices, S&P 500
Money supply, M2
Interest rate spread, ten-year Treasury bonds less federal funds
Index of consumer expectations
Source: Conference Board.

New York State and New Jersey

Housing Permits (Monthly, in Thousands, Not Seasonally Adjusted)

Private housing units, permit-authorized
Construction Report C40
(Seasonally adjusted by the Federal Reserve Bank of New York.)
Source: U.S. Department of Commerce, Bureau of the Census.

Coincident Variables

New York State and New Jersey

Nonfarm Payroll Employment (Monthly, in Thousands, Seasonally Adjusted)

Unemployment Rate (Monthly, Percent, Seasonally Adjusted)

Average Weekly Hours in Manufacturing (Monthly, Seasonally Adjusted)

Hours series were smoothed to remove outliers due to such factors as strikes and weather. Observations exceeding three standard deviations from trend line were adjusted.
Sources: New York State Department of Labor; New Jersey Department of Labor.

Real Earnings (Millions of Dollars, Seasonally Adjusted Annual Rate)

Wages and salaries, total
(Deflated by national consumer price index.)
Source: U.S. Department of Commerce.

Endnotes

1. For example, payroll data are a measure of a single market, and gross state product figures are available only annually and are subject to a two-year lag in their release.

2. The indexes for Pennsylvania and New Jersey are reported monthly by the Federal Reserve Bank of Philadelphia. The Texas leading index is reported bimonthly by the Federal Reserve Bank of Dallas. An index of leading economic indicators for the Massachusetts economy has recently been developed (Clayton-Matthews and Stock 1998-99).

3. The National Bureau of Economic Research (NBER) determines peaks and troughs in national economic activity. The dating of these turning points is based on the consideration of myriad variables. A major input into the dating procedure is the national index of coincident economic indicators originally constructed by the U.S. Department of Commerce (1987). The indexes are now maintained and reported by the Conference Board.

4. Crone (1998) has recently constructed an index of coincident economic indicators for each of the forty-eight contiguous states.

5. The development of state coincident indexes is constrained by the relatively short time period for which the state data are available. This constraint is particularly important because it limits the number of turning points in state economic activity that can be used to estimate and evaluate an index of leading economic indicators.

6. We discuss our specification for the New Jersey LEI in the "Empirical Results" section.

7. The Texas trade-weighted dollar is an exchange rate that measures the relative price of Texas-made products in the world market. It uses the relative shares of merchandise exports to forty-one countries to compute a (weighted-average) real value of the dollar facing Texas producers.

8. The rule currently used to determine if the national index of leading economic indicators is signaling a recession is a decline of 2 percent or more (at an annual rate) over six months coupled with a decline in the majority of the component series (Conference Board 1997).

9. The Pennsylvania LEI predicted all four of the state's recessions since 1973 with leads of five months or more and predicted two of the four recoveries; the New Jersey LEI predicted all four of the state's recessions since 1973 with leads of one to seven months, but predicted only one of the four recoveries.

10. The Texas leading index led both peaks and troughs in the coincident index by an average of two months.

11. The NBER's dating of recessions is also subject to occasional revisions.

12. As an alternative to focusing on the national composite index of leading indicators, some forecasters have used (two) consecutive quarters of negative GDP growth as the basis for predicting recessions.

13. The Stock-Watson model actually allows for the calculation of a coincident index for period t based only on currently available information $(C_{t|t})$ as well as information from the full sample $(C_{t|T})$. While the two series typically are in close agreement, we nevertheless draw a distinction between them. Specifically, we use the full-sample CEI $(C_{t|t})$ series in Chart 1 to date state business cycles. For the construction of the LEI, however, we associate the coincident index with the behavior of the $C_{t|t}$ series. This is the appropriate choice for forecasting purposes. Our technical appendix and data appendix contain, respectively, a brief description of the methodology and a list of the variables used to construct the CEI for each state.

14. We also experimented with a leading index based on a six-month forecast, but the nine-month horizon produced a slightly better lead time for some recessions and expansions. Although a longer horizon can improve the lead time, it will produce less accurate forecasts. As we will discuss shortly, the formulations of the recession index and expansion index will consider growth in the CEI over seven- and eight-month horizons as well as over a nine-month horizon. This feature of the modeling strategy therefore allows us to incorporate alternative horizons into the analysis. Because the recession and expansion indexes may be preferable for gauging the likelihood of future recessions and expansions, these considerations lessen the significance attached to our particular choice of a nine-month forecasting horizon for the LEI.

15. The VAR model essentially consists of a set of one-step-ahead forecasting equations for each variable in the system. The law of iterated projections and the estimated VAR model can be used to generate multi-step-ahead forecasts for each variable. The LEI can then be constructed from knowledge of the multi-step-ahead forecasts. See Stock and Watson (1989) and Crone and Babyak (1996) for additional discussions.

16. Ordinary least squares remains a consistent estimator of the parameters of equation 1. However, we use an estimator proposed by

Note 16 continued
Newey and West (1987) to calculate the standard errors of the model. Because the forecasting horizon of the CEI is nine months and the sampling interval of the data is one month, the Newey-West estimator allows the disturbance term to follow an eight-order moving-average (MA) process.

17. The Stock and Watson (1989, 1993) recessionary and expansionary patterns allow the monthly CEI growth sequences to be quite complex. Consequently, calculating the recession and expansion probabilities requires integrating a seventeen-dimensional normal density function.

18. Compared with the framework of Stock and Watson (1989, 1993), our strategy for forecasting recessions and expansions lacks its technical sophistication. Nevertheless, we find that our approach performs rather well. Specifically, the estimated probabilities are quite accurate in predicting both recessions *and* expansions, generally display good lead time, and generate few false signals.

19. We do not incorporate equation 3 into the analysis because the differential dating of information sets in conjunction with single-equation forecasting models does not lend itself to the type of probability calculations used to construct the recession and expansion indexes.

20. The definitions of the recessionary and expansionary patterns in equation 5 are *not* collectively exhaustive because of the existence of sequences that will not be contained in either event's set. However, their sum typically is very close to unity. As discussed in the technical appendix, we exclude the indeterminate growth sequences from the calculation of the recession and expansion indexes to ensure that their sum is equal to unity.

21. This can be seen through an examination of the system in equation 7.

22. While we restrict the discussion to a single forecast horizon, Chart 2 also provides the intuition for the methodology used to calculate the recession (and expansion) index using the system specified in equation 7.

23. This probability is also indicated by the shaded area in Chart 2 and corresponds to the likelihood of observing lower future levels of the CEI. It is worth noting that the calculation of the recession and expansion indexes described in the technical appendix assumes that the variance of the disturbance terms for the system in equation 7 is constant. Recently, McConnell and Perez Quiros (2000) have documented that a permanent decline in the volatility of U.S. GDP growth occurred in 1984. If the growth rate in the CEI for New York State and New Jersey were to experience a similar decline in volatility over our sample period, then the recession and expansion indexes would need to account for this feature of the data. Specifically, the calculation of the indexes would require different estimated variance-covariance matrices for the disturbance terms for the system in equation 7, with the matrices estimated over separate subperiods.

24. We considered other regional economic indicators such as regional consumer confidence; regional new car and light truck registrations; New York Stock Exchange member firms' profits; and employment in the chemical, manufacturing, and finance industries. However, these variables were either statistically insignificant or displayed the theoretically incorrect sign.

25. The financial market indicators consist of the value of the S&P 500 and an interest rate spread measuring the difference between the yield on ten-year Treasury bonds and the federal funds rate.

26. This delay reflects publication lags in the individual coincident indicators.

27. We used various criteria, including the Bayesian information criterion and the predictive least squares sum of squared residuals.

28. For example, the value of the LEI series for January 1980 in Charts 3 and 4 corresponds to the forecasted growth in the CEI from January to September 1980, conditional on information available through February 1980.

29. The smoothing filter is given by $s(L) = (1/6)\,(1 + 2L + 2L^2 + L^3)$, where L denotes the lag operator defined by $L^n X_t = X_{t-n}$. As described in Tables 1 and 2, the interest rate spread is also smoothed by using an average of its value during the current and previous two months.

30. One possible explanation for this result relates to the markedly different timing of the state and national recessions during this episode. Specifically, the state recessions preceded the national recessions by almost fifteen months. Thus, the state-level leading indicators by themselves may not have been fully capable of generating a downturn in the LEI prior to the onset of the recession. However, it is also important to recall that forecasting the 1990-91 recession at the national

level also proved to be problematic. For example, the leading index and the recession index developed by Stock and Watson experienced a complete breakdown and missed the 1990-91 recession in its entirety.

31. The contribution of each indicator is determined by setting all of the other components equal to zero and then calculating the relevant quantity from equation 8.

32. It is unclear how one should classify a lead time of zero months. Therefore, we do not include this event in a count of accurate leading signals.

33. The value of the recession index in January 1980 again corresponds to the probability of a recession from January to September 1980, conditional on information available through February 1980.

34. As we discuss, we employ preliminary data on state payroll employment to evaluate the out-of-sample performance of the LEI models. Because the publicly available data on this series begin in 1981, the evaluation can include only the recessionary episode of 1989-92.

35. There is the additional issue of whether the objective should be to forecast the preliminary or final value of the coincident index. The analysis will continue to specify the dependent variable of the LEI models as the nine-month growth rate in the final coincident index. Our choice is initially motivated by the belief that the preliminary payroll employment figure will act as an unbiased estimate of the final figure. More importantly, we present evidence that the LEI models work quite well in terms of their out-of-sample forecasting performance under this more stringent assumption.

36. Another difference between the two approaches is that the estimated parameter vector in equation 2 is assumed constant over the full sample period, while the estimated parameter vector in equation 9 is updated every period.

37. Annual revisions to the state payroll employment series for the previous calendar year normally are released in late February. Subsequent revisions to the payroll employment data are generally not of great importance. We thank Jason Bram for his assistance in obtaining the historical preliminary payroll employment data and constructing the real-time payroll employment series.

38. Our procedure actually results in a one-year overlap of the real-time LEI series and therefore can be used to investigate the sensitivity of the real-time forecasts to data revisions. An examination of these overlapping segments indicates that the behavior of the series was qualitatively similar. For purposes of presentation, however, the overlapping segments of the real-time LEI series are excluded from Charts 9 and 10.

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