Indexes of Economic Indicators: What Can They Tell Us about the New England Economy?

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Each month, the Boston Federal Reserve publication *New England Economic Indicators* reaches about 6,000 subscribers. Many of these readers undoubtedly want to know: "How is the New England economy doing?" In response, *Indicators* offers a comprehensive compilation of timely data. Yet no one of these indicators can possibly provide an overall assessment of the New England economy. Nor can any other individual piece of information offered by other regional or state agencies.

This article explores the development of composite coincident indexes summarizing the condition of the economy of New England and its six states. While composite indexes have long been used to analyze the national economy, they may be needed even more for regions because of the lack of current comprehensive measures of state activity, as well as the frequent lack of clarity in indicators that are available. The article discusses two approaches to constructing composite indexes, the traditional averaging method used by the U.S. Department of Commerce and a latent variable method advanced by two academic researchers, James Stock and Mark Watson, and recently applied to states in a study conducted at the Federal Reserve Bank of Philadelphia. A general model for deriving a coincident economic index is described, along with its relationship to the Stock-Watson and Philadelphia Fed research. The Philadelphia Fed specification is then applied to the New England states in order to measure how regional business cycles have compared with national cycles. In addition, an alternative composite coincident index is constructed for Massachusetts, using as inputs newly developed data based on state tax collections, which have the advantage of being quite timely and not subject to revisions (in contrast to more commonly used indicators).

I. Motivations

Composite indexes of U.S. economic indicators have a long history. Originally developed a half century ago by researchers at the National Bureau of Economic Research, a private organization, such indexes are now issued monthly by the U.S. Department of Commerce. The government's index of leading indicators gets widespread attention when it is released. Less noticed, but released just as frequently, are the index of coincident indicators, which measures the current state of the national economy, and the index of lagging indicators.

Composite indexes are attractive because of their simplicity and compactness. Interest in economic trends is widespread, but most people have neither the time nor the inclination to try to interpret each individual piece of economic data that becomes available. Furthermore, even for professional observers of the macroeconomy, individual indicators may be problematic. Any particular economic series may give an ambiguous signal, or it may contradict another piece of data.

National composite indexes (and individual indicators) may be misleading for regions because regional business cycles do not parallel national cycles exactly. For example, the strongest recoveries from the early 1980s recessions occurred on the East and West Coasts, and several interior states lost employment or showed virtually no gain in employment for several years after the national economy had picked up (Bradbury and Kodrzycki 1992). By contrast, in the upturn from the most recent national recession of 1990–91, it is widely acknowledged that the New England states and California were laggards. New England also headed into that recession well before the nation.

Composite indexes of coincident indicators may be particularly valuable for regional analysis because other available data are limited. For one thing, frequent and timely information on overall economic activity is lacking for states. As noted by others (see especially McNees and Tootell 1991 and Crone 1994), gross state product (GSP) is issued only annually, with a long lag. Data for 1991, for example, were made available in August 1994. State personal income scores higher (but not high) in terms of availability. It is issued quarterly, about four months after the end of the quarter. In addition, personal income may be problematic as an indicator of state economic activity because it includes income that a state's residents earn from assets located elsewhere and from transfer payments (such as Social Security and unemployment benefits).[1] Employment is undoubtedly the best commonly available current measure of state economic activity. Data are issued monthly, with a lag of only one or two months. Economic activity is measured only imperfectly by employment, however. For one thing, output changes with no change in labor demand as productivity varies over time and over the business cycle. Furthermore, the demand for labor can vary without a resulting change in the number of people who are employed. For example, given labor costs that depend more on the number of workers than the length of the workweek (such as training costs, unemployment insurance taxes, or requirements for employer provision of employee health insurance coverage, as exist in some states), employers may find implementation of longer work hours for existing staff to be a less expensive means of increasing production than additional hiring.

Employment is undoubtedly the best commonly available current measure of state economic activity, but it measures only imperfectly.

A second reason for the potential attractiveness of composite indexes at the regional level is that individual economic indicators tend to be quite noisy. Month-to-month volatility is a by-product of the inherently small state samples for indicators that are obtained as part of a national survey, as well as the limited resources of state governments for supplemental data-gathering efforts. For example, initial payroll employment statistics are obtained from a survey of selected business establishments and then revised annually to reflect information obtained through the unemployment insurance program (which covers almost all employers). The March 1994

[1] The quarterly personal income data separately identify wages and salaries earned in-state. But in-state business and investment income cannot be extracted from the remaining amount of personal income, as further breakdowns are available only annually at best. To the extent that economic activity is taken to mean consumption rather than income from current production, however, it may be argued that (unadjusted) personal income is an appropriate indicator.

benchmark revisions moved the reported recent cyclical trough for New England employment by close to two years, from August 1993 to December 1991. As another example, the measured monthly unemployment rate for the New England states has jumped by at least half a percentage point between three times (in Connecticut and Rhode Island) and eight times (in Massachusetts) during the past three years.[2] During the same period, the national unemployment rate never showed a change of this magnitude in a single month.

Despite the potential usefulness of developing composite indexes to supplement other data, state governments do not routinely issue such information. Furthermore, only scattered efforts along these lines have appeared on the part of other researchers.

II. Methodology

Traditional indexes of economic indicators are weighted averages of the economic indicators used to construct the index, with the weights chosen by judgment. Notwithstanding many complications and refinements, the Commerce Department composite coincident index exemplifies this traditional approach (Green and Beckman 1992 and 1993). Similar indexes for California and Texas have also been developed (California Department of Finance 1976 and Philips 1990), and nine composite regional performance measures are issued regularly by the Conference Board.[3]

National indexes of economic indicators have long been scrutinized both for their accuracy and for their conceptual validity. While different authors have reached varied conclusions regarding the empirical qualities of composite indexes, a consensus has developed that the traditional method is based neither on appropriate statistical methodology nor on an explicit economic theory (see Koopmans 1947, Auerbach 1982, de Leeuw 1991).

The more recent conceptual foundation of a composite economic index is the Sargent-Sims (1977) single index model of the economy. The key idea is that the current state of the economy is unobservable but may be detected by finding the co-movement in a selected set of observable economic indicators. The remaining movement in each economic indicator represents its idiosyncratic component—that is, the part unrelated to the state of the economy.[4]

Stock and Watson developed a methodology to estimate models based on the Sargent-Sims concept and used this methodology to derive new national composite economic indexes. Specifically, Stock and Watson (1989, 1992) set out to provide a more solid statistical foundation for the composite coincident index released by the Department of Commerce, using the technique developed in their 1988 article. Even though Stock and Watson's estimated weights for individual indicators differ somewhat from those used to form the Department of Commerce series, the correlation between the two indexes is 0.936 and they appear to move quite closely over individual business cycles. Stock and Watson (1993) went on to develop an alternative leading index.[5]

Traditional indexes of economic indicators are weighted averages of the indicators used to construct the index, with the weights chosen by judgment.

Crone (1994) applied the Stock-Watson methodology to the states in the Philadelphia Federal Reserve District. He attempted to find the closest pos-

[2] The Massachusetts sample for computing the unemployment rate is about 2,300 households. In the other New England states, samples of only about 500 to 600 are used, but the survey results are supplemented by econometric estimates in order to smooth the results.

[3] Dua and Miller (1994) recently used a similar methodology to develop coincident and leading indexes of employment for Connecticut. For an alternative, econometric study of regional employment, see McNees and Tootell (1991).

[4] Any given economic indicator may move independently of the state of the economy for a variety of reasons. Typical explanations for short-term movements include measurement error, fluctuations in the weather, the timing of holidays, the occurrence of labor strikes, or political developments. Indicators may follow different patterns over longer periods of time, for example, if some are sensitive to demographic trends, while others reflect the procedures for conducting monetary policy.

[5] It may be argued that although the Stock-Watson leading index is based on a more rigorous view of the relationship between a composite index and the state of the economy than is true of the Commerce Department measure, Stock and Watson's choices of underlying leading indicators are not any more rooted in economic theory (in the sense of de Leeuw 1991). Empirically, the inability of their revised leading indicator model to predict the 1990–91 recession was attributable in great part to the choice of indicators, especially the inclusion of financial variables. The Stock-Watson composite coincident index is less controversial, as it uses data series similar to those in the Commerce Department index. Indeed, its performance in the most recent business cycle appears to have spurred revision of the Commerce Department index of coincident indicators (Green and Beckman 1993).

sible state analogues to the four indicators used in the Commerce Department's national index: the number of jobs in nonagricultural establishments, inflation-adjusted manufacturing and trade sales, inflation-adjusted personal income less transfer payments, and an index of industrial production. State establishment employment and real retail sales come reasonably close to the first two national data concepts. Lacking state counterparts for the remaining components of the national index, Crone substituted average weekly hours in manufacturing and the unemployment rate in the state models. When Crone had combined these four variables in a national model, they came fairly close to reproducing the Commerce Department index. The state indexes produced by this approach indicated that recessions have generally occurred in the mid-Atlantic states at times of national recession, but that their duration often was different.[6]

The more recent concept of an economic index holds that the current state of the economy may be detected by finding the co-movement in a selected set of observable economic indicators.

Conceptually, the Stock-Watson and Crone indexes differ somewhat from the Sargent-Sims single index representing the state of the economy. Stock and Watson observed that the variables entering the Commerce Department coincident economic index are not cointegrated. In non-technical terms, this means that the series do not share a common long-run trend and therefore they can move arbitrarily far apart.[7] By differencing the variables in the model, Stock and Watson were able to derive an index that captures the common high-frequency (that is, purely cyclical) movement in the data.

Since the work of Nelson and Plosser (1982), it is commonly acknowledged that most economic time series appear to be subject to (semi-) permanent as well as temporary shocks. For example, business "cycles" can be influenced by lingering effects from shifts in productivity that occurred much earlier (and that show up also in a trend that varies over time), as well as by purely cyclical disturbances.[8] As noted by Stock and Watson (1988), economic indicators will share a common stochastic trend—and therefore can be used to form a single economic index that captures this newer, hybrid view of business cycles—only if they are cointegrated.

Empirically, it is possible that composite indexes may yield similar estimates of turning points in the economy, regardless of the underlying concept of the relationship between trends and cycles. But generating a model using data that are cointegrated with each other and with an overall measure of economic activity (such as gross domestic product or gross state product) has one clear advantage: In this case, the movement of the economic index over longer time horizons can be interpreted as the rate of growth in the economy, and it can reliably be used to compare the state of the economy for two dates that are relatively far apart—such as successive business cycle peaks or troughs.[9] Therefore, all else equal, it is preferable to use cointegrated data in forming a composite index.[10]

III. Modeling the State of the Economy

This section addresses modeling and estimation issues in the development of economic indexes. Readers interested only in empirical results may wish to skip to Section IV.

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[6] Pennsylvania suffered longer recessions than the nation, for example, and New Jersey had relatively severe downturns around the time of the national recessions of 1973–75 and 1990–91, but relatively modest downturns in the early 1980s.

[7] For further discussion of cointegration, see Engle and Granger (1987), Dickey, Jansen, and Thorton (1991) and Hamilton (1994, Chapter 19). For an example applying this concept to an analysis of consumption behavior, see Fuhrer (1992). Cointegrated series individually are nonstationary (that is, they contain a trend), but a linear combination of them is stationary (trendless).

[8] Mathematically, the economy is represented by a difference stationary process—that is, a combination of a stationary stochastic process and a nonstationary stochastic process (see Beveridge and Nelson 1981). Only if the errors in the stationary stochastic process are independent of the errors in the stochastic trend can it be maintained that the economy can be described in terms of a distinct long-run secular trend and a short-run cycle. The empirical findings of Nelson and Plosser (1982) are at odds with this latter representation.

[9] The Commerce Department deals with this issue by mechanically constraining the resulting composite index to match the long-term growth rate of real GDP; a corrected version of this procedure is reported in Green and Beckman (1993). While this adjustment results in an appropriate overall trend, it may not capture accurately the trend within subintervals.

[10] Other considerations include the timeliness and volatility of the data.

The following is a general model of the state of the economy and its influence on individual economic indicators (see Stock and Watson 1992, p. 66):

$$(1) \qquad X_t = BC_t + \gamma_0 + \gamma_1 t + \mu_t$$

$$(2) \qquad \phi(L)C_t = \delta + \eta_t$$

where **t** is a time trend, X_t is an n-vector of observable time series, C_t is a k-vector of unobservable common components, **B** is an n×k array of coefficients (also called factor loadings) on the common components, $(\gamma_0 + \gamma_1 t)$ is a non-stochastic trend, $\phi(L)$ is a lag polynomial matrix, δ is a k×1 vector of non-stochastic drifts of the common components, and μ_t and η_t are stochastic processes of dimensions n×1 and k×1, respectively.

For the purpose of constructing an economic index, only the special case in which the model reduces to the Sargent-Sims single index formulation is of interest—that is, where k=1 and only one common component is present. (The term "common component" is used as a synonym for terms such as "common factor," "common trend," and "common stochastic trend" that may describe co-movement among individual economic time series.) For this special case, the common component is interpreted as representing the state of the economy. Then equation (1) implies that each economic indicator is composed of three parts: the state of the economy, multiplied by the appropriate coefficient; a deterministic trend (possibly zero); and a stochastic process that gives each series its own idiosyncratic character.[11] Equation (2) describes the "law of motion" of the economy.[12] Because the state of the economy is described by an autoregressive process, random shocks can have persistent effects.

When the observable series are stationary stochastic processes, the general model can be directly applied in estimation. Many general economic indicators exhibit a trend, however. For nonstationary data, with the nonstationarity entering through the common component, the data are said to be cointegrated in the Engle and Granger (1987) sense.[13] For this case, the data are cointegrated of order (1,1) with (n−1) cointegrating vectors. In other words, the data are tied together in (n−1) dimensions by linear relationships that prevent the series from wandering far apart. They can drift in one direction only—that indicated by the common component. If the common component is also cointegrated with a measure of aggregate economic activity, then one can be confident it represents the state of the economy. Under these conditions, the model may be estimated as indicated by equations (1) and (2), with the addition of a specification for the error processes (and taking into account the revisions in dimensionality when k=1, as indicated in footnotes 10 and 11).

When the underlying series are nonstationary, but the state of the economy cannot be regarded as the only possible source of nonstationarity (that is, the data are not cointegrated), then the model is differenced for purposes of estimation. This is the specification used in both the Stock-Watson and the Philadelphia Federal Reserve studies. If we assume that the idiosyncratic errors (μ_t) result from long-term secular processes that are different for each series—because the data are not cointegrated—then these errors can be assumed to be independent of the shocks to the state of the economy. Thus, C_t would represent only the common cyclical movement in the data. Its turning points can provide evidence on the timing of business cycles, but its long-run movements will not be meaningful (since the underlying data are not cointegrated).

Alternative econometric techniques can be used to solve for the unobserved state of the economy. These methods essentially are derived from factor analysis, which is used heavily in the behavioral sciences (see the box).

Estimating the Philadelphia Federal Reserve Specification

As noted, four indicators underlie the index specified in the Philadelphia Federal Reserve study by Crone: payroll employment, real retail sales, average weekly hours of manufacturing production workers, and the unemployment rate. (See the Appendix for a further description of the data.) These series were found not to be cointegrated for the New England states; this is not surprising, given that employment and sales have a positive trend while average weekly hours and the unemployment rate are trendless. Thus, as is appropriate with non-cointegrated inputs, the series are differenced. (For employment, retail sales, and hours, the data are

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[11] In the case of k=1, the common component appears in equation (1) as a scalar (rather than a vector), and its coefficient B is an nx1 vector (rather than a matrix).

[12] With k=1, the common component, the drift, and the error term all become scalars, and $\phi(L)$ a vector.

[13] In other words, the common component is a unit root process; in equation (2) (as revised for k=1) the lag polynomial vector $\phi(L)$ has a unit root.

Solving Unobservable Variable Time-Series Models

Dynamic factor analysis and the Kalman filter involve different algorithmic methods to estimate models that are intimately related.[14] As Engle and Watson (1981) and Watson and Engle (1983) point out, a wide spectrum of factor analysis models are special cases of the so-called state-space model, which means that the Kalman filter can be used to estimate the unobserved factors. Indeed, the equation system (1)–(2) belongs to the family of dynamic factor models presented in Harvey (1989, p. 450), as well as those in Stock and Watson (1992), which are solved by means of the Kalman filter.

Factor analysis starts by identifying the common unobservable component (or "factor") that explains the largest share of the variance in the chosen set of observable indicators. The analysis proceeds by searching sequentially for additional common factors that are uncorrelated with the previously identified common factors and that explain the largest share of the remaining variance in the observed indicators. The procedure ends when it is determined that the last common factor contributes little to explaining movement in the indicators. The factor analysis technique was used originally in non-economic applications, in which multiple common components existed. In some other applications, including this article, only one common component exists. Also, although classical factor analysis has been concerned primarily with cross-section data, the same framework can be applied to time series data as well—hence the designation "dynamic factor analysis."

With nonstationary time series data, a direct correspondence exists between factors and the common trends of cointegration. When the data are cointegrated, the number of factors that are nonstationary and the number of common trends are identical. Additional factors may be present, but they would be stationary; furthermore, they likely would explain only a relatively small proportion of the variance in the data.

The Kalman filter finds the unobservable variable(s) (and the associated coefficient estimates) that minimize the difference between the actual and fitted values of the observed indicators. The method starts by assuming a value for the unobserved variable(s) in the initial period and it sequentially produces optimal estimates for subsequent periods, using information for previous periods. If a model such as depicted in equations (1)–(2) has error terms that are not serially correlated, then these equations correspond directly to the measurement and transition equations, respectively, that constitute the so-called state-space framework of the Kalman filter. If they are serially correlated, then the equations must be transformed appropriately. For examples of transformations, see Stock and Watson (1992), Harvey (1981, 1989), Hamilton (1994), Engle and Watson (1981), and Watson and Engle (1983).

The factor analysis and Kalman filter techniques both determine common components of arbitrary scale. Thus, after the common component has been determined, it may be convenient to rescale the results.

expressed in logarithms prior to differencing.) Each differenced series is normalized by subtracting its mean and dividing the result by its standard deviation, so that the mean of each series is zero and its standard deviation is unity.

The state of the economy is posited to be reflected contemporaneously in the first three series, but to affect the unemployment rate with lags of one to three months in addition to entering the equation currently. In the equation for the law of motion for the economy, the drift parameter is set equal to zero. The resulting equations are as follows:

$$(3) \qquad \Delta X_{it} = \beta_i \Delta C_t + \varepsilon_{it} \quad i = 1, 2, 3$$

$$\Delta X_{4t} = \beta_{40}\Delta C_t + \beta_{41}\Delta C_{t-1} + \beta_{42}\Delta C_{t-2} + \beta_{43}\Delta C_{t-3} + \varepsilon_{4t}$$

$$(4) \qquad \Delta C_t = v_t .$$

The stationary stochastic terms are modeled as second-order autoregressive processes, and an identification restriction is imposed on the variance of the error term in the equation for v_t:

[14] For a description of factor analysis, see Gorsuch (1974) and Joreskog (1967). The Kalman filter is described in Anderson and Moore (1979, Chapter 3), Harvey (1981, Chapter 4), and Hamilton (1994, Chapter 13).

$$\varepsilon_{it} = r_{i1}\varepsilon_{i,t-1} + r_{i2}\varepsilon_{i,t-2} + e_{it} \quad i = 1, 2, 3, 4$$

$$v_t = r_1 v_{t-1} + r_2 v_{t-2} + e_t$$

$$\text{var}(e_i) = \sigma_i^2$$

$$\text{var}(e) = 1.$$

The terms e_{it} and e_t are independent white-noise processes.

The estimates are obtained by transforming the model into state-space form, and obtaining maximum likelihood estimates of the parameters by using the Kalman filter to evaluate the likelihood function (see the box on "Solving Unobservable Variable Time-Series Models"). The indexes are estimated for the period April 1969 to August 1994. Parameter estimates are reported in Appendix Table 1. The final indexes are adjusted to reflect trends in gross state product, which was not done in the Philadelphia Federal Reserve study, but is in keeping with the U.S. Commerce Department methodology.[15] The results are described in Section IV.

Estimating a Revised Specification for Massachusetts

The alternative model for Massachusetts builds upon the Philadelphia Federal Reserve specification in two important ways. First, it adds two series related to tax revenues: the withholding tax base for the state personal income tax and the base of the state sales tax. (Some advantages of using the income and sales tax data are described at the beginning of Section IV, and additional details regarding the construction of the data are provided in the Appendix.) Second, the alternative model exploits the cointegration properties of three series: the two tax bases and retail sales. Using Johansen's procedure to test for cointegration (see the Appendix for results and discussion), these three series were found to be cointegrated with one common component.[16] The advantage that cointegration gives to the specification is that these series need not be differenced. Their common component informs the estimation procedure of the level of the underlying index, so that comparisons of the level of the index are meaningful over long periods of time.[17]

The data for employment, weekly hours, and the unemployment rate were prepared as in the Philadelphia specification above—that is, log-differenced (differenced in the case of the unemployment rate) and normalized, so that the mean of each series is zero and its standard deviation is unity. The data for the tax bases and retail sales were each deflated and expressed in logarithms, and then normalized by subtracting the mean and dividing the result by the standard deviation, so that the mean of each series is zero and its standard deviation is unity.

The model takes the following form:

$$(5) \quad X_{it} = \beta_i C_t + \mu_{it} \quad i = 1, 2, 3$$

$$\Delta X_{it} = \beta_i \Delta C_t - \gamma_i \delta + \mu_{it} \quad i = 4, 5$$

$$\Delta X_{6t} = \beta_{60}\Delta C_t + \beta_{61}\Delta C_{t-1} + \beta_{62}\Delta C_{t-2} + \beta_{63}\Delta C_{t-3} - \gamma_6 \delta + \mu_{6t}$$

$$(6) \quad C_t = C_{t-1} + \Delta C_t$$

$$\Delta C_t = r_1 \Delta C_{t-1} + r_2 \Delta C_{t-2} + \delta + e_t$$

where

$$\mu_{it} = r_{i1}\mu_{i,t-1} + r_{i2}\mu_{i,t-2} + e_{it} \quad i = 1, \ldots, 6$$

$$\gamma_i = \beta_i/(1 - r_1 - r_2) \quad i = 4, 5$$

$$\gamma_6 = (\beta_{60} + \beta_{61} + \beta_{62} + \beta_{63})/(1 - r_1 - r_2)$$

and the terms e_{it} and e_t are independent white-noise processes. Subscripts $i = 1$ to 3 refer to the cointegrated series (the two tax bases and retail sales), $i = 4$ and 5 refer to employment and hours, and $i = 6$ refers to the unemployment rate.

The state of the economy, C_t, reflects both the stochastic and non-stochastic (δ) trends of the economy embodied in the three cointegrated series, as well as the common cyclical components measured by all six series. In the equations describing the withholding tax base, the sales tax base, and retail sales, both the observed data and the unobserved state of the economy enter in levels. The specifications for employment, weekly hours, and the unemployment rate are as in the Philadelphia model, with the exception of the addition of the $\gamma_i\delta$ terms, which ensure that the expectations of their respective equations are zero, as required by the normalizations of the three series. The state of the economy is modeled as an integrated, autoregressive moving average pro-

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[15] As noted in footnote 9, the Commerce Department coincident index incorporates the trend in gross domestic product. Owing to a lack of recent data on gross state product, the New England trends are based on calculations through 1991.

[16] Even though it has an upward trend over time, payroll employment was found not to be cointegrated with the tax and retail sales series (or with measures of state production and income).

[17] A number of other variables also were tested (but rejected) for potential use in a coincident index, on the basis of their current availability or their relationship to broad measures of economic activity.

cess with drift; the remaining stochastic terms are modeled as second-order autoregressive processes.

In order to identify the model the factor loading on the withholding tax base, β_1, is constrained to unity. The model is put into state-space form, and maximum likelihood estimates of the parameters are obtained using the Kalman filter. The model is estimated for the period April 1969 to August 1994, and the parameter estimates are found in Appendix Table 1.[18] The trend in gross state product is used to adjust the index.

IV. Estimated Results: Coincident Indexes for the New England States

The New England indexes are based on the same underlying indicators as in the Philadelphia Federal Reserve study, with one exception. Retail sales data are available only for Massachusetts and the New England total. For the remaining states, the indexes are therefore based only on employment, hours, and the unemployment rate.[19] The Massachusetts and New England indexes are estimated with and without retail sales. The third version of the Massachusetts index includes three variables that are cointegrated with each other and with state income and output: constant-dollar values for the withholding tax base for the state personal income tax, the base of the state sales tax, and retail sales (as well as employment, hours, and the unemployment rate).[20]

The two tax indicators for Massachusetts were developed specifically for this study, and they have several appealing characteristics. Tax collection data are released monthly in a timely manner, within days of the end of the month.[21] The lag between the economic activity reflected in taxes and the time the taxes are collected is short. For example, large companies that remit withholding taxes weekly within days of the end of the pay period account for about 85 percent of total revenues from withholding. Medium-sized employers pay taxes in the following month. Large retail stores, telecommunications companies, and utilities—accounting for approximately 70 percent of total tax receipts—pay sales taxes in the same month in which the transactions occur. The bulk of the remaining sales tax revenues comes from taxpayers that pay monthly, for transactions in the previous month.[22] The bases of the Massachusetts personal income and sales taxes are broad enough to encompass a large proportion of income and spending. This means that the tax data are likely to be cointegrated with other income-based economic measures. The data are not based on a sample; they are derived from the full population of taxpayers. Finally, and in part reflecting the lack of sampling, revisions to tax collection data are insignificant.

Tax bases are constructed from revenue data by adjusting for law changes in the base and rates. The bases are then seasonally adjusted and, because they are noisy, smoothed with a filter (see the Appendix).

The tax indicators for Massachusetts have several appealing characteristics: They are timely, they are broad-based, they are derived from a full population of taxpayers, and revisions are insignificant.

The lack of comparable tax data for other states (as well as the lack of retail sales information) prevented the estimation of a similar alternative model for the remaining New England states. For one thing, some of these states do not have broad-based taxes that would reflect general economic conditions.[23] Furthermore, for those states with broad-based taxes,

[18] The sales tax base was omitted in estimating the index for the period March 1976 to October 1977, because the series was suspect during this time. See the Appendix for further discussion.

[19] Crone faced the same constraint in developing a composite index for Delaware.

[20] Another version of the Massachusetts index was calculated using only the three cointegrated series. The results were similar to those of the six-series index at low frequencies. However, excluding employment, hours, and the unemployment rate resulted in disagreement with other composite indexes in the timing of turning points. It also resulted in more frequent instances of false recessionary and expansionary signals.

[21] The fact that tax receipts must be deflated by a price index for use in the model makes these series somewhat less timely than this statement implies. However, the need for deflation is common to most data that are likely candidates for use in an economic index. Also, because tax receipts are far more variable than price indexes, a reasonable current estimate of real tax receipts may be obtained by forming a forecast of prices.

[22] Smaller employers and retail establishments pay quarterly and account for approximately 1 percent of withholding taxes on wages and 10 percent of sales taxes.

[23] The most extreme case is New Hampshire, which has neither a general income tax nor a general sales tax; Connecticut enacted a general income tax only recently.

estimates of the revenue effects of law changes either are not publicly available or are available only over a relatively short time period.[24] Finally, sometimes the structure of a tax is too complicated or too subject to change to permit outside researchers to obtain reliable estimates of the revenue effects of law changes, even when the state government has published helpful data.[25] Thus, although tax revenue data are potentially quite valuable for studying the state of the economy, their use poses greater challenges for the analyst than other indicators that may be used without adjustment.

For both the tax-based and the non-tax-based indexes, the long-run trends are constrained to be the same as the trend in gross state product. This procedure raises the computed trend growth rates of the indexes. The upward adjustment is not surprising in the case of the Philadelphia Federal Reserve specification, as two of the underlying indicators (hours and unemployment) do not have a positive trend and employment has a trend that is noticeably below that of gross state product. The upward adjustment is somewhat surprising for the tax-based index, since it uses series that are cointegrated with gross state product. Although an argument could be made for not constraining the trend in the case of the alternative Massachusetts index, the outcome has some intuitive appeal and it may be compared more directly to the results of the other specifications.

Results

Figure 1 shows the resulting coincident indexes for New England and each state. Table 1 indicates the computed regional peaks and troughs in comparison with those of the national economy as determined by the National Bureau of Economic Research, as well as the peak-to-trough changes in the regional indexes.[26,27] For New England and Massachusetts, separate results are shown for the four-variable ("A") and three-variable (without retail sales; "B") models, although their turning points usually are identical. The alternative Massachusetts index, using tax data, is shown as variant "C."[28]

The most recent recession in New England was much more prolonged than the national recession. The New England indexes reached their maximum in December 1988, nineteen months ahead of the national peak, and their minimum in July 1991, four months behind the national trough. Indexes for the individual states indicate recessions lasting from fourteen months longer than the national recession in Maine to twenty-nine months longer in Connecticut and Massachusetts (in the C specification).

This most recent regional downturn was also severe in terms of the peak-to-trough decline in the value of the index. The declines in state indexes ranged from 6.1 percent in Maine to 19.4 percent in Rhode Island. By contrast, the national index declined only 2.4 percent according to the Commerce Department specification and 3.1 percent according to the Philadelphia Fed specification (see Appendix Table 4).

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[24] The Center for the Study of the States has issued quarterly estimates of state tax revenues, adjusted for law changes. However, for now these data are not usable in a model because they exist for only four years. Also, they were designed principally to detect differences across states rather than as time series for individual states.

[25] For example, the state of Connecticut issues a tax expenditure budget containing estimated annual revenue effects of law changes. In the case of the state sales tax, very large law changes took place in the early 1990s, a period of substantial changes in economic conditions. To our knowledge, the available tax expenditure estimates have not been verified in light of actual experience. Thus, any attempt to allocate a portion of the revenue change at that time to tax law changes, and the remainder to changes in the economy, is necessarily subject to considerable uncertainty. In the case of Massachusetts, the structure of the state sales tax has remained relatively stable; also, it is simpler than Connecticut's in that all covered items are subject to a single rate.

[26] Estimation of a national index using the Philadelphia Fed specification (and constrained to have the same trend from 1969 to 1994 as gross domestic product) generally gives business cycle turning points similar to those indicated by the National Bureau of Economic Research and the Commerce Department Composite Index of Coincident Indicators. See Appendix Table 4. The exceptions are that the 1973–75 national recession does not start until early 1974, and the most recent national recession, officially deemed to have ended in March 1991, lasts until early 1992 using the Philadelphia Fed specification.

[27] The peaks and troughs for New England and each state are given by the local maxima and minima, respectively, in the index. In some cases, they may be imprecise because the economy was relatively flat for an extended period around the time of the turning point. For this reason, the charts in Figure 1 can be helpful in assessing particular cycles.

[28] Both the Philadelphia Federal Reserve and the tax-based models appear to produce reasonable estimates. For one thing, estimated multipliers (that is, the computed change in the composite economic index for a given change in an observed indicator) are all of the correct sign. They also confirm that no single series dominates any of the composite indexes. Another specification check involved comparing the in-sample forecast errors for the observable indicators with errors from univariate models. Second-order autoregressive models produced larger errors than the Philadelphia Federal Reserve and tax-based specifications in 83 percent of the cases, which implies that the estimated state of the economy usually adds information not contained in each series' own history. However, in 51 percent of the cases, the best univariate model—among those with a first or second order autoregressive term and a first or second order moving average term—outperformed the multivariate model. This result suggests that a richer parameterization of the errors in the Stock-Watson-type models often could improve their in-sample performance. Results of the specification tests are available from the authors upon request.

Table 1
Comparison of New England and National Business Cycles

	Regional/State Cycles and Difference from National (Number of Months)			
	New England-A	New England-B	Connecticut	Maine
National Peaks				
December 1969	Feb 70(−2)	Jul 69(+5)	Mar 70(−3)	Apr 70(−4)
November 1973	Jul 74(−8)	Jul 74(−8)	Oct 74(−11)	Aug 74(−9)
January 1980	Feb 80(−1)	Feb 80(−1)	Apr 80(−3)	Mar 80(−2)
July 1981	Apr 81(+3)	Apr 81(+3)	Nov 81(−4)	Jul 81(0)
July 1990	Dec 88(+19)	Dec 88(+19)	Mar 89(+16)	Mar 90(+4)
National Troughs				
November 1970	Jun 71(−7)	Jun 71(−7)	Jun 71(−7)	Sep 71(−10)
March 1975	Jun 75(−3)	Jun 75(−3)	Sep 75(−6)	Apr 75(−1)
July 1980	Jul 80(0)	Jul 80(0)	Aug 80(−1)	Jul 80(0)
November 1982	Oct 82(+1)	Oct 82(+1)	Jun 82(+5)	Mar 82(+8)
March 1991	Jul 91(−4)	Jul 91(−4)	Apr 92(−13)	Jan 92(−10)
Length of Contraction				
Dec 69–Nov 70: 11 months	16(+5)	23(+12)	15(+4)	17(+6)
Nov 73–Mar 75: 16 months	11(−5)	11(−5)	11(−5)	8(−8)
Jan 80–Jul 80: 6 months	5(−1)	5(−1)	4(−2)	4(−2)
Jul 81–Nov 82: 16 months	18(+2)	18(+2)	7(−9)	8(−8)
Jul 90–Mar 91: 8 months	31(+23)	31(+23)	37(+29)	22(+14)
Percent Change in Index Peak to Trough[a]				
1969–70	−5.9	−7.0	−5.0	−2.6
1973–75	−8.6	−9.8	−5.5	−4.9
1980	−3.1	−3.6	−1.0	−1.8
1981–82	−3.1	−3.8	−0.6	−1.5
1990–91	−12.7	−14.2	−8.7	−6.1

Note: Columns labeled "A" use the specification in equations (3) and (4), estimated using employment, retail sales, average weekly hours, and the unemployment rate. Columns labeled "B" and those without a letter use only three variables, omitting retail sales. Massachusetts-C is based on equations (5) and (6), estimated using the withholding base for the state personal income tax, the base for the state sales tax, employment, retail sales, average weekly hours, and the unemployment rate. The "+" sign is used to denote leads, and the "−" sign lags, relative to national turning points.

[a]Dates refer to years of national peaks and troughs, but percent changes are based on regional/state peaks and troughs.

Source: Authors' calculations.

Prior to the 1990–91 recession, the timing of regional and national recessions was more similar, though not identical. In most cases, Connecticut and New Hampshire appear to have been relatively late in entering recessions. The Philadelphia Fed specification (but not the C specification) indicates that Massachusetts typically was relatively early in starting recovery. Patterns for the remaining states were more mixed.

The 1973–75 downturn in New England was unusually steep. Although the overall drop in economic activity was not as large as during the recession of the late 1980s to early 1990s, the earlier recession produced a sharper rate of decline (measured as the percent change in the index divided by the length of the downturn). Furthermore, the overall declines in Rhode Island and Massachusetts (16.3 and between 8.5 and 11.7 percent, respectively) were very large. The economies of several New England states also experienced considerable deterioration around the time of the 1969–70 recession. Not all recessions were unusually severe in New England, however. Most notably, Connecticut and New Hampshire showed very little decline during the national recessions of the early 1980s.

Discussion of Alternative Specifications and Alternative Indicators

Comparisons of the Massachusetts specifications suggest that composite indexes are sensitive to the choice of underlying indicators. While the two non-

Table 1 continued

Comparison of New England and National Business Cycles

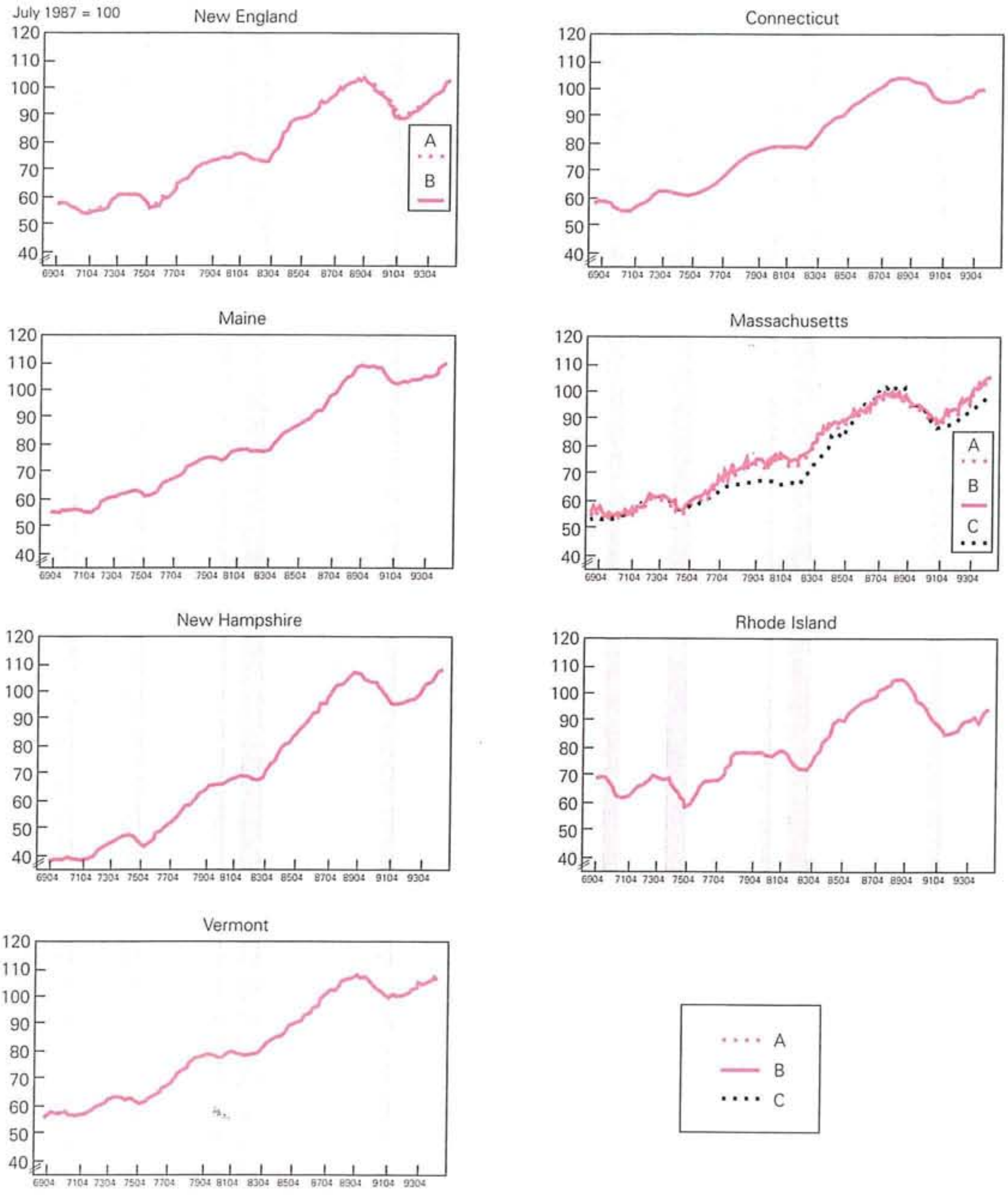
Regional/State Cycles and Difference from National (Number of Months)					
Massachusetts-A	Massachusetts-B	Massachusetts-C	New Hampshire	Rhode Island	Vermont
Jul 69(+5)	Jul 69(+5)	May 70(−6)	Jul 70(−7)	Jun 69(+6)	Mar 70(−3)
Jul 74(−8)	Jul 74(−8)	Sep 73(+2)	Jun 74(−7)	Jun 74(−7)	Aug 73(+2)
Feb 80(−1)	Feb 80(−1)	Feb 80(−1)	Mar 80(−2)	Apr 80(−3)	Dec 79(+1)
Apr 81(+3)	Apr 81(+3)	Apr 81(+3)	Oct 81(−4)	Apr 81(+3)	Aug 81(−1)
Jul 88(+24)	Mar 88(+28)	Apr 88(+27)	Mar 89(+16)	Feb 89(+13)	Jun 89(+13)
Aug 70(+3)	Aug 70(+3)	Dec 70(−1)	Apr 71(−5)	Jun 71(−7)	Jun 71(−7)
Apr 75(−1)	Apr 75(−1)	May 75(−2)	May 75(−2)	Jun 75(−1)	Jul 75(−3)
Jun 80(+1)	Jun 80(+1)	Sep 80(−2)	Sep 80(−2)	Sep 80(−2)	Jul 80(0)
Jan 82(+10)	Jan 82(+10)	Nov 81(+12)	Jun 82(+5)	Dec 82(−1)	Apr 82(+7)
Feb 91(+1)	Feb 91(+1)	May 91(−2)	Aug 91(−5)	Dec 91(−9)	Jul 91(−3)
13(+2)	13(+2)	7(−4)	9(−2)	24(+13)	15(+4)
9(−7)	9(−7)	20(+4)	11(−5)	12(−4)	23(+7)
4(−2)	4(−2)	7(+1)	6(0)	5(−1)	7(+1)
9(−7)	9(−7)	7(−9)	8(−8)	20(+4)	8(−8)
31(+23)	35(+27)	37(+29)	29(+21)	34(+26)	25(+17)
−4.5	−5.6	−2.1	−3.2	−8.9	−3.1
−8.5	−9.8	−11.7	−6.2	−16.3	−4.4
−4.1	−4.2	−3.2	−0.8	−2.0	−1.9
−3.7	−4.3	−1.7	−1.8	−10.4	−2.3
−11.8	−11.9	−15.3	−10.8	−19.4	−7.6

tax-based indexes (that is, Massachusetts "A" and "B") almost always produce the same business cycle turning points, their estimates of the length of downturns differ by more than three months from the tax-based Massachusetts "C" in the first two of the five recessions (1969–70 and 1973–75). All three specifications are reasonably consistent in ranking recessions as to their severity. The recession of the early 1990s was the most serious, followed by the 1973–75 recession, and the 1981–82 downturn was the mildest (or nearly so for the B specification). The tax- and non-tax-based indexes disagree about the severity of the 1969–70 recession, however, perhaps because of the relative unreliability of the tax data in the early years of the sample. (See the Appendix for a description of the data.) The indexes also give somewhat different indications of how the current state of the Massachusetts economy compares with its late 1980s peak. The non-tax-based indexes were approximately 4 to 5 percent above their previous peak as of August 1994, while the tax-based index remains shy of its previous peak. This discrepancy can be traced largely to a single indicator, the average workweek in manufacturing, which was not particularly short during the recession, and which recently has been substantially longer than at the 1988 peak.[29] Hours worked carries more weight in the A and B versions than in the C version of the index.

[29] Employment, retail sales, the unemployment rate, and the income and sales tax bases are all currently weaker than they were in the late 1980s. The indicated strength of the indexes in 1994 is largely a by-product of the trending procedure used.

Figure 1

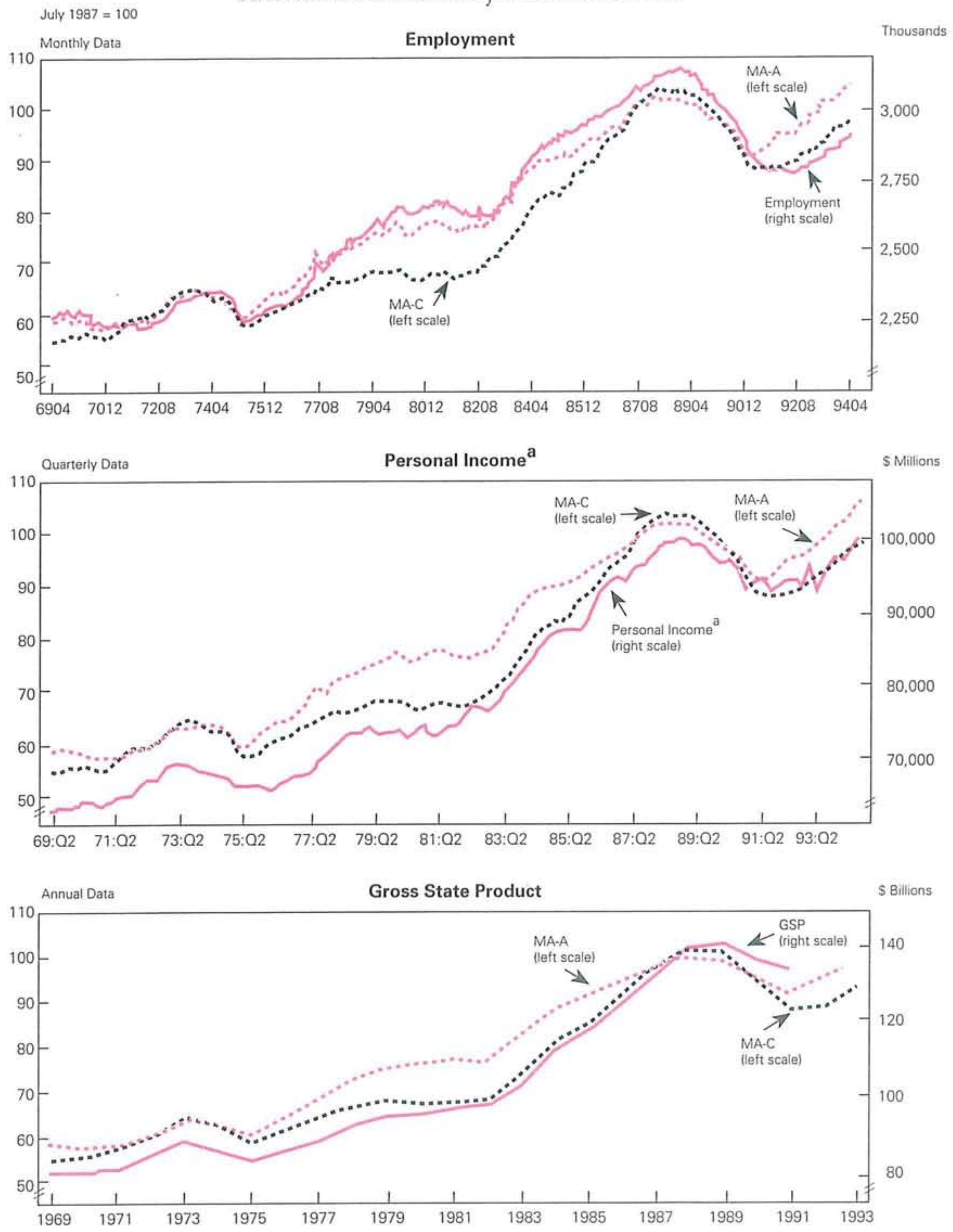
Coincident Economic Indexes for New England



Note: Series labeled "A" use the specification in equations (3) and (4), estimated using employment, retail sales, average weekly hours, and the unemployment rate. Graphs labeled "B" and those without a letter use only three variables, omitting retail sales. Massachusetts "C" is based on equations (5) and (6), estimated using the withholding base for the state personal income tax, the base for the state sales tax, employment, retail sales, average weekly hours, and the unemployment rate.
Shaded regions represent national recessions.
Source: Authors' calculations.

Figure 2

Alternative Indicators for Massachusetts



[a]Deflated by Boston CPI.
Source: Authors' calculations.

Table 2
Comparison of Massachusetts Business Cycles as Measured by Employment, Personal Income, Gross State Product, and Coincident Economic Indexes

I. Employment (Monthly Data)

Peaks			Troughs		
Employment	Index A	Index C	Employment	Index A	Index C
October 1969	Jul 69(+3)	May 70(−7)	January 1972	Aug 70(+17)	Dec 70(+13)
July 1974	Jul 74(0)	Sep 73(+10)	June 1975	Apr 75(+2)	May 75(+1)
February 1980	Feb 80(0)	Feb 80(0)	July 1980	Jun 80(+1)	Sep 80(−2)
April 1981	Apr 81(0)	Apr 81(0)	October 1982	Jan 82(+9)	Nov 81(+11)
December 1988	Jul 88(+5)	Apr 88(+8)	August 1992	Feb 91(+18)	May 91(+15)

II. Personal Income (Quarterly Data)

Peaks			Troughs		
Personal Income	Index A	Index C	Personal Income	Index A	Index C
Q2 1970	Q3 69(+3)	Q2 70(0)	Q4 1970	Q3 70(+1)	Q4 70(0)
Q2 1973	Q3 74(−5)	Q3 73(−1)	Q1 1976	Q2 75(+3)	Q2 75(+3)
Q1 1979	Q1 80(−4)	Q1 80(−4)	Q2 1980	Q2 80(0)	Q3 80(−1)
Q4 1980	Q2 81(−2)	Q2 81(−2)	Q1 1981	Q1 82(−4)	Q4 81(−3)
Q4 1988	Q3 88(+1)	Q2 88(+2)	Q3 1991[a]	Q1 91(+2)	Q2 91(+1)

III. Gross State Product (Annual Data)

Peaks			Troughs		
GSP	Index A	Index C	GSP	Index A	Index C
1973	1973	1973	1975	1975	1975
1989	1988	1988	1991	1991	1991

Note: Numbers in parentheses refer to differences between the coincident economic indexes and employment or personal income. Personal income is deflated by the Boston CPI.

[a]Abstracts from a tax-law-induced decline in the first quarter of 1993.

Source: Authors' calculations.

Other commonly used single-series indicators of the regional economy also are not uniform in their assessment of business cycles. Table 2 and Figure 2 compare three alternative indicators of the Massachusetts economy—payroll employment, personal income deflated by the consumer price index for Boston, and real gross state product—with each other and with the Massachusetts "A" and "C" indexes. Because it is measured only annually, gross state product fell only in the two most severe recessions—in the mid 1970s and the late 1980s to early 1990s. Massachusetts employment and personal income declined during all five recessionary periods. However, they indicate the same turning point only once—a peak in the fourth quarter of 1988. Employment peaked later than personal income in three of the four remaining cycles, and reached its trough later in three out of the five cycles. The composite "A" and "C" indexes tend to lead employment, but their turning points with respect to personal income are more varied. In general, however, the composite indexes are more "cyclical" than employment and personal income, in that the indexes show larger percentage declines during recessions. This property may be helpful in distinguishing true downturns from routine fluctuations.

Despite their various differences, the composite indexes for the New England states would have signalled by sometime in 1991 that a regional recovery had begun, in contrast to more gloomy assessments that resulted from relying on employment as the single best indicator of the economy. This is because the indexes for the two largest states in the region, Massachusetts and Connecticut, turned up earlier than the employment data did. The three indexes for Massachusetts show a pickup no later

Table 2 continued

Comparison of Massachusetts Business Cycles as Measured by Employment, Personal Income, Gross State Product, and Coincident Economic Indexes

Length of Contraction (Months)			Percent Change, Peak to Trough		
Employment	Index A	Index C	Employment	Index A	Index C
27	13(−14)	7(−20)	−3.0	−4.5	−2.1
11	9(−2)	20(+9)	−4.7	−8.5	−11.7
5	4(−1)	7(+2)	−0.9	−4.1	−3.2
18	9(−9)	7(−11)	−1.9	−3.7	−1.7
44	31(−13)	37(−7)	−11.5	−11.8	−15.3

Length of Contraction (Quarters)			Percent Change, Peak to Trough		
Personal Income	Index A	Index C	Personal Income	Index A	Index C
2	4(+2)	1(−1)	−1.1	−3.5	−1.3
11	3(−8)	7(−4)	−5.4	−7.2	−10.9
5	1(−4)	6(+1)	−1.6	−2.5	−2.7
1	3(+2)	2(+1)	−1.9	−2.4	−1.3
11	10(−1)	14(+3)	−7.4	−10.9	−14.8

Length of Contraction (Years)			Percent Change, Peak to Trough		
GSP	Index A	Index C	GSP	Index A	Index C
2	2	2	−5.0	−4.6	−8.9
2	3	3	−5.1	−9.7	−14.3

than spring of 1991, while employment did not hit bottom until August 1992.[30] The Connecticut index began to recover in spring 1992, whereas employment continued to decline for the remainder of the year.[31]

In summary, then, even after certain economic indicators have been selected from among the many candidates, and after a specification has been chosen, it is impossible to conclude that the constructed economic index is *the* best measure of the state of the economy. This is because alternative composite indexes are not entirely consistent in dating contractions (and, by extension, expansions). Furthermore, officially recognized state business cycle reference dates do not exist for states, and even in retrospect they could not be determined straightforwardly from available indicators such as gross state product, personal income, and employment. At least for states, composite economic indexes are instructive rather than definitive.

Consistency of Composite Indexes

Another issue is the internal consistency of composite indexes with respect to recessionary and ex-

[30] As indicated in Table 2, Massachusetts real personal income hit bottom in the third quarter of 1991. Because of lags in the release of personal income figures, an upturn would not have been noticed until mid-1992.

[31] The comparisons cited in the text on the timing of the recovery are not totally fair, as they cite employment data (and estimated composite indexes) after the benchmark revisions of March 1994, rather than the unrevised employment data for 1991 to 1993. However, our preliminary calculations of composite indexes using pre-benchmark data also indicated that a recovery started prior to a pickup in the employment numbers. Furthermore, the Massachusetts-C version of the composite index relies relatively less on employment data and is therefore much less prone to revision than versions A and B.

Table 3
False Signals from Composite Coincident Indexes

Year	Maine	Massachusetts-A	Massachusetts-B	Massachusetts-C	Rhode Island	Vermont
	False Recessionary Signals					
1970	—	(Oct–Dec)	(Oct–Dec)	—	—	—
1973	—	—	—	—	May–Aug	—
1974	—	—	(Feb–Apr)	—	—	—
1977	—	Aug–Oct	Aug–Oct	—	—	—
1979	—	—	—	Jul–Oct	—	—
1982	(Oct–Dec)	—	—	—	—	Oct–Jan 83
1989	(Jul–Oct)[a]	—	—	—	—	—
1993	—	—	Oct–Dec	—	Oct–Jan 94	—
	False Expansionary Signals					
	Maine	Massachusetts-A	Massachusetts-B	Massachusetts-C	Rhode Island	Vermont
1970	Sep–Nov	—	—	—	—	—
1974	—	—	—	(Jun–Aug)	—	Apr–Jun

Note: Parentheses around dates indicate cases where the designation of a signal as false is questionable, because of evidence either on the national business cycle or, in the case of Massachusetts, the designation of the period as a recession or expansion according to an alternative composite index. The indexes for the New England total, Connecticut, and New Hampshire gave no false signals.

[a]Although the decline during this period is inconsistent with subsequent movement in the Maine index, it is consistent with recessionary readings for all of the other New England states.

Source: Authors' calculations.

pansionary signals. Table 3 indicates false signals, where a false recessionary (expansionary) signal is defined as at least three consecutive declines (increases) in the index during a period of expansion (recession). Parentheses around dates indicate periods when the direction of the index was inconsistent with its own dating of business cycles, but consistent with the dates for national business cycles or with alternative state indexes. In other words, for these periods, the signals provided by the index could be justified.

Composite indexes are quite reliable during recessions. They misleadingly increased three times in a row during recessions only in two instances (1970 for Maine and 1974 for Vermont).

Recessionary signals during expansions are more common. Composite indexes falsely indicated recessions in mid-1973 and late 1993 for Rhode Island and late 1982 for Vermont. For Massachusetts, both the A and B indexes declined in mid-1977, and the B index also declined in late 1993. The Massachusetts-C index decreased for four consecutive months in 1979.[32]

Timely Release of Composite Indexes

In light of the potential value of composite coincident indexes for New England, but bearing in mind the ambiguous results as to which specification is best, the authors plan to calculate the various coincident indexes monthly, and to make them publicly available.[33] Such an experiment may shed additional light on the validity of regional composite indexes.

Most indicators are available within approximately one month of the end of the reference month (see Appendix Table 5 for the release dates for each series). The exception is retail sales, for which data are issued with a two-month delay. Retail sales is a component of the four-series indexes for Massachusetts and New England (Massachusetts-A and New England-A) and the tax-based index (Massachusetts-C).

The retail sales data add information to the composite indexes, despite their relatively late availability. A reasonable response may be to calculate Massachusetts and New England coincident indexes that include the retail sales component, but to base

[32] All these comparisons are based on examining currently available data, and do not take into account false readings based on preliminary data. We have not looked at the historical performance of coincident indexes based on unrevised data. A proper retrospective exercise would involve not just the retrieval of appropriate data, but also reestimation of coefficients.

[33] Tentative plans call for annual reestimation of the indexes using updated inputs, in conjunction with rebenchmarking to take into account release of annual data for gross state product.

the initial estimates of the indexes on a forecast of retail sales (for example, on the basis of a univariate autoregressive moving-average model, or using the Kalman filter forecast of the index and the estimated coefficients for the retail sales equation) rather than waiting for the retail sales data to be released. Similarly, since the Boston consumer price index (used to deflate the tax and retail sales data) is released only every other month, the initial calculation of the composite index may be speeded up by using a forecast of inflation.

It is impossible to conclude that one constructed economic index is the best measure of the state of the economy: At least for states, composite economic indexes are instructive rather than definitive.

V. Conclusions

What does this exercise teach about constructing regional economic indexes? Such indexes fall short of satisfying those who desire an irrefutable measure of the business cycle. Nonetheless the attempt to construct coincident economic indexes at the regional level is worthwhile, and will continue to be pursued by the authors—for several reasons.

First, despite the demand for such indexes, a widely accepted and widely used index for the region does not exist. Recent advances in statistical methodologies, as in the fields of common trends and cointegration, and innovative applications of these methods, as in the work by Stock and Watson, have made the estimation of such indexes possible and practical. Also, the use of regional tax revenue data as a source of information for such indexes appears to have been overlooked or underutilized. (On the other hand, the use of tax data necessitates detailed historical information on the revenue effects of changes in tax law. For this reason, this study was able to use tax indicators only for Massachusetts. Another limitation is that the revenue effects of future tax law changes may not be as accurately forecastable in "real time" as they are with historical hindsight.)

Second, the indexes presented here are in accord with what knowledgeable observers believe about the New England economy. The estimated turning points and the estimated recession severities seem reasonable. For example, the recession of the late 1980s to early 1990s was unusually long and deep; the mid-1970s recession also produced a sharp decline in economic activity. This implies that the basic premise of the models being used is correct—that a common state of the economy is reflected in each series individually.

Third, the indexes are less noisy than the observable data from which they are generated. This is a useful characteristic, since the alternative of no index requires subjectively balancing the idiosyncracies of several observable series or, what is worse, relying on a single data series as a proxy for the state of the economy simply because it is smooth.

Fourth, the indexes show that the current state and regional recoveries in New England began much earlier than was previously thought—especially before the dramatic upward revision in March 1994 of the establishment employment series. (In fact, even indexes that include the pre-revised establishment employment—not reported in this paper—show recoveries much earlier than conventional wisdom at that time suggested.)

Fifth, the timeliness of the indexes may at least partially fill the information gap created by the lag in regional statistics, especially with regard to personal income and gross state product. This characteristic of the indexes can aid regional forecasters. Since forecasters' projections generally "take off" from the most recently available data, the timeliness of the index provides a more accurate point of departure. Also, since the economy appears to have momentum, a good current economic indicator can help regional prognosticators more accurately predict the first derivative of short-run forecasts. Finally, a methodology similar to the one employed in this paper could be used in the development of additional indexes of regional activity that could help in either analyzing current conditions or making forecasts.

Appendix

Data Sources and Definitions

Except for gross state product and the tax revenue data, all series were obtained from the Federal Reserve Bank of Boston *New England Economic Indicators* data base, which can be accessed through the New England Electronic Economic Data Center at the University of Maine in Orono. *Payroll employment* estimates the number of full-time and part-time wage and salary workers on the payrolls of nonagricultural establishments, seasonally adjusted, in thousands (Source: U.S. Bureau of Labor Statistics). *Retail sales* estimates the operating receipts of stores primarily engaged in retail trade, seasonally adjusted, in millions of dollars (Source: U.S. Bureau of the Census; seasonal adjustments for New England and Massachusetts data by the Federal Reserve Bank of Boston). *Average weekly hours* refers to the average workweek for manufacturing production workers, seasonally adjusted (Source: U.S. Bureau of Labor Statistics; seasonal adjustments for the New England states by the Federal Reserve Bank of Boston). *The unemployment rate* equals the number unemployed (civilians who had no employment during the survey week, were available for work, except for temporary illness, and had made specific efforts to find employment sometime during the prior four weeks) as a percentage of the civilian labor force (all persons 16 years of age and older who are employed or available for employment, except armed services personnel), seasonally adjusted (Source: U.S. Bureau of Labor Statistics). *The consumer price index* for all urban consumers measures the average change in the prices paid by urban consumers for a fixed market basket of goods and services relative to the price of that basket during the 1982–84 period (Source: U.S. Bureau of Labor Statistics). Because data for Boston are available only every other month (every third month prior to 1978), missing observations were obtained through linear interpolation. *Gross state product* (GSP) is the state analogue to gross domestic product (Source: U.S. Bureau of Economic Analysis). Because of a change in the methodology to estimate implicit deflators, a consistent constant-dollar GSP series is available only back to 1977. Estimates for prior years were constructed using prior BEA estimates of inflation.

Conceptually, construction of a tax base from its revenue stream simply involves dividing revenues by the tax rate. If the base on which the tax is computed changes—owing, say, to a change in tax law—then a corresponding adjustment to the base must be made so that it is defined consistently over time. Otherwise, movement in the tax base would reflect the state of the law in addition to the state of the economy.

In practice, several complications usually arise: tax-law base changes may be difficult to measure; effective tax rates may differ from statutory tax rates (this is usually associated with simultaneous changes in statutory tax rates and tax base definitions); phase-in periods of varying duration often accompany rate or base changes; and changes in tax collection procedures and technology can affect the timing and month-to-month variation in revenue collections. In constructing historical income tax withholding and sales tax bases, the problems due to these complications are less severe in recent years, partly because improvements in revenue-collecting procedures and technology have made the data more reliable and less noisy, and partly because the revenue-collecting agency has better knowledge of the revenue impact of recent tax law changes.

The steps involved in constructing the withholding and sales tax bases are described briefly here. Details are available from the authors.

Withholding tax base. The statutory base is essentially wage and salary disbursements, less the value of personal and dependent exemptions claimed by workers on their withholding forms. These exemptions account for less than 10 percent of wage and salary disbursements. Since these exemptions have changed four times over the 1968–94 period, the tax base was adjusted to include all wage and salary disbursements. Although the per-person and per-dependent exemption levels are known, the actual number of exemptions claimed on withholding forms is not. Estimates of the average per-worker exemption amounts claimed during each of the five regimes were formed using information on withholding tax collections and rates, employment (as measured by the Massachusetts Department of Employment and Training), and wage and salary disbursements (as measured by the quarterly data of the U.S. Bureau of Economic Analysis).

An initial estimate of the tax base was formed by adjusting monthly collections for the number of tax-deposit days per month, constructing a few short phase-in periods, adding the estimates of the exempt portion of the base, and seasonally adjusting the result. Because the series was noisy, the filter $(1 + 2L + 2L^2 + L^3)/6$ was applied. This filter has been used extensively by the U.S. Commerce Department to smooth noisy series. Its characteristics are described in Stock and Watson (1989, p. 367).

The resulting series exhibited a marked difference in month-to-month variation pre- and post-FY 1978. Also, owing to a lack of adequate historical documentation on the revenue effects of some of the tax law changes pre-FY 1978, the data for this early time period were suspect. Since the data were cointegrated with the BEA measure of wage and salary disbursements (for the entire interval), the BEA series was used to proxy for the tax-based series during the pre-1978 time period.

Sales tax base. During the 1968–94 period, the sales tax has undergone only two major changes: a simultaneous rate and base change beginning in 1976, and a moderate expansion of the base in late 1990. Official analyses of the revenue impact of the 1990 base change were used to factor the 1968–90 base upward to be consistent with the current base definition. Historical estimates of the 1976 change were unavailable; therefore, estimates of the relationship between personal disposable income and sales tax collections were used to estimate an effective tax-rate change for this period.

The series was adjusted for the number of deposit days, seasonally adjusted, and filtered as above. The series is highly suspect between early 1976 and late 1977, perhaps because of a lengthy and complex phase-in period for changes in the tax law. Therefore, for this period the sales tax data were omitted and the index was estimated using only the remaining indicators.

Parameter Estimates

Parameter estimates for New England, each New England state, and the United States are displayed in Appendix Table 1.

Cointegration Tests

This section lists the integration and cointegration properties of the three series making up the Massachusetts-C index. Unit root tests are used to indicate whether a series is integrated—that is, whether it exhibits a trend. The multivariate equivalents provide evidence of cointegration.

Appendix Table 2 summarizes unit root properties based on Dickey-Fuller tests. For two of the series, the sales tax base and the withholding tax base, the Dickey-Fuller t-tests of a unit root cannot reject the null hypothesis of a unit root regardless of whether a deterministic trend is present. For retail sales, however, the t-test rejects the null hypothesis of a unit root for the residuals from a linear deterministic trend. For this series, we further investigate this hypothesis with an augmented Dickey-Fuller test, using the $T(\rho-1)$ test, which has greater power with a stationary alternative. The augmented Dickey-Fuller test fails to reject the null hypothesis of a unit root. For all series, the Dickey-Fuller and augmented Dickey-Fuller tests reject the null hypothesis of a unit root in the first differences of the series. We conclude that all three series are integrated of order one.

Appendix Table 3 lists the multivariate unit root tests based on the Johansen test (see Johansen 1988, 1991; Johansen and Juselius 1990; and Dickey, Jansen, and Thorton 1991 for descriptions of the tests). Regardless of whether constants are included in the auxiliary regressions, the combination of trace and maximal eigenvalue tests suggests that only one common unit root (one common stochastic trend) is present. Consequently, in extracting the unobservable component, we "de-mean" but do not detrend each of the series.

In tests between the index and gross state product, personal income, and wages and salaries, cointegration results proved to be marginal. The index (before constraining the trend to be the same as that of gross state product) was found to be cointegrated (at the 5 percent level) with gross state product, personal income, and wage and salary disbursements when paired with each series singly. When the four series were tested jointly, however, the hypothesis of a single common trend could not be accepted. When the four series were detrended, the hypothesis of a single common trend could be accepted, but this result leaves open the question of why the series have different nonstochastic trends. Extensive results are available from the authors upon request.

National Business Cycle Turning Points

Appendix Table 4 compares official business cycle turning points, as determined by the National Bureau of Economic Research, to turning points in the Commerce Department Composite Index of Coincident Indicators and in the Philadelphia Federal Reserve national index, adjusted to mirror the long-term trend in real gross domestic product. Appendix Table 5 lists the public release dates for selected economic indicators.

Appendix Table 1
Parameter Estimates
Standard Errors in Parentheses

New England—A

Parameter	Employment	Retail Sales	Hours	Unemployment Rate	v
β_i or β_{40}	.8144 (.0399)	.2281 (.0688)	.1286 (.0330)	−.2031 (.0569)	
β_{41}				−.1716 (.0591)	
β_{42}				−.0207 (.0605)	
β_{43}				−.7823 (.0598)	
r_{i1}	.4495 (.4515)	−.5292 (.0736)	−.5609 (.0533)	−.3126 (.0582)	
r_{i2}	.4745 (.4319)	−.2620 (.0738)	−.2587 (.0503)	−.2184 (.0588)	
σ_i	.1531 (.0727)	1.1406 (.0613)	.7351 (.0300)	.8829 (.0365)	
r_1					.1978 (.0710)
r_2					.3084 (.0685)

New England—B

Parameter	Employment	Hours	Unemployment Rate	v
β_i or β_{40}	.8127 (.0395)	.1313 (.0332)	−.1971 (.0568)	
β_{41}			−.1718 (.0590)	
β_{42}			−.0279 (.0604)	
β_{43}			−.0836 (.0594)	
r_{i1}	.4586 (.4592)	−.5628 (.0531)	−.3131 (.0588)	
r_{i2}	.4765 (.4424)	−.2603 (.0501)	−.2264 (.0592)	
σ_i	.1501 (.0684)	.7343 (.0299)	.8842 (.0366)	
r_1				.1875 (.0723)
r_2				.2985 (.0696)

Connecticut

Parameter	Employment	Hours	Unemployment Rate	v
β_i or β_{40}	.3885 (.0757)	.4825 (.0189)	−.4944 (.1230)	
β_{41}			.0079 (.1548)	
β_{42}			.3020 (.1697)	
β_{43}			−.1083 (.1174)	
r_{i1}	−.2923 (.0991)	−.5404 (.5292)	−.0229 (.8394)	
r_{i2}	.0343 (.0914)	−.2891 (.0500)	.1043 (.1457)	
σ_i	.6812 (.5129)	.7599 (.0309)	.7593 (.0906)	
r_1				.4557 (.1880)
r_2				.4179 (.1723)

Maine

Parameter	Employment	Hours	Unemployment Rate	v
β_i or β_{40}	.5156 (.1402)	.0565 (.0282)	−.4518 (.1297)	
β_{41}			−.0243 (.1980)	
β_{42}			.1345 (.1146)	
β_{43}			−.0533 (.1000)	
r_{i1}	−.2636 (.1175)	−.5508 (.0535)	−.0905 (.0766)	
r_{i2}	−.2370 (.1577)	−.2392 (.0510)	.0706 (.0759)	
σ_i	.7287 (.1135)	.7624 (.0310)	.8438 (.0691)	
r_1				.2650 (.2830)
r_2				.4394 (.2231)

Appendix Table 1 (continued)
Parameter Estimates
Standard Errors in Parentheses

Massachusetts—A

Parameter	Equation: Employment	Retail Sales	Hours	Unemployment Rate	v
β_i or β_{40}	.8038 (.0534)	.3795 (.1119)	.1094 (.0410)	−.0876 (.0601)	
β_{41}				−.1251 (.0578)	
β_{42}				−.0367 (.0584)	
β_{43}				−.1486 (.0590)	
r_{i1}	.7225 (.7280)	−.5518 (.0756)	−.6147 (.0553)	−.2992 (.0613)	
r_{i2}	.1877 (.6753)	−.2913 (.0745)	−.2447 (.5237)	−.1095 (.0619)	
σ_i	.2331 (.1489)	1.1079 (.0619)	.7336 (.0307)	.9454 (.0396)	
r_1					−.1439 (.1023)
r_2					−.0047 (.0922)

Massachusetts—B

Parameter	Equation: Employment	Hours	Unemployment Rate	v
β_i or β_{40}	.7903 (.0641)	.1114 (.0415)	−.0743 (.0638)	
β_{41}			−.1202 (.0595)	
β_{42}			−.0237 (.0606)	
β_{43}			−.1393 (.0606)	
r_{i1}	.3591 (.4972)	−.6010 (.0539)	−.2814 (.0625)	
r_{i2}	.5408 (.4701)	−.2345 (.0511)	−.0919 (.0633)	
σ_i	.2876 (.1124)	.7330 (.0298)	.9526 (.0400)	
r_1				−.1410 (.1129)
r_2				−.0198 (.1106)

Massachusetts—C

Parameter	Equation: Withholding Tax Base	Sales Tax Base	Retail Sales	Employment	Hours	Unemployment Rate	State (Transition)
β_i or β_{60}	1 (Restricted)	.9810 (.0292)	.9723 (.0467)	18.1142 (2.4072)	1.7159 (.8948)	45.0477 (82.0551)	
β_{61}						−38.9697 (186.2010)	
β_{62}						−65.0331 (154.6230)	
β_{63}						52.5934 (55.9688)	
r_{i1}	1.3734 (.0516)	1.0420 (.0464)	.6142 (.0581)	−.0262 (.0625)	−.6078 (.0537)	−.4791 (.1096)	
r_{i2}	−.4595 (.0515)	−.6737 (.0445)	.0292 (.0585)	.0960 (.0596)	−.2388 (.0510)	−.1405 (.0895)	
σ_i	.0551 (.0023)	.0875 (.0041)	.2294 (.0093)	.8693 (.0362)	.7393 (.0300)	.7907 (.0760)	.0057 (.0049)
δ							.0003 (.0003)
r_1							1.3955 (.4974)
r_2							−.4339 (.4647)

Appendix Table 1 (continued)
Parameter Estimates
Standard Errors in Parentheses

New Hampshire

	Equation			
Parameter	Employ-ment	Hours	Unemploy-ment Rate	v
β_i or β_{40}	.2474 (.0871)	.0110 (.0090)	−.4521 (.1429)	
β_{41}			.5802 (.2672)	
β_{42}			−.5629 (.2961)	
β_{43}			.2919 (.1555)	
r_{i1}	−.1364 (.0914)	−.6550 (.0498)	.0367 (.1816)	
r_{i2}	−.1136 (.0757)	−.4378 (.0484)	.0716 (.0898)	
σ_i	.7343 (.0467)	.7394 (.0299)	.7655 (.0944)	
r_1				1.0987 (.2816)
r_2				−.1841 (.2566)

Rhode Island

	Equation			
Parameter	Employ-ment	Hours	Unemploy-ment Rate	v
β_i or β_{40}	.3382 (.0918)	.0317 (.0243)	−.5145 (.1524)	
β_{41}			.0644 (.2121)	
β_{42}			.0009 (.1657)	
β_{43}			.1289 (.1474)	
r_{i1}	−.1780 (.0956)	−.4275 (.0549)	−.2478 (.1501)	
r_{i2}	−.0584 (.0813)	−.2906 (.0552)	.1513 (.1101)	
σ_i	.8484 (.0541)	.9048 (.0366)	.7371 (.1022)	
r_1				.5929 (.3547)
r_2				.2003 (.3170)

Vermont

	Equation			
Parameter	Employ-ment	Hours	Unemploy-ment Rate	v
β_i or β_{40}	.4523 (.0888)	.0329 (.0245)	−.4777 (.1110)	
β_{41}			.0828 (.1433)	
β_{42}			.0248 (.1209)	
β_{43}			−.0755 (.0875)	
r_{i1}	−.3073 (.0885)	−.5913 (.0540)	.0501 (.0998)	
r_{i2}	−.1294 (.0797)	−.3019 (.0531)	.1333 (.0840)	
σ_i	.7649 (.0574)	.8089 (.0328)	.7976 (.0643)	
r_1				.3032 (.1405)
r_2				.4403 (.1358)

United States

	Equation				
Parameter	Employ-ment	Retail Sales	Hours	Unemploy-ment Rate	v
β_i or β_{40}	.5694 (.0519)	.0745 (.0231)	.1107 (.0268)	−.3935 (.0615)	
β_{41}				−.3020 (.0761)	
β_{42}				.1514 (.0737)	
β_{43}				.1449 (.0636)	
r_{i1}	.0827 (.1717)	−.3076 (.0569)	−.5005 (.0573)	−.3895 (.1234)	
r_{i2}	−.0145 (.1683)	−.1672 (.0568)	−.1668 (.0571)	−.1170 (.1019)	
σ_i	.4778 (.0601)	.7407 (.0302)	.8729 (.0360)	.6696 (.0582)	
r_1					.3626 (.0849)
r_2					.4657 (.0830)

Appendix Table 2
Unit Root Properties

Variable	Dickey-Fuller T-Tests No Trend	Dickey-Fuller T-Tests With Trend	Augmented Dickey-Fuller T($\rho-1$)-Tests No Trend	Augmented Dickey-Fuller T($\rho-1$)-Tests With Trend
Levels				
Sales Tax Base	−1.716	−2.674	−1.849	−6.623
Retail Sales	−2.238	−3.469	−3.795	−10.726
Withholding Base	−.834	−1.239	−1.068	−4.153
First Differences				
Sales Tax Base	−10.606	−10.588	−244.847	−238.808
Retail Sales	−25.326	−25.286	−577.882	−577.965
Withholding Base	−10.663	−10.649	−317.771	−317.963
Critical Values (.05)	−2.880	−3.425	−14.000	−21.400

Appendix Table 3
Multivariate Unit Root Test Results

Hypothesis Null/Alternate	Johansen Cointegration Tests: With Constants	Critical Value (.05)	With Constants, No Trend	Critical Value (.05)	No Constants	Critical Value (.05)
Trace Tests						
At Least 1 Unit Root/ 0 Unit Roots	.160	3.962	2.840	8.083	1.224	3.840
At Least 2 Unit Roots/ 0 Unit Roots	18.656	15.197	29.653	17.844	52.271	12.530
Maximal Eigenvalue Tests						
2 Unit Roots/1 Unit Root	18.496	3.962	26.814	8.083	51.047	3.840
Trend Test						
No Trend/Trend	n.a.	n.a.	2.680	3.840	n.a.	n.a.

n.a. = not applicable.

Appendix Table 4
Comparison of Business Cycle Turning Points

(1) NBER Business Cycle Turning Points	(2) Commerce Department Coincident Index	(3) Coincident Index Using Philadelphia Federal Reserve Specification and GDP Trend	(4) Gross Domestic Product
Peak			
December 1969	October 1969	Same as (1)	Q3 1969
November 1973	Same as (1)	May 1974	Q4 1973
January 1980	Same as (1)	March 1980	Q1 1980
July 1981	August 1981	Same as (1)	Q3 1981
July 1990	June 1990	June 1990	Q2 1990
Trough			
November 1970	Same as (1)	Same as (1)	Q2 1970
March 1975	Same as (1)	June 1975	Q1 1975
July 1980	Same as (1)	Same as (1)	Q2 1980
November 1982	December 1982	December 1982	Q3 1982
March 1991	Same as (1)	February 1992	Q1 1991
Percent Change, Peak to Trough			
1969–70	−2.4	−2.6	−0.9
1973–75	−6.6	−5.2	−4.1
1980	−3.0	−2.2	−2.6
1981–82	−3.9	−5.4	−2.8
1990–91	−2.4	−3.1	−1.5

Source: National Bureau of Economic Research, U.S. Bureau of Economic Analysis, and authors' calculations.

Appendix Table 5
Public Release Dates for Economic Indicators

Indicator	Massachusetts	Other New England States	Indicator	Massachusetts	Other New England States
Payroll Employment	Last Wednesday of following month.[a]	Last Wednesday of following month.[a]	Withholding Tax Base	First week of following month.[c]	Not available.
Retail Sales	Between the 22nd and 29th day of second following month.[b]	Not available.	Sales Tax Base	First week of following month.[c]	Not available.
Average Workweek in Manufacturing	Last Wednesday of following month.	Last Wednesday of following month.	Consumer Price Index	Approximately one week after employment release; odd-numbered months only.[d]	Not available.
Unemployment Rate	First Friday of following month.[b]	Last Wednesday of following month.			

[a]Refers to release date by the U.S. Bureau of Labor Statistics. Data may be available approximately one week earlier from the state.
[b]Applies also to New England total.
[c]Refers to potential public release date; data currently not released.
[d]Refers to Boston CPI.
Source: Issuing agencies.

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