# A More Timely and Useful Index of Leading Indicators

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**Abstract**
Effectively predicting cyclical movements in the economy is a major challenge. While there are other approaches to forecasting, the U.S. leading index has long been used to analyze and predict economic fluctuations. We describe and test a new procedure for making the index more timely. The new index significantly outperforms its less timely counterpart and offers substantial gains in real-time out-of-sample forecasts of changes in aggregate economic activity and industrial production. It provides timely and accurate ex-ante information for predicting, not only the business cycle turning points, but the monthly changes in the economy.

## 1. INTRODUCTION

### 1.1 The Problem

Most of the macroeconomic data for the United States require considerable time to collect, process, and release. Lags of one month are common for principal monthly indicators. For the quarterly data, including the national income and product accounts (NIPA), the lags are longer. Moreover, many of these indicators are subject to sizable revisions that are only realized over long time intervals. The data revisions presumably reduce measurement errors but they add to uncertainty and forecasting errors, as do gaps and lags in the availability of the data.

The actual recognition lags are considerably longer than these publication lags as it is difficult to recognize signals in noisy data. As a result, not just private but even public decision and policy makers are faced with long delays and much uncertainty about the current (let alone the future) conditions of the economy. Although government is the main source of macroeconomic statistics, its access to the data is not much more timely than that of the public.

At the same time, the publication lags and revision schedules vary greatly and some indicators are everywhere available promptly. In particular, financial market price and yield data are available electronically in real time during each trading day. The U.S. leading index includes stock prices and interest rate spreads that have no significant data lags and relatively few, if any, revisions. The financial market indicators convey a great deal of information with predictive value, yet, until recently, they were represented in the leading index, not by their most recent monthly values, but by their values in the preceding month for which data for other indicators were also available. For these series the timely availability of accurate data is not an issue, but indexing procedures did not take advantage of the most recent information.

The failure to use the most current available data in the leading index is a likely major source of forecast errors. Some nonparametric rules and probability model applications of the leading index performed well in forecasting recent cyclical developments, even using real-time data, as reported by Andrew J. Filardo (2002). However, some other studies have suggested that the composite leading index was not a good predictor of industrial activity in real time. Aside from the path breaking work by Francis X. Diebold and Glenn D. Rudebusch (1991) on the importance of real time evaluations, studies by Arturo Estrella and Frederic S. Mishkin, (1998), suggested similar conclusions. They emphasized the importance of selected financial indicators such as interest rate spreads and bond and stock price indexes as better predictors of business cycle turning points. At least in part to address these criticisms, in addition to the new index procedures, we evaluate the accuracy of LI, both the old and new leading indexes.

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### 1.2 The Attempted Solution

How should one deal with the data shortcomings and make the composite indexes less vulnerable to them, more timely, and more useful for economic analysis and forecasting? The old composite index of leading economic indicators is replaced by a new index, which uses more timely and more complete data. The missing-data problem encountered in the construction of the composite indexes calls for a practical solution that combines three principles. (1) Use the most recent complete monthly data for those components where they are available. (2) Use the simplest uniform methods of forecasting that will produce acceptable estimates for those components where the data for the most recent complete month are not available. (3) Apply strictly consistent tests to the old and new indexes to compare their predictive performance, and accept the results of the new procedure only if they pass these tests.

This paper describes in detail how The Conference Board solved the above problem. It also assesses the accuracy of the new composite leading index using out-of-sample tests with both historical and "real-time" data. This is in contrast to many earlier tests of the leading indicators that rely only on historical, revised data series, not on information available at the time of publication. We find that the new procedure yields significant gains and that the resulting leading index is more timely and useful, in the sense that the leading index significantly improves forecasts across a broad range of models.

### 1.3 Outline

Part Two of the paper describes the traditional method of constructing a composite leading index, sets out its rationale, and provides its critique. An alternative method that is capable of producing a timelier and more useful index is then developed. The availability of component data and the implied production schedules are given full consideration in defining the new index calculation procedures and comparing it formally with the conventional one. This portion of the paper ends with a discussion of the expected costs and benefits of the new approach.

Part Three analyzes the structure of the underlying data and the role of data revisions. It compares the historical leading index, defined as the leading index calculated with the latest available data, with successive vintages of the old and new leading indexes. By using real-time data for each of their ten components in the current set of leading indicators (see The Conference Board, Business Cycle Indicators Handbook, 2001), we put the indexes on a strictly consistent and comparable basis. Charts comparing the old and new indexes show that they are nearly identical in the early parts of the time series, which comprise revised data. But they differ increasingly in the later pre-revisions parts of the series. In its last section, part III discusses the coincident or current conditions index (CCI), which the leading index (LI) is designed to predict.

Part Four asks how well the leading index predicts CCI; it considers briefly other measures of overall economic activity as well. The equations or models and the procedures designed for testing the performance of the index are presented and discussed. So are the tables providing the evidence on the summary measures of the associated forecast errors.

The last section (V) draws together our conclusions and places them in the context of some other related findings in the literature.

## 2. CONSTRUCTION OF THE COMPOSITE LEADING INDEX

### 2.1 The Logic and Consequences of the Traditional Method

There is much variation among business cycles in duration and magnitude, causes and consequences. The contributions of specific factors differ over time. This helps to explain why composite indexes designed to describe and predict economic growth and fluctuations generally work better over time than do their individual components (different indicators selected for the best past performance). The leading index, for example, represents better the multicausal, multifactor nature of the economic movements than does each of its following components: the average workweek, initial claims for unemployment insurance, new investment commitments (orders, contracts, housing permits), real money supply, yield spread, stock prices, and consumer expectations. The contributions of these components vary over time, depending on the characteristics of each cycle. The leading series themselves vary in timing, smoothness, currency, etc. The index gains from this diversification.[1]

[1] The indicator approach is just one of many approaches to business cycle analysis. Introduced first by Mitchell and Burns (1946), it has been a major component of the NBER business cycle program and has proved useful over the years.

However, many technical problems arise from this diversity, perhaps none more vexing than those stemming from the fact that some indicators are available promptly, others with substantial lags.

The traditional method employed since the early post-World War II years successively by the National Bureau of Economic Research (NBER), the Bureau of Economic Analysis (BEA) in the U.S. Department of Commerce, and lately The Conference Board incorporated two rules. First, all components of the index refer to the same month. Second, only actual data – no forecasts – are used.

This first adopted and long used procedure had its logic. The set of the data used was time-consistent, since it covered the same period, as usual in index construction. In addition, by consisting of actual data, the index avoided errors inevitably associated with forecasting.

However, the methodology suffered from failing to use the latest available financial and other data with presumably more relevance and more predictive value than the data actually used, which were one month older. While forecasting the missing variables introduces error, it also improves the timeliness of the composite index.

The old procedure also had no good way of coping with the serious problem of missing data. The practice followed occasionally in the U.S. and routinely in most foreign countries has been to calculate the indexes with a partial set of components – e.g., a minimum of 40 to 60 percent depending on the country according to the Organization for Economic Cooperation and Development (OECD).[2] An equally arbitrary rule of at least 50 percent of components was used in the United States until recently.

While any rule based on less than the full complement of the data allows the indexes to be more up-to-date, all such rules raise serious problems. First, there is the very undesirable trade-off between the coverage and the timing of the index: the more complete its coverage, the less timely is the index. Second, without a full set of components, the volatility adjustment (standardization) factors used to calculate the contributions of the components often change dramatically depending on which series, and how many of them, are missing.

The only effective way to avoid these problems while adhering to the rules of the traditional method was to delay the issuance of the index until preliminary data became available for all of its components. For the monthly indicators used in the most recent version of the traditional index this meant a production lag of almost two months.

### 2.2 The Gain in Timeliness from the New Method

In the old procedure, the index released during the current month (t) referred to the month (t-2). In the new procedure, implemented by The Conference Board since January 2001, the index released in the same month (t) refers to the month (t-1). This is a major advantage of greater timeliness.

Let $Y$ be the vector of indicator series with data lags such that they are not available in the current publication period. Variables in Y are generally data on real macroeconomic activity and price indexes. Specifically, for the present U.S. Leading Index they include new orders for consumer goods and materials, new orders for nondefense capital goods, and real money supply. (Nominal money supply is available but the personal consumption expenditure deflator used to adjust it is not.)

Let $X$ be the vector of the indicator series that are available for the most recent complete month. These include the promptest financial indicators such as stock prices, bond prices, interest rates, and yield spreads. They also include many other, less prompt but frequently reported series. Seven of the ten components of the U.S. Leading Index fall in this category.[3]

Table 1 shows the availability of the components of LI in the two most recent complete months, using March (t) as an example (the situation in any other month is analogous). It also illustrates the publication schedules of the old and the new index. In our example, the old index would be calculated in the first week of March (t) for January (t-2), the month with a complete set of components. The new index would be calculated in the third week of March for February (t-1), the month for

[2] See Nilsson (1987). Also see web page http:// www.oecd.org/std/li1.htm
[3] This count depends on the publication date of the Business Cycle Indicators report during each month. The statement holds for the present publication schedule adopted in January 2001.

which 70 percent of the components are available and 30 percent are forecast. Before the introduction of the new method, users of the indicator approach had to wait for two more weeks until April for the February index.

A simple formalization of the old and new indexing procedure may be given as follows:

$$LI^{old}_{t,t-2} = I(X_{t-2}, Y_{t-2}) \quad (1)$$

and

$$\hat{LI}^{new}_{t,t-1} = I(X_{t-1}, \hat{Y}_{t-1}) \quad (2)$$

Here $I(\cdot)$ denotes the indexing procedure[4] used; $LI_{t,t-i} = I(\cdot)$ denotes the value of the index for the month t-i published in the month t, where i denotes the publication lag. The first subscript on the index gives the month of release; the second subscript, the month of the target or reference. The symbol ^ refers to a magnitude based at least in part on some kind of forecasting.

### 2.3 The Costs and Benefits of the New Procedure

The indicators used to construct the leading index tend to move ahead of the business cycle as represented by CCI, its components, and other measures of overall economic activity in real terms. For example, businesses adjust hours before changing employment by hiring or firing; new orders for machinery and equipment are placed before completing investment plans; etc. Thus, by design, the composite index of leading indicators helps predict changes in the economy. The old leading index performed this function with errors due largely to missing data and other measurement problems. In the new index, some of these problems are reduced but new errors are introduced by the forecasts of $\hat{Y}_{t-1}$.

For the new procedure to be preferred, it is necessary that the errors of $\hat{LI}^{new}$ be smaller than those of $LI^{old}$ so that $\hat{LI}^{new}$ does a better job of forecasting the economy. Conceivably, $\hat{LI}^{new}$ could be inferior to $LI^{old}$. However, using $X_{t-1}$ instead of $X_{t-2}$ results in a substantial advantage of greater timeliness, as the new index is available more than half a month earlier than the corresponding old index. Furthermore, the $\hat{Y}_{t-1}$ forecasts are typically short, hence they should produce relatively small errors. Also, the individual errors of the components of the vector $\hat{Y}_{t-1}$ may offset each other when combined to form the composite index. Thus, there are three good reasons why the new procedure can be expected to be an improvement.[5]

Of course, there exist a great variety of ways to forecast $Y_t$. However, the advantages of simplicity, stability, and low costs argue for concentrating on easily implemented autoregressive models that pass some fairly strict tests. For practical reasons associated with production of the indexes on a monthly basis, frequent changes in the forecast model are avoided. The Conference Board uses the same model for fixed periods of at least a year or two, but re-estimates it every month. The model will be tested every year or so and, if necessary, replaced with a better working one. Therefore, simple and easily implemented lag structures were the focus of The Conference Board's search for a forecasting method.

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[4] In this paper we take $I(\cdot)$ to be fixed and identical to the Conference Board's indexing procedure. The Conference Board follows longstanding practice of using standardization factors to equalize the volatility of the index components so that relatively more volatile series do not exert undue influence on the index. On details of indexing, see The Conference Board, Business Cycle Indicators Handbook, 2001.

[5] The $\hat{Y}_{t-1}$ forecasts for the U.S. are restricted to one-month ahead forecasts, but for other countries multi-step forecasts for some Y variables are necessary. In most foreign countries there are fewer weekly and monthly and more quarterly and annual series, and for this and other reasons the lags tend to be longer, up to 3-5 months. Hence, outside the U.S. the need for the new procedure is even greater than for the U.S., although the potential errors from forecasting the Y variables are greater, too.

Robert H. McGuckin et al. (2001) examined AR (i) models with lag lengths, i, of one to four months. The forecasts improve strongly for *i = 1, 2* and only marginally at best for *i = 3, 4.* Unconstrained processes work better than the constrained ones.[6] Hence, the simple second order autoregressive hotbox imputation method was adopted after much experimentation and due consideration of the practical needs of monthly production schedules.

## 3. COMPARING THE LEADING INDEXES AND THEIR PREDICTIVE TARGET

### 3.1 Calculating the New and the Old Indexes in a Consistent Manner

The long history of the leading and coincident indexes has been punctuated from time to time by changes in the composition of these indexes and some of their technical properties. The reasons for these alterations lie in advances of the research on business cycles and the indicators, and in changes in the availability and quality of the underlying statistical time series.[7] There is no support for the notion that component series were added to and subtracted from the index to obtain high correlations with measures of aggregate economic activity.[8]

In order to compare the new and old leading indexes on a consistent basis, we calculated the indexes using real time data on each of their ten components. This puts the new and old indexes on strictly equal footing, eliminating all changes in composition or methodology (base years, standardization factors, etc.) – and hence all possible discontinuities or differences due to these factors.

Old Index.

The real time data used in this study were first electronically archived in 1989 by the former Statistical Indicators Division of the U.S. Department of Commerce and later, since 1995, by The Conference Board. The data available in January 1989 are called the "January 1989 vintage" and consist of a monthly sample covering the period January 1959 to November 1988. Each consecutive monthly vintage adds the next month's observation. Thus, the next vintage consists of the comparable data available in February 1989, covering the sample period January 1959 to December 1988, and so on, through August 2002, which is reported in the September 2002 vintage. Hence, there are 165 vintages and 165 corresponding sets of data that are used to create 165 series of the old index, each starting in January 1959.

New Index.

The above is a stylized description of the real time data because the components are not all published at the same time. Rather there is a steady stream of new data on the components of the leading index throughout a given month. The following example explains how we create the new leading index with the real time data we have: Assume we are in the third week of January 1989. The December 1988 values of the three Y components of the index (see Table 1 and text above) have not been published yet. The latest data available for these components end in November 1988 and are saved in the January 1989 vintage. The December 1988 values of the remaining seven components have already been published at various dates in January. Note that under the schedule for the old leading index these seven components will not be archived until February 1989.

We use the three components from the January 1989 vintage and forecasts of their values for December 1988 and combine them with the values of the seven components that are saved in the February 1989 vintage to get the new leading index

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[6] The simplest model was $\hat{Y}_t = Y_{t-1}$, i.e., an autoregressive process of order one where the constant is zero and the coefficient is one. Even this model improved a little on the old index but less so than the corresponding unconstrained version. The available data on X could help forecast the missing Y series, but their use would result in overweighing the X variables in the index and does not repay the effort.
[7] For comprehensive information on the structure and evolution of cyclical indicators and composite indexes, see Klein (1999a, b) and Zarnowitz (1992) chs. 10 and 11.
[8] The NBER and the U.S. Bureau of Economic Analysis (BEA) conducted no fitting exercises to improve forecasting with LI, but producers of cyclical indicators must be sensitive to the effects of real changes in the economy's structure, institutions, and policies. A good example is the addition of real money supply to LI in the 1973-75 review and benchmarking. There are also occasional efforts to improve the index by removing or replacing a component that became unduly volatile or otherwise deteriorated like the index of sensitive materials prices (included in LI prior to the 1996 revision by The Conference Board).

covering the period January 1959 to December 1988. We call this the January 1989 vintage since it would have been published in the third week of January 1989 if the new procedure were in place. The next vintage of the leading index is constructed similarly. Thus, each vintage of the new leading index has one more monthly observation than the old leading index. The 165 data sets of real time data described above give 165 vintages of the new leading index. The last vintage of the new index we use is the September 2002 vintage, which covers January 1959 through August 2002.

The formal and general representation of such a data structure as laid out in Diebold and Rudebusch (1991) is a matrix with 1...s columns, one for each successive vintage, and with 1...r rows, one for each successive period covered by the data available within each vintage. Here $L_{rs}$ is the value of the leading index (old or new), which covers month r and which has been published in month s.

### 3.2 Real-Time Vintages of the New and Old Leading Indexes

Chart 1 compares five randomly selected vintages of the new Leading Index with each other and the historical index. The vintage series end one month before the publication dates of 1/89, 11/91, 7/98, 3/00, and 6/01, respectively, while the historical index incorporates all revisions in the data through September 2002. All six series start in January 1959, and all have common index base, 1987 = 100.

By construction, all six indexes have the same composition and the same computational characteristics. Hence, any difference between them must be due to the effects of (1) data revisions and (2) forecasting the missing data. But at any time historical post-revision values account for the great bulk of all observations, and they are generally identical in the different vintages. Forecasts for missing data apply only to the most recent values (end months for each vintage) of three of the components of LI. This explains why the differences between the vintages tend to be so limited.

Indeed, it is mainly the new orders for consumer goods and materials and the new orders for nondefense capital goods, which have large revisions, partly due to their deflators. Similarly, revisions affect at times importantly the implicit deflator for personal consumption expenditures used to adjust M2, money supply. The other leading indicators either have no revisions at all (stock prices, the yield spread) or have only rare and relatively small revisions.

A closer look at the chart reveals that the patterns of cyclical change are virtually identical in the different vintages of the new LI; moreover, even the short irregular fluctuations also look closely similar.[9] However, the successive vintages show an upward tilt. The historical index, which is the last (9/2002) vintage, shows the strongest upward trend; the earlier vintages start from somewhat higher levels and end at somewhat lower levels. Underestimation of growth and inflation appears to be a frequent characteristic of preliminary data in long expansions like the 1960s and 90s.[10]

While inter-vintage discrepancies appear more visible around some of the past turning points, in the 1960s, the 1970s, and 1982, the specific-cycle peaks and troughs in the leading index fall on the same dates for all different vintages in a whole succession of business cycles. Indeed, the historical index agrees on the dates of cyclical turns with the earlier vintages. The agreement is exact in a large majority of cases and close in the few instances where the timing is not identical.

For the period since 1959, Chart 1 shows the consensus peak and trough dates for the leading index. They are marked P and T where they precede the onset of business cycle recessions and recoveries, respectively, and x where there are "extra" turns not associated with general economic declines and rises. In 1959-2002, seven recessions occurred in the United States, as shown in the chart by shaded areas; the beginning and end dates of these phases, i.e., the U.S. business cycle peaks and troughs, respectively, are listed at the top of the chart. All vintages of the leading index share the property of turning down ahead of business cycle peaks, and up ahead of the troughs. The length in months of each of these leads is shown in Chart 1 by a negative number placed next to each of the eight P and each of the eight T markings.[11] The leads at peaks range from 6

[9] Analysis of this issue must await another paper. Moreover, reliance on charts requires some care. When 1959, the initial year of the real-time data sample, is used as the index base, the five vintages and the historical data all are just about indistinguishable on a graph for the first six or seven years covered. Later on, discrepancies between the vintages appear and increase gradually. When a later year such as 1987 is chosen as the base, the vintages get to differ on that account in both the early and the late periods, and the differences tend to disappear in the mid–1980s (see Chart 1).

[10] Zarnowitz (1992), ch. 13, shows a similar pattern for related forecasts. On how data revisions can interact with the differences between real-time perceptions and ex-post realizations of important macroeconomic variables, see Orphanides (2001).

[11] By convention, leads are represented by negative numbers, lags by positive numbers.

to 21 months and average 11 months; for those at troughs, the numbers are 1 to 8 and about 4.5 months. In addition, the algorithm developed by Gerhard Bry and Charlotte Boschan (1971), which mimics closely the procedures of NBER researchers for selecting turning points, picked three "extra" declines (six x turns).

A plot of the corresponding vintages of the old index looks very much like Chart 1 and including it here would not repay the additional space required (the chart is available upon request). For both the old and the new indexes, the set of the specific cycle turning points is the same, as presented in Table 2. Data revisions have caused a few small shifts between the earlier and the later vintages; these are listed in the footnotes to Table 1 and refer to irregular or flat turning zones (see Chart 1).

Because their cyclical timing is essentially identical, the new and old leading indexes cannot be distinguished by how well they anticipate the onset of business cycle recessions and recoveries. With the same composition, they face the same data and produce the same leads. But the new procedure reduces the delays involved in publication and results in a more timely index, which should prove helpful in actual recognition of turning points.

### 3.3 Comparing the Old and New Indexes Directly

Chart 2 plots the new LI and the old LI for the period since 1989 covered by our "real time" sample. Each point on the graph represents the end value of each of the 165 vintages of data. $\hat{LI}^{new}$ covers the period December 1988 – August 2002; $LI^{old}$ covers November 1988 – July 2002. The lower panel of the chart shows the percent differences between the two real-time level series plotted in the upper panel. It is evident that these differences are very small most of the time: $\hat{LI}^{new}$ and $LI^{old}$ practically overlap. Further, the time series of the differences is essentially random and has little if any bias: most of the time, the positive and negative differences balance each other.

In addition, Chart 2 in its upper panel shows the "historical LI," that is the last vintage which incorporates all revisions to date. This historical index series deviates from both the old and the new LI by much more than they deviate from each other, but mainly in the level, not in the pattern of cyclical change which is shared by all three series. Much of the time during the 1990s the historical index runs slightly above the other indexes reflecting the aforementioned tendency of the indicators to understate growth and inflation during expansions.

The randomness of the differences between the old and the new LI is certainly a welcome feature as it means that forecasting the missing components of the index introduces no net systematic error. So is the fact that the discrepancies are generally small, fractions of one percent. This suggests that any errors caused by the new procedures are likely to be more than offset by improved timeliness. Nonetheless, the differences in timing between the two indexes occasionally cause them to differ strongly because of large benchmark revisions in some components: in a few scattered months, $\hat{LI}^{new}$ uses pre-benchmark data while $LI^{old}$ uses post benchmark data.

Chart 2 also confirms that the old and new real-time leading composites available since 1989 can hardly be distinguished by their cyclical timing. Since differences in forecasting the turning points is not an issue, we base all our tests on how well the new vs. old LI does in forecasting times series that represent total economic activity. These tests are both more general and more demanding than turning point comparisons: They use a regression framework and distinguish quantitatively between historical and real-time data.

### 3.4 The Coincident Index as a Measure of Current Economic Conditions

The Leading Index is widely used as a tool to forecast changes in the direction of aggregate economic activity and in particular business cycle turning points. The reference chronologies of the latter are determined historically by the National Bureau of Economic Research. In this task, NBER relies to a large extent on the principal coincident indicators: nonfarm establishment employment, real personal income less transfers, real manufacturing and trade sales, and industrial production. Hence, business cycle peaks and troughs are well approximated by the dates of peaks and troughs in the current conditions index (CCI).

Chart 3 demonstrates the close correspondence between the timing of CCI and the chronology of U.S. expansions and contractions. It also shows that the LI leads the CCI at all business cycle peaks and troughs. Finally, it demonstrates that CCI and real GDP, which is the most comprehensive measure of U.S. output, are very closely associated.

While highly correlated with real GDP, CCI has several advantages over GDP as a target measure for testing the new composite leading economic index. The leading index is developed to predict the CCI, which, unlike GDP, is available monthly. CCI is made up of several variables, not just output. Its four components, together, cover all economic activities that are important for our present purposes. GDP is the most comprehensive measure of output but it is subject to long strings of revisions, which are often large; CCI is revised less, partly because the revisions of its components frequently offset each other. Hence, the linkage to the cyclical turning points is closer for CCI than GDP (Zarnowitz, 2001a). For these reasons, our main focus is on the CCI as a measure of current economic activity.

Because of the interest in and importance of real GDP as the most comprehensive economic variable, we performed forecasting exercises using this aggregate, too. Tests of how well LI predicts GDP must first solve the problem of how to transform the two series to common frequencies. One would like to take advantage of the fact that the leading indicators are monthly, but interpolations of quarterly to monthly real GDP can adversely affect the results. This is because they arbitrarily smooth real GDP, which is the series that is used both as the dependent variable and, lagged, as one of the explanatory variables. In the absence of a reliable monthly GDP[12], it is preferable to work with quarterly LI. Although this transformation causes a considerable loss of information, it does not distort the results in any obvious way. Hence, we decided to use quarterly LI in the form of the average observations for each successive quarter.[13] We find that the tests with real GDP and LI are supportive of the new procedure. These results are presented in an appendix.

The problems with using quarterly GDP are the main reason why many studies use industrial production (IP) as the target variable. But IP is only one of the components of CCI, and it covers a relatively small and declining part of the economy (manufacturing, mining, and electric and gas utilities). On the other hand, the use of IP means that transactions in materials and intermediate products are explicitly accounted for in large measure, which is probably appropriate. Hence, we report, in addition to the results for CCI, tests based on the industrial production index. This provides a benchmark of the results for critics who argue that the leading index does not do well when based on real-time data (See Diebold and Rudebusch, 1991).

## 4. HOW WELL DOES THE LEADING INDEX PREDICT?

### 4.1 The Testing Models and Procedures

Before proceeding with our primary task of evaluating the new procedure for estimating the U.S. Leading Index, it is logical to ask whether the old LI adds useful information to forecasts of basic measures of aggregate economy. This is particularly important in light of recent criticisms of the LI as a forecasting tool. At the same time we also investigate the new LI, but absent the timing improvements, which are taken-up in a separate section. This simplifies and clarifies the discussion by allowing us to examine the importance of timing by building on the analysis of the old LI and the new LI, first without and then with taking account of the timeliness issue.

In approaching this issue we use the following standard for our tests: LI should improve on simple autoregressive forecasts for the monthly measures of aggregate activity: CCI or IP. We begin by asking whether the historical leading index improves on the standard forecast. This, of course, is a well-traversed path in the literature with well-expected results.

A much more ambitious task is to construct an out-of-sample, real-time test of whether the leading index improves on the basic autoregressive forecast of aggregate economic activity (changes in CCI). To ensure that the leading indicator data conform to the data available at the time of original publication, we continue to employ the indexes $\hat{LI}^{new}$ and $LI^{old}$ introduced in part 3 above, both of which consist of real-time data for the ten components on the present (1996) list of leading indicators.

[12] The new estimates of monthly GDP by Macroeconomic Advisers, a private forecasting firm, were unavailable to us at the time, and are still limited to the 1990s and not widely accepted.
[13] An alternative transformation might be to use the value of the LI in the final month of each quarter, but we decided against this method because it would ignore the other monthly observations.

Each of the 165 vintages in our real-time sample provides data for a forecast of monthly change in CCI (or IP). The first month in our sample period is December 1988, the last month is August 2002. Thus the sample period provides a series of 165 estimated regressions for each forecast model. Each estimated model is based on observations starting in January 1959 and ending in the following successive months: December 1988, January 1989,..., August 2002.

Forecast regressions have the same structure for each vintage and are used to create a sequence of forecast errors. These forecast errors are summarized by an estimate of a mean square error based on differences between the forecast and the historical values of the corresponding actual growth rates in the target economy-wide aggregate. This procedure is repeated for a series of forecasting exercises that vary the forecast horizons (1,3, 6 months-ahead), spans over which growth is measured in the estimating equation (1,3,6, 9 months) and lags of the forecast variables (1,3, 6, 9).

We use real-time data for LI so as to reproduce fairly the actual forecasting situation for the old and new leading index alike. For CCI, however, we use historical data so this target variable remains the same over all vintages and forecast models. Here we follow the common practice requiring the forecaster to use preliminary estimates to predict data incorporating future revisions in the target variable. This allows a comparison of our results to those of other studies that pursue the same strategy.[14]

<u>The Forecast Models.</u>

The forecast regression models are specified in changes in natural logarithms for both the coincident index and the leading indexes. This is done in order to avoid spuriously high correlations due to common trends that obtain in the levels of the indexes. As noted by Maximo Camacho and Gabriel Perez-Quiros (2002, pp. 62-63), the augmented Dickey-Fuller test cannot reject the null hypothesis of a unit root in the levels of the LI series but is consistent with stationarity of log differences of LI**.** Given the trends in the LI and the even stronger trend in CCI, the use of the change model is most appropriate (See Chart 3). But the monthly changes in CCI are quite volatile and those in LI even more so. Further, the lags of the former behind the latter index tend to be considerably longer than one month, even on average, and particularly long near the peak capacity utilization. Some coordinated extensions of the forecasts horizons and numbers and spans of the growth rates used seemed to be appropriate here, but we opted for a broad range of simple specifications so as to avoid any risks of data or model mining. Combining forecasts 3- and 6- months ahead with 3-, 6- and 9- month growth rates and the same numbers of lagged explanatory terms was deemed reasonably safe and sufficient for our present exploratory purposes.

Let $\Delta_j CCI_t$ denote the growth rate over the past j months ending in month t. The span j is allowed to vary from one to 3, 6, and 9 months. To provide a standard for evaluating the forecasting power of the leading index, a simple autoregressive equation is used in which $\Delta_j CCI_t$ is related to its own lags, $\Delta_j CCI_{t-1}$ to $\Delta_j CCI_{t-k}$, with the number of lagged terms, k, varying from one to 3, 6, and 9.

$$\Delta_j CCI_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1,i} \Delta_j CCI_{t-i-p+1} + \varepsilon_{1,t} \begin{cases} k, j = 1,3,6,9 \\ p = 1,4,7 \end{cases} \tag{3}$$

There follow tests of whether adding lags of the old or new leading index to this equation reduces out-of-sample forecast errors. Equation (4) adds lags of the old index to the benchmark Eq. (3):

$$\Delta_j CCI_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2,i} \Delta_j CCI_{t-i-p+1} + \sum_{i=1}^{k} \delta_{2,i} \Delta_j LI_{t-i-p+}^{old} + \varepsilon_{2,t} \begin{cases} k, j = 1,3,6,9 \\ p = 1,4,7 \end{cases} \tag{4}$$

Equation (5) adds lags of the new leading index instead:

$$\Delta_j CCI_t = \alpha_3 + \sum_{i=1}^{k} \beta_{3,i} \Delta_j CCI_{t-i-p+1} + \sum_{i=1}^{k} \delta_{3,i} \Delta_j LI_{t-i-p+1}^{new} + \varepsilon_{3,t} \begin{cases} k, j = 1,3,6,9 \\ p = 1,4,7 \end{cases} \tag{5}$$

This gives 16 different combinations of the spans of growth rates (j) and number of lags (k) for each of the above three models. We repeat the same exercise for forecasts three and six months ahead (p = 4 and p = 7). This provides us with 48 forecast exercises classified by three factors: the length of forecast horizon, the number of the lagged explanatory terms, and transformation of the data (span of the growth rates).

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[14]See in particular Diebold and Rudebusch (1991). The revised data are believed to be closer to the truth. However, the use of revised data in lagged values of the dependent variable gives the autoregressive element an advantage vis-à-vis the contribution of the leading index term which is based on preliminary data. Assessments of the forecasts thus mix forecasting and measurement errors. This approach makes it more difficult for the LI to improve the forecast.

No effort was made to optimize the predictive regression specifications (this belongs in another paper). Rather, we tried to get a sufficiently comprehensive and diverse picture of what the alternative leading indexes –historical and real time, old and new – can contribute, even under relatively unfavorable conditions. This approach – looking at a broad and symmetric set of models – was modified in one way: Only results for models for which the span of growth in the variables in the model is greater than or equal to the forecast horizon are reported. Longer forecasts are not well served by short growth rates and the use of short spans in the longer forecasts provided unreliable results. Nonetheless, we include these clearly inferior forecast exercises when we calculate the summary MSE's across all the models and forecast horizons.

### 4.2 Out of Sample Forecasts of Changes for Common Forecast Horizons.

Table 3 reports the mean square errors (MSE) for the forecasts which use growth rate spans of one, three, six, and nine months ($j = 1,3,6,9$) and one, three, six, and nine month lags for each explanatory variable ($k = 1,3,6,9$). It covers 36 forecast exercises, 16 for one-month ahead, 12 for 3-month ahead, and 8 for 6- month-ahead forecasts. This covers all possible models where the span of the forecast variables is greater than or equal to the forecast horizon. The reported entries are MSE $x10^5$. The table compares the accuracy of one, three, and six month ahead autoregressive forecasts of changes in CCI (column 4) with the forecast accuracy of models that use, in addition, the lagged changes in LI: the historical, old, and new indexes (columns 5, 6, and 7, respectively).

The equations with the historical index reduce the MSE's in all cases for the six-month ahead forecasts and in all but one case each for the one-month and three-month ahead forecasts (cf. columns 4 and 5). The exceptions are the two shortest forecasts with models that use only one lag. This is consistent with the often-noted view among leading index users that the shortest changes do not produce good forecasts. Nonetheless, the difference between these entries and the corresponding entries in column 4 is very small and probably of low significance. Compared with the old and new real-time leading indexes, the historical index delivers the most accurate forecasts throughout (cf. column 5 with columns 6 and 7).

These findings confirm the prior results and expectations. Earlier studies repeatedly found the historical index to be a good forecasting tool, whereas some questioned the usefulness of the real time indexes. The historical leading index, like the target historical coincident index (CCI), is essentially free of revision (measurement) errors; in contrast, a real-time leading index is preliminary as its critical latest values are subject to revisions. This is true of the new as well as the old real-time index.

Adding the lagged changes in the old index to the autoregressive equations reduces the MSE's in 30 out of the 36 cases (cf. columns 4 and 6). The six adverse results all refer to forecasts with short growth rate spans, mostly of one month. Much the same applies to the equations that include lagged changes in the new index, except that here in two cases MSE's improved among the 6-month forecasts.

What is clear is that the LI reduces forecast errors across most models and forecast horizons. In addition the costs of the new procedure do not appear large, based on a comparison with the MSE's of the old and historical LI. This suggests these costs will be outweighed by the gains to the timeliness of the new index, an issue we turn to next.

### 4.3 More Timeliness Implies a Gain in Forecasting Accuracy

In the last section we neglected the fact that the identity of the target period "one month ahead" means something different for the old index than for the new index, which is much prompter. Here we address this issue explicitly to evaluate the gain from the timelier procedure

The old leading index is one month behind the new one (see section II.B.). For example, Chart 1 shows that the first vintage in our real-time sample gives a new index forecast for January 1989, but the old index based on the same data would predict instead December 1988. To see how this gain in timeliness affects the relative predictive performance of the new LI vs. the old LI, we now evaluate how the two indexes forecast for sequences with the same target periods.[15]

We deal with the problem of using $\Delta_j LI^{old}_{t-2}$ to forecast $\Delta jCCI_t$ in two ways. The first is a direct (one-step) prediction in the regression framework: $\Delta_j LI^{old}_{t-2}$ and $\Delta_j CCI_{t-2}$ are used to jointly predict $\Delta_j CCI_t$ . The second is a two-step prediction: a

[15] Let us restate that this cannot be done with the aid of Table 3, which shows how the two indexes perform over the same forecast horizons but with different target periods.

second-order autoregressive model is employed to estimate $\Delta_j LI^{old}_{t-1}$ and then the latter value, along with $\Delta_j CCI_{t-1}$, is used to predict $\Delta_j CCI_t$. This provides a forecast consistent with the simple autoregressive process used throughout this analysis.

Table 4 retains the format of Table 3 and restates the MSE's for the equations with lagged CCI and $LI^{new}$ terms. As would be expected, using the equations with $\Delta_j LI^{old}_{t-2}$ to predict $\Delta_j CCI_t$ instead of $\Delta_j CCI_{t-1}$ results mostly in substantially higher errors. The MSE's in Table 3, column 6, are lower than their counterparts in Table 4, column 5 and 6, in 67 out of 72 cases (they lose out to the direct forecasts in lines 1-4, and to the two-step forecasts in line 1). Whereas the predictions with the old index terms are entirely competitive in Table 3, they are clearly not in Table 4, where the new index outperforms the old index heavily.

A comparison of the direct and two-step forecasts with the old index discloses a very mixed picture (cf. columns 5 and 6). For forecasts three months ahead, the two-step ahead predictions are more accurate, but for the shorter forecast horizon, the direct predictions tend to be more accurate. For the longer horizon, the picture is mixed, with the two-step dominating for the 9-month and the direct for the 6-month spans. The overall score here is even, 18 for the direct and 18 for the two-step forecasts.

Table 5 confirms for all of our real-time out-of-sample forecasts of log changes in the U.S. Current Conditions Index between 1989-2002 that the U.S. Leading Index improves on the autoregressive benchmark model. The overall MSE's (averages for 16 models) are lower for the regressions with lagged CCI and LI terms than for the regressions with lagged CCI terms only. This is true for one-month, three-month, and six-month ahead predictions alike, and not only for the historical index (column 2) but even for the real-time new index (column 3) and old index when differences in the targeted calendar months are ignored (column 4). Only when the same calendar months are targeted do the MSE's of the equations using the old index data exceed the autoregressive benchmark MSE's (cf. cols. 5 and 6 with col. 1). The average standard deviations show much the same relations as the average MSE's (see the entries in parentheses). To facilitate the comparisons, Table 5 provides also the ratios of the MSE's of the models with the LI terms to the autoregressive model.

We conclude that there can be no doubt about the incremental (net) predictive content of the leading index, even when its preliminary real-time data are used to forecast the "final" or "true" data for the coincident index. Section IV.E shows the same for the forecasts of other measures of the industrial production index. The contrary findings in the literature are, we strongly suspect, explained by the use of leading indexes that incorporate definitional (composition) changes rather.

### 4.4 More on the Properties of Forecasts with Leading Indicators

The two basic findings of our study, then, are: (1) the leading indicators, properly selected and collected in an index, convey significant predictive information about the economy's change in the next several months, beyond what can be learned from the economy's recent past. (2) The new index is dramatically more accurate than the old index in forecasting growth of CCI in the same impending target months. In addition, our results inspire confidence because they make sense in the light of what is known from many past studies about some tendencies common in short-term economic forecasts.

Thus, a very general property here is perhaps the simplest one: the longer the forecast horizon, the larger the error. Tables 3 and 4 clearly conform to this rule when one compares forecasts with all but the shortest growth rate spans (compare the one, three, and six-month horizons). We would also expect that the larger the number of explanatory (lagged) terms, the smaller generally will be the MSE's. This effect also tends to be a characteristic of Tables 3 and 4.

We also observe that, given the forecast horizon and lags, MSE's generally increase with the span in months over which the growth rates are calculated. This is a very strong tendency, in the range of 20-80 percent. This is true for each of the four models covered in columns 4-7.

Such a steep rise in the errors may seem alarming, but in fact it is not and has an easy explanation. The longer its span (j), the larger is the growth rate $\Delta_j CCI_t$ reflecting the economy's upward trend. The means of $\Delta_1$, $\Delta_3$, $\Delta_6$, and $\Delta_9$ for our dependent variable are 0.0021, 0.0066, 0.0132, and 0.0220, respectively. Thus, $\Delta_j CCI$ grows a little faster in size than in length, e.g., $\Delta_6$, is 6.3 times $\Delta_1$ and $\Delta_9$ is 10.5 times $\Delta_1$. This is a faster progression than that of the corresponding MSE's. Hence the errors actually tend to <u>decrease</u> in relative terms, while <u>increasing</u> in absolute terms. Table 6 uses of the ratios of root mean square errors of the forecasts to the means of $\Delta_j CCI$ to show that the so measured relative MSE's drop steadily as j and k increase. The declines are surprisingly large and uniform for the different forecast horizons and models. This tempers the first impression that increases in the spans of change and the number of lagged terms affect the accuracy of the forecasts adversely.

### 4.5 The Leading Index Also Helps to Predict Industrial Production

In European countries, it is mainly the index of industrial production that is used as the principal target of leading index forecasts, and some U.S. analysts prefer it as well (despite the fact that it is narrow, declining in coverage, and itself only one of the components of CCI). For comparability with this work, therefore, we add Tables 7 and 8, which parallel for U.S. industrial production what Tables 3 and 4 show, respectively, for CCI. The findings are very similar.

Table 7 shows that the historical LI improves on the autoregressive benchmark forecasts in all but two of the 36 cases listed. (There are no Xs in columns 5, 6, and 7, respectively). This is very similar to the forecasts of CCI growth (see Table 3 and section IV.B above). The good representation of manufacturing by the leading indicators tends to favor forecasts of industrial production; the processes of component selection and construction of LI may be favoring the forecasts of CCI.

Table 8 shows that the old index performs generally much worse than the new index when the same calendar month is targeted by both. As indicated by the Xs, the direct forecasts with $LI^{old}$ yield larger MSE's than their counterparts with $LI^{new}$ in all but two of the 36 cases (note that the exceptions are six-month forecasts with short growth rates; see column 5). For the two-step forecasts with $LI^{old}$, the score is 32 worse than the forecasts with $LI^{new}$ and four better (all of the latter looking six-months ahead; see column 6). Once more, all of this parallels the results for the CCI predictions reported in Table 4.

## 5. CONCLUDING THOUGHTS

The new procedure for calculating the U.S. Leading Index combines seven current financial and non-financial indicators with simple forecasts of three other indicators that are only available with lags. This makes the new index much timelier and demonstrably superior to the old index with the same components. The latter had eschewed forecasting but at the expense of being less complete, less timely, and less accurate for its targets. We show this directly by evaluating forecasts for the same calendar months with both the new and old index. The more efficient and more complete use of the available data, along with a workable procedure to fill temporarily the gaps due to missing data, combine to provide a better leading index.

Aside from the gains to the new procedure, the analysis also shows, using real time out-of-sample evaluation methods, that the index of leading indicators provides useful forecasting information. This appears to contradict the empirical evidence from several recent studies that find fault with the ex ante performance of the composite index of leading economic indicators.

*A priori* we expected that the poor real time performance found by some researchers might have been caused by the leading index not having been as up-to-date as the financial indicators. The old procedure for calculating the index left out the most recent financial data, which are likely to provide first signals of weakening and downturns in profits and early investment and credit commitments.[16] The real-time out-of-sample tests presented in this paper show that the new more timely leading index contains useful ex-ante information for predicting fluctuations in economic activity.

We expect the leading index to do better than a few components because the sources and profiles of business cycles differ over time. This means that a leading index that contains both the financial and the real indicators should be better than its individual components over time, and according to many historical tests actually is. The more comprehensive and diversified, and the better selected, its components, the more effective the index. In some periods, financial indicators outperform real activity indicators in their ability to lead; in other periods, the opposite is the case. Thus, it is unlikely that the composite index would be inferior to its financial sub-index over more than short periods.

A full examination of this issue is well beyond the scope of this paper. We are now beginning a deeper investigation of the problem of how to use the indicators best by extending the sample periods to include more cyclical events and concentrate on recessions and recoveries; also by improving the specifications of our forecasting models. We are also extending the examination to countries outside the United States. But in light of our results to date, we conclude that our expectation that the composite index methodology provides a useful tool for predicting and assessing business cycles is still a very viable hypothesis.

[16] On the empirics and theory of interconnected movements in real, financial, and expectational variables, see Zarnowitz (1999), esp. 80-82; also Evans, et al. (1998).

**APPENDIX: THE LEADING INDEX ALSO HELPS TO PREDICT REAL GDP**

Many economists prefer real GDP as the broadest and comprehensive measure of aggregate economic activity. Although, as discussed above, the coincident index (CCI) as a monthly measure of economic activity is highly correlated with real GDP and has some advantages over real GDP, we also repeated our tests to see if the leading index helps to predict growth in real GDP. For completeness, therefore, this appendix presents Table A1, which parallels Table 3 in the text. In order to perform our tests with real GDP we transformed LI into the quarterly frequency by taking the average of monthly observations within a quarter as noted in section III.D of the paper. This avoids problems with interpolating real GDP to make it monthly and uses all available LI information in a given quarter. The forecasting exercises are analogous to those presented in section IV.A. The findings are very similar to those reported earlier in the paper.

Let $\Delta_j RGDP_t$ denote the growth rate over the past j quarters ending in quarter t. The span j is allowed to vary from one to 2, 3, and 4 quarters. To provide a standard for evaluating the forecasting power of the leading index, a simple autoregressive equation is used in which $\Delta_j RGDP_t$ is related to its own lags, $\Delta_j RGDP_{t-1}$ to $\Delta_j RGDP_{t-k}$, with the number of lagged terms, k, varying from one to 2, 3, and 4.

$$\Delta_j RGDP_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1,i} \Delta_j RGDP_{t-i-p+1} + \varepsilon_{1,t} \begin{cases} k, j = 1,2,3,4 \\ p = 1,3,4 \end{cases} \quad \text{(A1)}$$

There follow tests of whether adding lags of the old or new leading index to this equation reduces out-of-sample forecast errors. Equation (A2) adds lags of the old index to the benchmark Eq. (A1):

$$\Delta_j RGDP_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2,i} \Delta_j RGDP_{t-i-p+1} + \sum_{i=1}^{k} \delta_{2,i} \Delta_j LI_{t-i-p+}^{old} + \varepsilon_{2,t} \begin{cases} k, j = 1,2,3,4 \\ p = 1,3,4 \end{cases} \quad \text{(A2)}$$

Equation (A3) adds lags of the new leading index instead:

$$\Delta_j RGDP_t = \alpha_3 + \sum_{i=1}^{k} \beta_{3,i} \Delta_j RGDP_{t-i-p+1} + \sum_{i=1}^{k} \delta_{3,i} \Delta_j LI_{t-i-p+1}^{new} + \varepsilon_{3,t} \begin{cases} k, j = 1,2,3,4 \\ p = 1,3,4 \end{cases} \quad \text{(A3)}$$

This gives 16 different combinations of the spans of growth rates (j) and number of lags (k) for each of the above three models. We repeat the same exercise for forecasts two and three quarters ahead (p = 3 and p = 4). This provides us with 48 forecast exercises classified by three factors: the length of forecast horizon, the number of the lagged explanatory terms, and transformation of the data (span of the growth rates).

Table A1 reports the mean square errors (MSE) for the forecasts which use growth rate spans of one, two, three and four quarters and one, two, three and four quarter lags for each explanatory variable. It covers 36 forecast exercises, 16 for one-quarter ahead, 12 for 3-quarter ahead, and 8 for 3-quarter-ahead forecasts. This covers all possible models where the span of the forecast variables is greater than or equal to the forecast horizon. The reported entries are MSE x$10^5$. The table compares the accuracy of one, two, and three quarter ahead autoregressive forecasts of changes in real GDP (column 4) with the forecast accuracy of models that use, in addition, the lagged changes in LI: the historical, old, and new indexes (columns 5, 6, and 7, respectively).

The equations with the historical index reduce the MSE's in all cases for the two- and three-quarter ahead forecasts and in all but two cases for the one-quarter ahead forecasts (cf. columns 4 and 5). As before, compared with the old and new real-time leading indexes, the historical index delivers the most accurate forecasts throughout (cf. column 5 with columns 6 and 7).

Adding the lagged changes in the old index to the autoregressive equations reduces the MSE's in 27 out of the 36 cases (cf. columns 4 and 6). The nine adverse results all refer to the shortest, i.e., one-quarter ahead forecasts, and all use the shortest, i.e., one and two quarter growth rates. Much the same applies to the equations that include lagged changes in the new index, where adding the lagged changes in the old index to the autoregressive equations reduces the MSE's in 28 out of the 36 cases (cf. columns 4 and 7).

The LI reduces forecast errors across most models and forecast horizons. In addition, the reductions in MSE's when the new index is used are slightly better in almost all cases (cf. columns 6 and 7) suggesting the new procedure has improved the information content of the LI.

**Table A1: Out-of Sample Forecasts of Quarterly Growth Rates in RGDP, U.S. 1989- 2002: Contribution of Autoregression and the Leading Index***

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of RGDP, LI (1 to k) | Mean Square Errors (MSE) for Model with Lagged Terms in | | | |
|---|---|---|---|---|---|---|
| | | | RGDP only | RGDP and $LI^h$ (historical index) | RGDP and $LI^{old}$ (real-time, old index) | RGDP and $LI^{new}$ (real-time, more timely index) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | | | **One Quarter Ahead Forecasts** | | |
| 1 | 1 | 1 | 2.919 | 2.929* | 3.134* | 3.109* |
| 2 | 1 | 2 | 2.805 | 2.763 | 3.038* | 2.966* |
| 3 | 1 | 3 | 2.817 | 2.680 | 2.955* | 2.865* |
| 4 | 1 | 4 | 2.795 | 2.675 | 2.941* | 2.868* |
| 5 | 2 | 1 | 4.043 | 3.955 | 4.425* | 4.217* |
| 6 | 2 | 2 | 3.666 | 3.864* | 4.313* | 4.168* |
| 7 | 2 | 3 | 3.395 | 3.321 | 3.634* | 3.537* |
| 8 | 2 | 4 | 3.334 | 3.177 | 3.455* | 3.381* |
| 9 | 3 | 1 | 5.251 | 4.207 | 4.434 | 4.238 |
| 10 | 3 | 2 | 4.833 | 4.008 | 4.330 | 4.113 |
| 11 | 3 | 3 | 4.456 | 3.899 | 4.336 | 4.111 |
| 12 | 3 | 4 | 3.900 | 3.550 | 3.973* | 3.777 |
| 13 | 4 | 1 | 5.624 | 4.391 | 4.430 | 4.362 |
| 14 | 4 | 2 | 4.753 | 4.146 | 4.224 | 4.209 |
| 15 | 4 | 3 | 4.448 | 4.037 | 4.126 | 4.112 |
| 16 | 4 | 4 | 4.523 | 4.118 | 4.223 | 4.216 |
| | | | | **Two Quarter Ahead Forecasts** | | |
| 17 | 2 | 1 | 7.806 | 7.053 | 7.477 | 7.269 |
| 18 | 2 | 2 | 7.762 | 7.023 | 7.606 | 7.319 |
| 19 | 2 | 3 | 7.783 | 6.965 | 7.457 | 7.234 |
| 20 | 2 | 4 | 7.859 | 6.910 | 7.271 | 7.060 |
| 21 | 3 | 1 | 11.257 | 9.445 | 9.883 | 9.362 |
| 22 | 3 | 2 | 9.563 | 8.513 | 9.296 | 8.746 |
| 23 | 3 | 3 | 9.608 | 8.113 | 8.959 | 8.384 |
| 24 | 3 | 4 | 9.633 | 8.369 | 9.241 | 8.743 |
| 25 | 4 | 1 | 13.771 | 10.471 | 10.536 | 10.167 |
| 26 | 4 | 2 | 10.949 | 9.115 | 9.278 | 9.005 |
| 27 | 4 | 3 | 10.705 | 9.127 | 9.323 | 9.086 |
| 28 | 4 | 4 | 10.581 | 9.307 | 9.426 | 9.273 |
| | | | | **Three Quarter Ahead Forecasts** | | |
| 29 | 3 | 1 | 16.368 | 14.623 | 14.595 | 14.234 |
| 30 | 3 | 2 | 16.217 | 13.879 | 14.115 | 13.581 |
| 31 | 3 | 3 | 16.665 | 14.013 | 14.582 | 14.024 |
| 32 | 3 | 4 | 16.945 | 14.672 | 15.274 | 14.845 |
| 33 | 4 | 1 | 21.795 | 18.571 | 18.735 | 18.172 |
| 34 | 4 | 2 | 18.892 | 16.680 | 17.035 | 16.614 |
| 35 | 4 | 3 | 19.216 | 16.726 | 17.094 | 16.679 |
| 36 | 4 | 4 | 19.077 | 17.210 | 17.546 | 17.239 |

*NOTE: LI converted to quarterly frequency by using average of three months as the quarterly observation. $MSE = \frac{\sum_{t=1}^{n} e_t^2}{n}$, t = 1,...,55. Because $e_t^2$ are very small, the entries in columns 4-7 show MSEx$10^5$. The x's denote the cases where the models with lagged $LI^{old}$ and $LI^{new}$ terms are less accurate than the autoregressive model, that is, where the entries in columns 4 and 6 are smaller than the corresponding entries in column 4.

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**Table 1: Data Availability and Old/New Index Publication Schedules: An Example**

| Line | Indicator Series[a] | | Available in March: Data for | | Included in March Publication Data for | |
|---|---|---|---|---|---|---|
| | | | January | February | January $I_t^{Old}$ | February $\hat{I}_t^{New}$ |
| (1) | (2) | | (3) | (4) | (5) | (6) |
| **1** | **New orders, consumer goods and materials** | $Y_1$ | Yes | No | Yes | Yes (Estimated) |
| **2** | **New orders, nondefense capital goods** | $Y_2$ | Yes | No | Yes | Yes (Estimated) |
| **3** | **Money supply, M2** | $Y_3$ | Yes | No | Yes | Yes (Estimated) |
| **4** | **Average weekly hours, manufacturing** | $X_1$ | Yes | Yes | Yes | Yes |
| **5** | **Ave. weekly initial claims for unemp. insurance** | $X_2$ | Yes | Yes | Yes | Yes |
| **6** | **Vendor perf., slower deliveries diffusion index** | $X_3$ | Yes | Yes | Yes | Yes |
| **7** | **Building permits, new private housing units** | $X_4$ | Yes | Yes | Yes | Yes |
| **8** | **Stock prices, 500 common stocks** | $X_5$ | Yes | Yes | Yes | Yes |
| **9** | **Interest rate spread** | $X_6$ | Yes | Yes | Yes | Yes |
| **10** | **Index of consumer expectations** | $X_7$ | Yes | Yes | Yes | Yes |

[a] Each series is identified with title first and by symbol second. Series in lines 1,2 ,and 3 are in constant 1996 dollars, calculated by The Conference Board using chain weighted price deflators. Series 5 is used in inverted form. The series are seasonally adjusted, except those that do not require seasonal adjustment (e.g., the S&P 500 stock price index). For complete information, including sources, see The Conference Board Business Cycle Indicators Handbook (2001).

**Table 2**
**Dates of Cyclical Turns in Old and New Leading Indexes, Six Selected Vintages, 1960 – 2002**

| **Line** (1) | **Vintages** (2) | **Trough** (3) | **Peak** (4) |
|---|---|---|---|
| 1 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 3/1960 | 3/1966 |
| 2 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 3/1967 | 1/1969 |
| 3 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 4/1970[a] | 2/1973[b] |
| 4 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 2/1975 | 4/1978 |
| 5 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 4/1980 | 10/1980 |
| 6 | Jan-89, Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 3/1982[c] | 6/1988 |
| 7 | Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 6/1989[d] | 1/1990 |
| 8 | Nov-91, Jul-98, Mar-00, Jun-02, Aug-02 | 1/1991 | 12/1994 |
| 9 | Jul-98, Mar-00, Jun-02, Aug-02 | 5/1995 | 1/2000 |
| 10 | Aug-02 | 3/2001 | |

[a] For both the old and the new indexes, the January 1989 series show a trough in October 1970, not April 1970. This exception reflects a double-trough pattern and a revision shifting the low from October to April.
[b] For both the old and the new indexes, the January 1989 and the November 1991 vintage series have peaks in January 1973, not February 1973.
[c] For both the old and the new indexes, the January 1989 series show troughs in January 1982, not March 1982.
[d] For both the old and the new indexes, the November 1991 vintage series have troughs in July 1989, not June 1989.

**Table 3**
**Out-of Sample Forecasts of Growth in the Current Conditions Index, U.S. Jan. 1989- Sep.2002: Contribution of Autoregression and the Leading Index**

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of CCI, LI (1 to k) | Mean Square Errors (MSE) for Model with Lagged Terms in: CCI only | CCI and $LI^h$ (historical index) | CCI and $LI^{old}$ (real-time, old index) | CCI and $LI^{new}$ (real-time, more timely index) |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | | **One Month Ahead Forecasts** | | | |
| 1 | 1 | 1 | 0.863 | $0.873^x$ | $0.877^x$ | 0.863 |
| 2 | 1 | 3 | 0.747 | 0.732 | $0.752^x$ | 0.739 |
| 3 | 1 | 6 | 0.764 | 0.719 | 0.733 | 0.729 |
| 4 | 1 | 9 | 0.770 | 0.713 | 0.723 | 0.719 |
| 5 | 3 | 1 | 1.044 | 1.022 | $1.063^x$ | $1.061^x$ |
| 6 | 3 | 3 | 1.090 | 1.074 | $1.104^x$ | $1.102^x$ |
| 7 | 3 | 6 | 0.953 | 0.904 | 0.939 | 0.940 |
| 8 | 3 | 9 | 0.949 | 0.882 | 0.907 | 0.905 |
| 9 | 6 | 1 | 1.207 | 1.099 | 1.133 | 1.121 |
| 10 | 6 | 3 | 1.299 | 1.180 | 1.202 | 1.193 |
| 11 | 6 | 6 | 1.351 | 1.235 | 1.282 | 1.271 |
| 12 | 6 | 9 | 0.929 | 0.850 | 0.879 | 0.867 |
| 13 | 9 | 1 | 1.500 | 1.333 | 1.361 | 1.356 |
| 14 | 9 | 3 | 1.543 | 1.369 | 1.386 | 1.381 |
| 15 | 9 | 6 | 1.566 | 1.397 | 1.388 | 1.392 |
| 16 | 9 | 9 | 1.574 | 1.369 | 1.339 | 1.337 |
| | | | | | **Three Month Ahead Forecasts** | |
| 17 | 3 | 1 | 2.436 | $2.486^x$ | $2.663^x$ | $2.656^x$ |
| 18 | 3 | 3 | 2.608 | 2.440 | $2.629^x$ | $2.622^x$ |
| 19 | 3 | 6 | 2.561 | 2.281 | 2.459 | 2.462 |
| 20 | 3 | 9 | 2.549 | 2.088 | 2.272 | 2.284 |
| 21 | 6 | 1 | 3.549 | 3.058 | 3.283 | 3.315 |
| 22 | 6 | 3 | 3.393 | 2.942 | 3.188 | 3.196 |
| 23 | 6 | 6 | 2.999 | 2.675 | 2.868 | 2.874 |
| 24 | 6 | 9 | 2.913 | 2.430 | 2.592 | 2.576 |
| 25 | 9 | 1 | 4.734 | 3.517 | 3.696 | 3.745 |
| 26 | 9 | 3 | 4.488 | 3.435 | 3.642 | 3.689 |
| 27 | 9 | 6 | 4.321 | 3.398 | 3.600 | 3.643 |
| 28 | 9 | 9 | 3.968 | 3.174 | 3.333 | 3.381 |
| | | | | | **Six Month Ahead Forecasts** | |
| 29 | 6 | 1 | 8.172 | 7.768 | 8.039 | $8.214^x$ |
| 30 | 6 | 3 | 8.174 | 7.537 | 7.904 | $8.208^x$ |
| 31 | 6 | 6 | 8.088 | 7.182 | 7.422 | 7.703 |
| 32 | 6 | 9 | 8.381 | 7.124 | 7.164 | 7.404 |
| 33 | 9 | 1 | 11.713 | 9.385 | 9.362 | 9.583 |
| 34 | 9 | 3 | 10.598 | 8.585 | 8.811 | 9.030 |
| 35 | 9 | 6 | 10.387 | 8.336 | 8.457 | 8.717 |
| 36 | 9 | 9 | 10.473 | 8.369 | 8.462 | 8.729 |

Note: $MSE = \frac{\sum_{t=1}^{n} e_t^2}{n}$, t = 1,...,165. Because $e_t^2$ are very small, the entries in columns 4-7 show MSEx$10^5$. The x's denote the cases where the models with lagged $LI^{old}$ and $LI^{new}$ terms are less accurate than the autoregressive model, that is, where the entries in columns 4 and 6 are smaller than the corresponding entries in column 4. All the differences between MSE's in column 4 and either column 5, 6 or 7 for one month ahead forecasts are significant at the 5 % level based on the encompassing test statistic (ENC_NEW) developed by Clark and McCracken (2001) to test for one-step ahead forecast accuracy in nested models. The test statistic is not applicable to 3 and 6-month ahead forecasts, but research is underway to develop the appropriate tests for multi-step ahead forecasts.

**Table 4**
**Comparable Forecasts of Growth in the Current Conditions Index Are More Accurate for the New Index Than for the Old Index, Jan. 1989- Sep.2002**

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of CCI, LI (1 to k) | Mean Square Errors (MSE)[a] For Model with Lagged Terms in | | |
|---|---|---|---|---|---|
| | | | CCI and $LI^{new}$ [b] | CCI and $LI^{old}$ Direct | CCI and $LI^{old}$ Two-Step |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | | | One Month Ahead Forecasts | | |
| 1 | 1 | 1 | 0.863 | 0.724[x] | 0.816[x] |
| 2 | 1 | 3 | 0.739 | 0.702[x] | 0.760 |
| 3 | 1 | 6 | 0.729 | 0.716[x] | 0.780 |
| 4 | 1 | 9 | 0.719 | 0.691[x] | 0.752 |
| 5 | 3 | 1 | 1.061 | 1.709 | 1.230 |
| 6 | 3 | 3 | 1.102 | 1.753 | 1.474 |
| 7 | 3 | 6 | 0.940 | 1.601 | 1.383 |
| 8 | 3 | 9 | 0.905 | 1.428 | 1.452 |
| 9 | 6 | 1 | 1.121 | 1.940 | 1.472 |
| 10 | 6 | 3 | 1.193 | 1.985 | 1.632 |
| 11 | 6 | 6 | 1.271 | 1.942 | 1.705 |
| 12 | 6 | 9 | 0.867 | 1.568 | 1.745 |
| 13 | 9 | 1 | 1.356 | 2.204 | 1.724 |
| 14 | 9 | 3 | 1.381 | 2.188 | 1.761 |
| 15 | 9 | 6 | 1.392 | 2.272 | 1.785 |
| 16 | 9 | 9 | 1.337 | 2.068 | 1.814 |
| | | | Three Month Ahead Forecasts | | |
| 17 | 3 | 1 | 2.656 | 2.870 | 3.164 |
| 18 | 3 | 3 | 2.622 | 2.813 | 3.057 |
| 19 | 3 | 6 | 2.462 | 2.632 | 2.755 |
| 20 | 3 | 9 | 2.284 | 2.409 | 2.492 |
| 21 | 6 | 1 | 3.315 | 4.929 | 5.111 |
| 22 | 6 | 3 | 3.196 | 4.944 | 5.761 |
| 23 | 6 | 6 | 2.874 | 4.346 | 5.711 |
| 24 | 6 | 9 | 2.576 | 3.874 | 5.516 |
| 25 | 9 | 1 | 3.745 | 5.252 | 5.900 |
| 26 | 9 | 3 | 3.689 | 5.167 | 6.630 |
| 27 | 9 | 6 | 3.643 | 4.990 | 6.462 |
| 28 | 9 | 9 | 3.381 | 4.647 | 6.602 |
| | | | Six Month Ahead Forecasts | | |
| 29 | 6 | 1 | 8.214 | 8.514 | 9.264 |
| 30 | 6 | 3 | 8.208 | 8.367 | 7.103 |
| 31 | 6 | 6 | 7.703 | 8.017 | 6.893 |
| 32 | 6 | 9 | 7.404 | 7.927 | 6.662 |
| 33 | 9 | 1 | 9.583 | 11.631 | 12.290 |
| 34 | 9 | 3 | 9.030 | 11.072 | 11.900 |
| 35 | 9 | 6 | 8.717 | 10.510 | 12.227 |
| 36 | 9 | 9 | 8.729 | 10.971 | 13.325 |

Note: $MSE = \frac{\sum_{t=1}^{n} e_t^2}{n}$, t = 1,...,165. Because $e_t^2$ are very small, the entries in columns 4-6 show MSEx$10^5$. The entries in column 4 are identical to those in Table 3, column 7. The x's denote the cases where the models with lagged $LI^{old}$ terms are more accurate than the models with lagged $LI^{new}$ terms, that is, where the entries in columns 5 and 6 are smaller than the corresponding entries in column 4.

**Table 5**
**Out of Sample Forecasts of Log Changes in the U.S. Current Conditions Index, All 16 Models: A Summary: January 1989- August 2002**

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| | **Forecast Horizon (Number of Months Ahead)** | Lagged Dependent Variables Used in the Regression Model | | | | | |
| | | | | | **CCI and $LI^{old}$** | | |
| | | **CCI only** | **CCI and $LI^{h}$** | **CCI and $LI^{new}$** | **Different targets** | **Same Target** | |
| **Line** | | | | | | **Direct Forecast** | **Two-step forecast** |
| **1** | **One Month** | 1.134 (0.303) | 1.047 (0.245) | 1.061 (0.243) | 1.067 (0.242) | 1.593 (0.578) | 1.393 (0.401) |
| **2** | **Three Months** | 2.718 (1.375) | 2.305 (1.024) | 2.470 (1.107) | 2.305 (1.024) | 3.249 (1.747) | 3.901 (2.292) |
| **3** | **Six Months** | 5.711 (4.117) | 4.980 (3.304) | 5.225 (3.472) | 5.083 (3.365) | 5.819 (4.167) | 5.932 (4.648) |
| | | **MSE Ratio to Autoregressive Model** | | | | | |
| **4** | **One Month** | 1.000 | 0.923 | 0.936 | 0.941 | 1.405 | 1.228 |
| **5** | **Three Months** | 1.000 | 0.848 | 0.909 | 0.848 | 1.185 | 1.435 |
| **6** | **Six Months** | 1.000 | 0.872 | 0.915 | 0.890 | 1.019 | 1.039 |
| | | **Percent of models with smaller MSE's than the autoregressive model** | | | | | |
| **7** | **One Month** | - | 93.75 | 87.50 | 75.00 | - | - |
| **8** | **Three Months** | - | 93.75 | 62.50 | 56.25 | - | - |
| **9** | **Six Months** | - | 62.50 | 43.75 | 62.50 | - | - |

Note: The entries in lines 1, 2, and 3 are averages of the MSE's in each category; those in parentheses are the corresponding average standard deviations. The entries in lines 4, 5, and 6 are ratios: the average MSE in each class is divided by its counterpart for autoregressive model (set equal to 1.000 in column 3). The entries in 7, 8, and 9 (columns 4, 5, and 6) are percentages of the regression models in each category with MSE's smaller than those of the autoregressive benchmark model.

**Table 6**
**Relative Errors of Out-of-Sample Forecasts of Growth in the Current Conditions Index, U.S.**
**Jan. 1989- Sep.2002:**

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of CCI, LI (1 to k) | For Model with Lagged Terms in | | | |
|---|---|---|---|---|---|---|
| | | | **CCI only** | **CCI and $LI^h$** (historical index) | **CCI and $LI^{old}$** (real-time, old index) | **CCI and $LI^{new}$** (real-time, more timely index) |
| **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| | | | **One Month Ahead Forecasts** | | | |
| 1 | 1 | 1 | 1.328 | 1.335 x | 1.338 x | 1.328 |
| 2 | 1 | 3 | 1.235 | 1.223 | 1.239 x | 1.229 |
| 3 | 1 | 6 | 1.249 | 1.212 | 1.224 | 1.220 |
| 4 | 1 | 9 | 1.254 | 1.207 | 1.215 | 1.212 |
| 5 | 3 | 1 | 0.488 | 0.483 | 0.493 x | 0.492 x |
| 6 | 3 | 3 | 0.499 | 0.495 | 0.502 x | 0.501 x |
| 7 | 3 | 6 | 0.466 | 0.454 | 0.463 | 0.463 |
| 8 | 3 | 9 | 0.465 | 0.449 | 0.455 | 0.454 |
| 9 | 6 | 1 | 0.264 | 0.252 | 0.256 | 0.255 |
| 10 | 6 | 3 | 0.274 | 0.261 | 0.264 | 0.263 |
| 11 | 6 | 6 | 0.279 | 0.267 | 0.272 | 0.271 |
| 12 | 6 | 9 | 0.232 | 0.222 | 0.225 | 0.224 |
| 13 | 9 | 1 | 0.176 | 0.166 | 0.167 | 0.167 |
| 14 | 9 | 3 | 0.178 | 0.168 | 0.169 | 0.169 |
| 15 | 9 | 6 | 0.180 | 0.170 | 0.169 | 0.169 |
| 16 | 9 | 9 | 0.180 | 0.168 | 0.166 | 0.166 |
| | | | | **Three Month Ahead Forecasts** | | |
| 17 | 3 | 1 | 0.746 | 0.753 x | 0.780 x | 0.778 x |
| 18 | 3 | 3 | 0.771 | 0.746 | 0.775 x | 0.773 x |
| 19 | 3 | 6 | 0.764 | 0.721 | 0.749 | 0.750 |
| 20 | 3 | 9 | 0.763 | 0.690 | 0.720 | 0.722 |
| 21 | 6 | 1 | 0.453 | 0.420 | 0.436 | 0.438 |
| 22 | 6 | 3 | 0.443 | 0.412 | 0.429 | 0.430 |
| 23 | 6 | 6 | 0.416 | 0.393 | 0.407 | 0.408 |
| 24 | 6 | 9 | 0.410 | 0.375 | 0.387 | 0.386 |
| 25 | 9 | 1 | 0.312 | 0.269 | 0.276 | 0.278 |
| 26 | 9 | 3 | 0.304 | 0.266 | 0.274 | 0.276 |
| 27 | 9 | 6 | 0.298 | 0.264 | 0.272 | 0.274 |
| 28 | 9 | 9 | 0.286 | 0.256 | 0.262 | 0.264 |
| | | | | **Six Month Ahead Forecasts** | | |
| 29 | 6 | 1 | 0.687 | 0.670 | 0.682 | 0.689 x |
| 30 | 6 | 3 | 0.687 | 0.660 | 0.676 | 0.689 x |
| 31 | 6 | 6 | 0.684 | 0.644 | 0.655 | 0.667 |
| 32 | 6 | 9 | 0.696 | 0.642 | 0.643 | 0.654 |
| 33 | 9 | 1 | 0.491 | 0.440 | 0.439 | 0.444 |
| 34 | 9 | 3 | 0.467 | 0.420 | 0.426 | 0.431 |
| 35 | 9 | 6 | 0.462 | 0.414 | 0.417 | 0.424 |
| 36 | 9 | 9 | 0.464 | 0.415 | 0.417 | 0.424 |

Note: The entries in column 4-7 represent ratios of root mean square errors of the forecasts to the means of the dependent variable ($\Delta_j CCI_t$). The x's mark the cases where the relative errors are on the average smaller for the autoregressive model than for the model with the lagged leading index terms. The x's in this table are in the same positions as in the corresponding Table 3; but note that these differences tend to be small and of doubtful significance.

**Table 7**
**Out-of Sample Forecasts of Growth in the Industrial Production Index, U.S. Jan. 1989- Sep.2002: Contribution of Autoregression and the Leading Index**

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of IP, LI (1 to k) | Mean Square Errors (MSE) for Model with Lagged Terms in: IP only | IP and $LI^{h}$ (historical index) | IP and $LI^{old}$ (real-time, old index) | IP and $LI^{new}$ (real-time, more timely index) |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| | | | | **One Month Ahead Forecasts** | | |
| 1 | 1 | 1 | 2.639 | 2.636 | 2.633 | 2.577 |
| 2 | 1 | 3 | 2.533 | 2.235 | 2.261 | 2.247 |
| 3 | 1 | 6 | 2.602 | 2.329 | 2.350 | 2.354 |
| 4 | 1 | 9 | 2.586 | 2.224 | 2.211 | 2.225 |
| 5 | 3 | 1 | 3.558 | 2.971 | 3.032 | 3.054 |
| 6 | 3 | 3 | 3.657 | 3.309 | 3.374 | 3.369 |
| 7 | 3 | 6 | 3.338 | 2.936 | 2.972 | 2.989 |
| 8 | 3 | 9 | 2.899 | 2.501 | 2.512 | 2.520 |
| 9 | 6 | 1 | 4.773 | 3.746 | 3.775 | 3.770 |
| 10 | 6 | 3 | 4.776 | 3.961 | 3.993 | 4.006 |
| 11 | 6 | 6 | 4.948 | 4.115 | 4.118 | 4.120 |
| 12 | 6 | 9 | 3.641 | 2.970 | 3.009 | 3.009 |
| 13 | 9 | 1 | 4.394 | 3.440 | 3.509 | 3.470 |
| 14 | 9 | 3 | 4.144 | 3.423 | 3.458 | 3.461 |
| 15 | 9 | 6 | 3.994 | 3.458 | 3.440 | 3.442 |
| 16 | 9 | 9 | 4.055 | 3.537 | 3.412 | 3.410 |
| | | | | **Three Month Ahead Forecasts** | | |
| 17 | 3 | 1 | 10.642 | 9.216 | 9.579 | 9.719 |
| 18 | 3 | 3 | 10.941 | 9.567 | 9.888 | 9.970 |
| 19 | 3 | 6 | 10.480 | 8.703 | 8.979 | 9.156 |
| 20 | 3 | 9 | 9.913 | 8.078 | 8.257 | 8.502 |
| 21 | 6 | 1 | 17.528 | 12.764 | 13.126 | 13.470 |
| 22 | 6 | 3 | 16.508 | 13.382 | 13.598 | 13.805 |
| 23 | 6 | 6 | 14.753 | 11.752 | 11.866 | 12.089 |
| 24 | 6 | 9 | 13.378 | 10.325 | 10.433 | 10.565 |
| 25 | 9 | 1 | 18.322 | 12.525 | 12.936 | 13.256 |
| 26 | 9 | 3 | 14.20 | 11.620 | 11.926 | 12.223 |
| 27 | 9 | 6 | 13.716 | 11.218 | 11.449 | 11.736 |
| 28 | 9 | 9 | 13.248 | 12.439 | 12.640 | 12.878 |
| | | | | **Six Month Ahead Forecasts** | | |
| 29 | 6 | 1 | 35.563 | 32.695 | 34.257 | 35.466 |
| 30 | 6 | 3 | 35.341 | 31.931 | 33.210 | 34.589 |
| 31 | 6 | 6 | 34.730 | 30.914 | 31.453 | 32.871 |
| 32 | 6 | 9 | 34.875 | 30.833 | 31.007 | 32.173 |
| 33 | 9 | 1 | 47.959 | 39.044 | 39.188 | 40.228 |
| 34 | 9 | 3 | 41.177 | 35.474 | 36.234 | 37.298 |
| 35 | 9 | 6 | 39.866 | 35.063 | 35.523 | 36.653 |
| 36 | 9 | 9 | 39.972 | 36.354 | 36.488 | 37.555 |

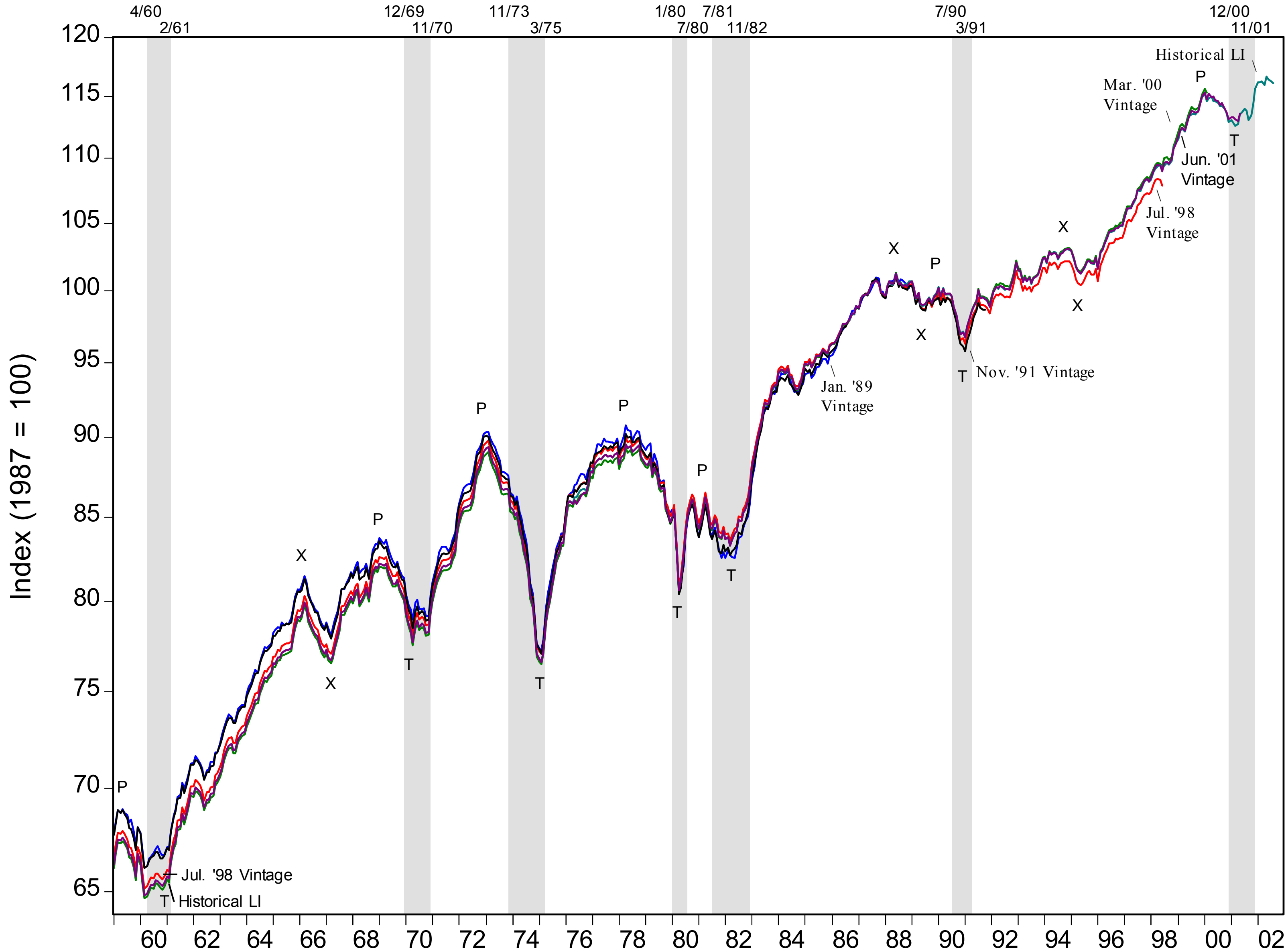
Note: $MSE = \frac{\sum_{t=1}^{n} e_t^2}{n}$, t = 1,...,165. Because $e_t^2$ are very small, the entries in columns 4-7 show MSEx$10^5$. The x's denote the cases where the models with lagged $LI^{old}$ and $LI^{new}$ terms are less accurate than the autoregressive model, that is, where the entries in columns 4 and 6 are smaller than the corresponding entries in column 4. All the differences between MSE's in column 4 and either column 5, 6 or 7 for one month ahead forecasts are significant at the 5 % level based on the encompassing test statistic (ENC_NEW) developed by Clark and McCracken (2001) to test for one-step ahead forecast accuracy in nested models. The test statistic is not applicable to 3 and 6-month ahead forecasts, but research is underway to develop the appropriate tests for multi-step ahead forecasts.

**Table 8**
**Comparable Forecasts of Growth in the Industrial Production Index Are More Accurate for the New Index Than for the Old Index**
**Jan. 1989- Sep.2002**

| Line | Span of Months over which Growth Rate is Calculated (j) | Number of Lags of Growth Rates of IP , LI (1 to k) | Mean Square Errors (MSE)[a] For Model with Lagged Terms in: IP and $LI^{new\ b}$ | IP and $LI^{old}$ Direct | IP and $LI^{old}$ Two-Step |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| | | | **One Month Ahead Forecasts** | | |
| 1 | 1 | 1 | 2.577 | 2.283[x] | 2.583 |
| 2 | 1 | 3 | 2.247 | 2.273 | 2.349 |
| 3 | 1 | 6 | 2.354 | 2.352[x] | 2.533 |
| 4 | 1 | 9 | 2.225 | 2.316 | 2.510 |
| 5 | 3 | 1 | 3.054 | 5.654 | 4.173 |
| 6 | 3 | 3 | 3.369 | 6.144 | 5.829 |
| 7 | 3 | 6 | 2.989 | 5.307 | 5.057 |
| 8 | 3 | 9 | 2.520 | 4.679 | 5.003 |
| 9 | 6 | 1 | 3.770 | 7.199 | 5.597 |
| 10 | 6 | 3 | 4.006 | 7.860 | 6.722 |
| 11 | 6 | 6 | 4.120 | 7.261 | 7.136 |
| 12 | 6 | 9 | 3.009 | 6.177 | 6.830 |
| 13 | 9 | 1 | 3.470 | 7.070 | 5.590 |
| 14 | 9 | 3 | 3.461 | 6.730 | 5.824 |
| 15 | 9 | 6 | 3.442 | 6.675 | 5.889 |
| 16 | 9 | 9 | 3.410 | 6.954 | 6.113 |
| | | | **Three Month Ahead Forecasts** | | |
| 17 | 3 | 1 | 9.719 | 11.852 | 10.257 |
| 18 | 3 | 3 | 9.970 | 11.870 | 11.379 |
| 19 | 3 | 6 | 9.156 | 10.488 | 10.611 |
| 20 | 3 | 9 | 8.502 | 10.111 | 9.690 |
| 21 | 6 | 1 | 13.470 | 20.367 | 19.770 |
| 22 | 6 | 3 | 13.805 | 20.926 | 28.318 |
| 23 | 6 | 6 | 12.089 | 17.948 | 27.199 |
| 24 | 6 | 9 | 10.565 | 16.463 | 25.024 |
| 25 | 9 | 1 | 13.256 | 20.756 | 23.782 |
| 26 | 9 | 3 | 12.223 | 19.593 | 28.758 |
| 27 | 9 | 6 | 11.736 | 18.959 | 29.137 |
| 28 | 9 | 9 | 12.878 | 19.784 | 32.123 |
| | | | **Six Month Ahead Forecasts** | | |
| 29 | 6 | 1 | 35.466 | 37.279 | 30.532[x] |
| 30 | 6 | 3 | 34.589 | 35.855 | 27.544[x] |
| 31 | 6 | 6 | 32.871 | 35.312 | 27.003[x] |
| 32 | 6 | 9 | 32.173 | 35.697 | 29.236[x] |
| 33 | 9 | 1 | 40.228 | 48.259 | 42.067 |
| 34 | 9 | 3 | 37.298 | 45.130 | 44.676 |
| 35 | 9 | 6 | 36.653 | 44.651 | 45.689 |
| 36 | 9 | 9 | 37.555 | 46.668 | 50.854 |

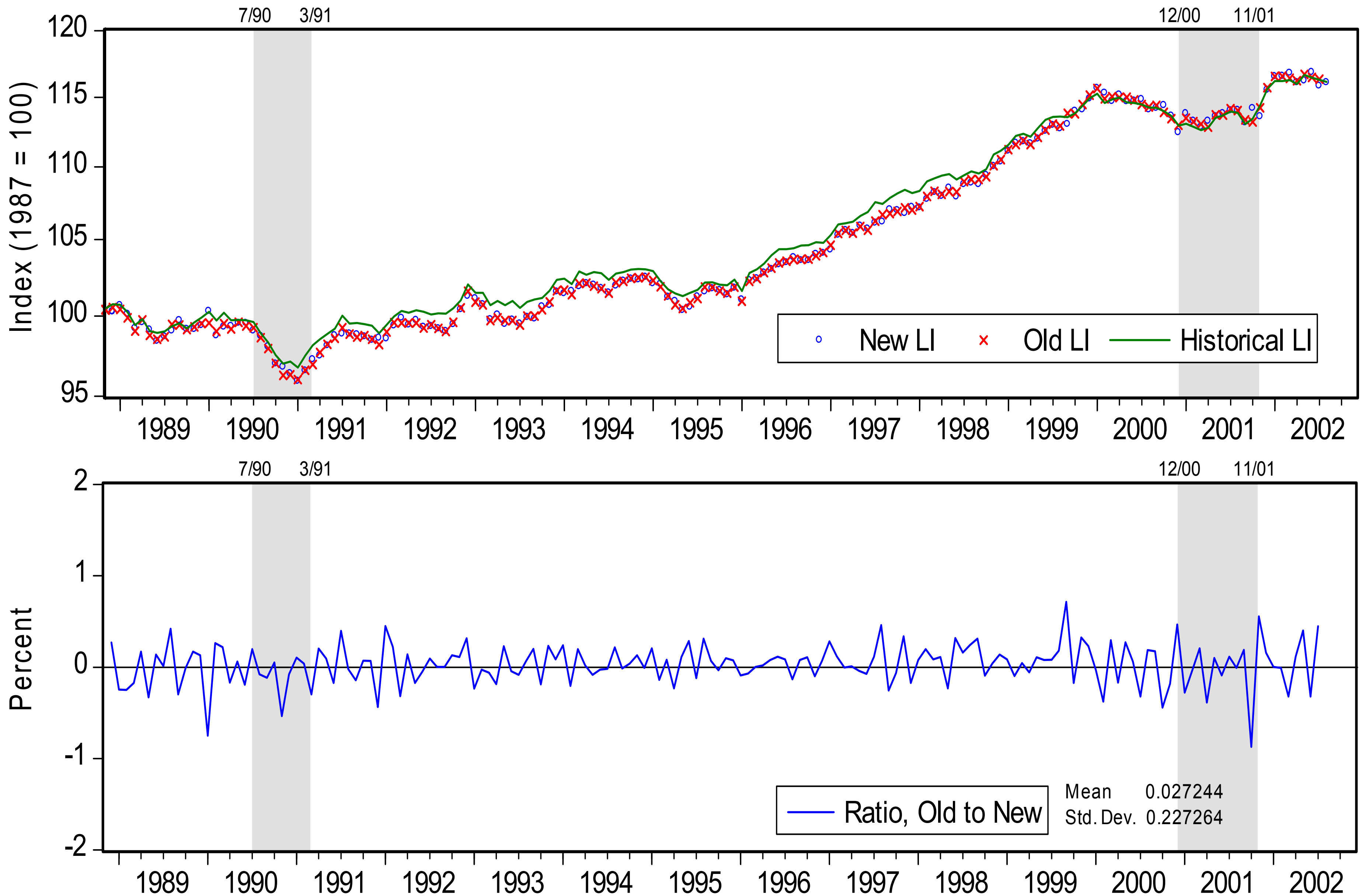
Note: $MSE = \frac{\sum_{t=1}^{n} e_t^2}{n}$, t = 1,...,165. Because $e_t^2$ are very small, the entries in columns 4-6 show MSEx$10^5$. The entries in column 4 are identical to those in Table 6, column 7. The x's denote the cases where the models with lagged $LI^{old}$ terms are more accurate than the models with lagged $LI^{new}$ terms, that is, where the entries in columns 5 and 6 are smaller than the corresponding entries in column 4.

## Chart 1: Historical LI (as of September 2002) and Five Selected Vintages of the New Leading Index
## January 1959 - August 2002

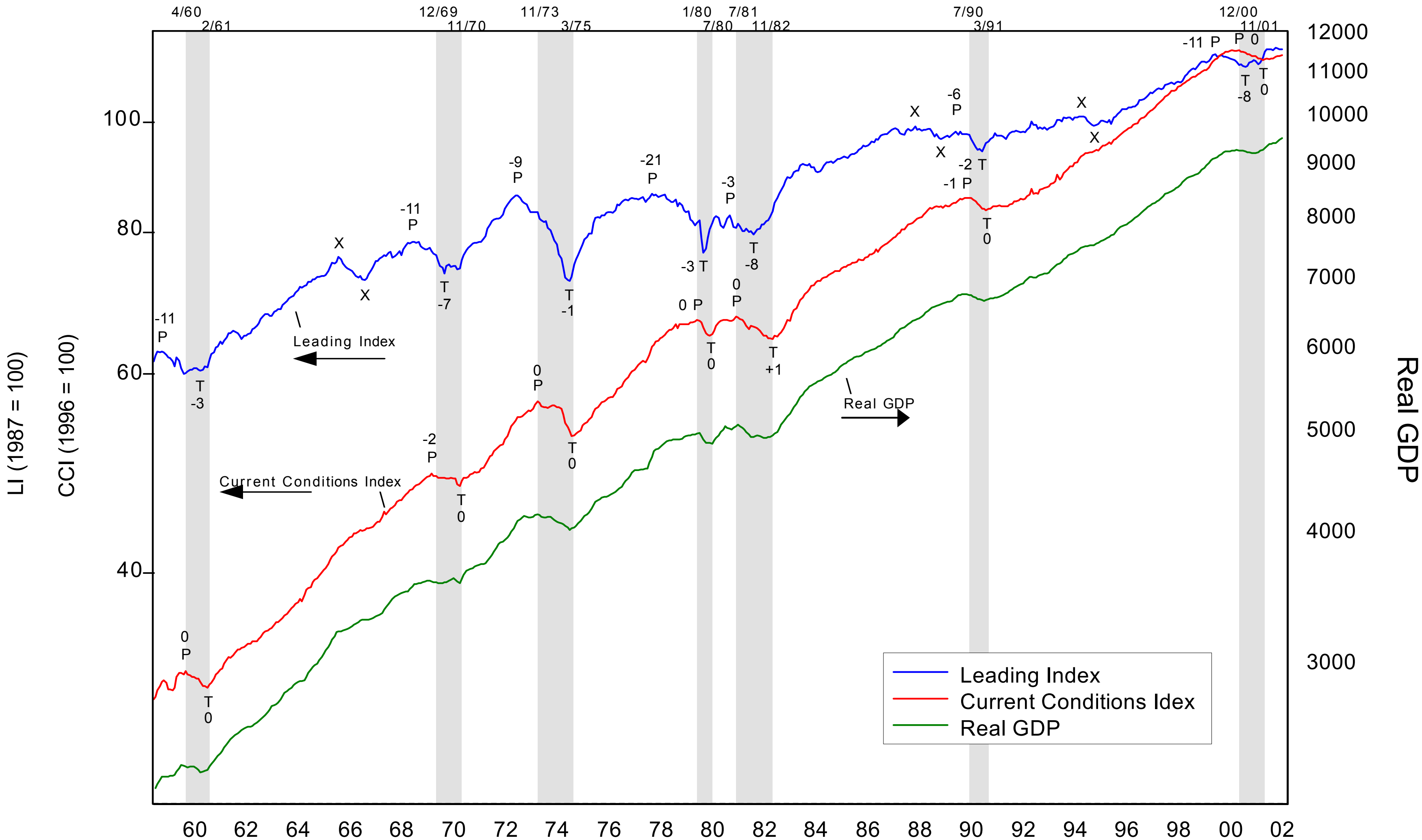



The shaded areas represent U.S. busines cycle recessions as dated by the National Bureau of Economic Research. The latest shading relates to the recession of 2001 and is dated according to the cyclical contraction of the CCI (the U.S. current conditions or coincident index). P denotes the specific-cycle peaks and T the troughs in the historical LI and the vintages of the new LI. The numbers at the P and T markings denote the leads in months at the business cycle peaks and troughs respectively.

# Chart 2: Old and New Composite Leading Indexes, November 1988 - August 2002



## Chart 3: U.S. Current Conditions Index, U.S. Leading Index and Real GDP
## January 1959 - August 2002




The shaded areas represent U.S. busines cycle recessions as dated by the National Bureau of Economic Research. The latest shading relates to the recession of 2001 and is dated according to the cyclical contraction of the CCI (the U.S. current conditions or coincident index). P denotes the specific-cycle peaks and T the troughs in the Leading and Current Conditions Indexes. The numbers at the P and T markings denote the leads or lags in months at the business cycle peaks and troughs respectively.