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# Why the Composite Index of Leading Indicators Doesn't Lead

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# WHY THE COMPOSITE INDEX OF LEADING INDICATORS DOESN'T LEAD

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ABSTRACT: *This paper assesses the real-time performance of the Commerce Department's composite index of leading indicators. We find that the composite leading index has failed to provide reliable advance warning of cyclical turning points. One reason for this failure is that the leading index's transition from expansion to contraction is generally not very sharp. Consequently, cyclical peaks in the index are difficult to discern in real time. While transitions from contraction to expansion are sharp on average, cyclical troughs in the leading index often precede cyclical troughs in the economy by only a few months. Consequently, even timely recognition of troughs in the leading index fails to provide advance warning of turnarounds in the general level of economic activity.*

## I. INTRODUCTION

Among all the indexes designed to give advance warning of business-cycle turning points, the Commerce Department's composite index of leading economic indicators (CLI) stands out as by far the most widely publicized.[1] In the popular press, it is touted as "the Government's main economic forecasting gauge" (New York Times, June 1, 1991, section 1, page 1), and is said to "forecast the economy over six to nine months" (New York Times, November 2, 1991, section 1, page 49). When plotted against time the CLI does, indeed, seem to change direction well in advance of the economy's cyclical peaks and troughs (Figure 1). The lead time for cyclical peaks ranges from one month to twenty months and averages 8.2 months. At cyclical troughs, the lead time ranges between one month and ten months and averages 4.2 months.

There are reasons, however, to believe that such plots and figures exaggerate the forecasting performance of the CLI. First, the CLI is released with a full one-month delay. The CLI for July 1992, for example, was not released until September 1. More significantly, cyclical peaks and troughs in the CLI are often not easily recognized as such until well after the fact. In a period during which the CLI has been expanding, it is difficult to tell (in real time) whether a decline in the most recent month's value of the CLI is an isolated event or the beginning of a new trend (Hymans 1973). Finally, the data and procedures used to construct the CLI are subject to revision. Data revisions are frequent but, ordinarily, have a relatively small impact on the index. In contrast, revisions to the procedures used to construct the CLI have sometimes altered the behavior of the index quite significantly.[2] Figure 2, for example, shows three plots of the time-path of the CLI, each covering the period from October 1972 through October 1973. Plot A shows the CLI path as it appeared in November 1973, at the start of the 1973-1975 recession. Plot B shows the behavior of the index as it appeared in March 1975, following a series of data revisions and just prior to a major methodological revision. Finally, plot C shows the behavior of the index as it appears today, reflecting revisions to both data and methodology. In today's data, the cyclical peak of the CLI occurs in March 1973, eight months prior to the business-cycle peak. In the real-time data, on the other hand, the only indications that a recession is on the way come from one-month pauses in CLI growth during April and September. Arguably, the performance of the

CLI in real time (before revisions) gives a more accurate picture of the advance warning we can expect to receive from the CLI in the future than does the performance of a version of the CLI that incorporates twenty years of hindsight.[3]

This paper begins with a review of the real-time forecasting performance of the composite leading indicators. Using a sophisticated, Bayesian methodology to signal turning points in the CLI, we show that the index has failed to provide reliable advance warning of both recessions and recoveries. In particular, by the time the CLI gives clear warning of a recession, the recession is usually well underway.

A first step in improving the forecasting performance of the CLI is understanding why the current version of the index fails to perform better. Toward this end, we examine more closely the behavior of the CLI over the course of the business cycle. We find that the CLI--unlike coincident measures of economic activity--typically declines much more slowly in the early months of its contraction phase than in the later months of its contraction phase. As a result, the transition from the expansion phase of the CLI to the contraction phase is often not sharp or distinct, making it difficult to recognize cyclical peaks in the leading index until well after the fact. Transitions from contraction to expansion are, on average, sharp, but cyclical troughs in the leading index often precede cyclical troughs in the economy by only a few months, so that even timely recognition of troughs in the leading index fails to provide advance warning of turnarounds in the general level of economic activity.

As a test of our hypothesis that the roundedness of CLI peaks helps explain why it is so difficult to obtain advance warning of recessions, we run regressions of the recognition lag at CLI turning points against alternative measures of roundedness. Results confirm that the rate of growth in the CLI in the months immediately following a CLI turning point are an important determinant of how quickly that turning point will be recognized as such.

We close with some observations on the policy implications of our results. In particular, we note that forecasters should be very cautious about retracting recession warnings once they have been issued. Furthermore, we argue that the forecasting performance of the CLI would be improved if, in evaluating series for inclusion in the leading index, greater weight was placed on the sharpness of the series' cyclical turning points.

## II. HOW WELL DO THE LEADING INDICATORS PERFORM?

### A. Recognizing Turning Points in the Leading Indicators

Some method for recognizing turning points in the CLI is required before the index can be used to signal recessions and recoveries. The preferred method for recognizing turning points in the leading index is based on a Bayesian updating formula derived by Neftci (1982) and modified by Diebold and Rudebusch (1989). Previous research has shown that the Bayesian approach performs better than simple rules of thumb--rules such as those which signal a recession following three consecutive declines in the CLI and a recovery following three consecutive increases (Koenig and Emery 1991, Diebold and Rudebusch 1989, 1991).

The mechanics of the Bayesian approach can be summarized as follows. In any month that the CLI reaches a cyclical trough, the probability that the CLI is in its contraction phase (indicating that the economy is soon to slip into recession) is set equal to zero.[4] In subsequent months, the probability that the CLI is in its contraction phase is updated. The evidence-gathering process is cumulative: the probability that the CLI is in its contraction phase in the current month is an increasing function of the probability that the CLI was in its contraction phase during the previous month. The probability that the CLI is in its contraction phase in the current month is also a function of this month's change in the CLI: the larger the decrease (smaller the increase) in the index, the greater is the probability that the CLI is in its contraction phase. Finally, the probability that the CLI is in its contraction phase in the current month is an increasing function of the number of past contraction phases relative to the cumulative length of past expansion phases: if transitions from expansion to contraction have been rare in the past, the updating formula assumes that they probably will also be rare in the future.

More precisely, the formula for the probability of recession is

$$(1) \qquad P_t = [P_{t-1} + PL\ (1 - P_{t-1})]\ Fd_t / \{[P_{t-1} + PL\ (1 - P_{t-1})]\ Fd_t + (1 - P_{t-1})(1 - PL)\ Fu_t\},$$

where $P_t$ is the estimated probability that the composite index of leading indicators is in its contraction phase at time t, so a recession is imminent; PL is the <u>a priori</u> probability that the CLI has entered its contraction phase, given that a month earlier the CLI was in its expansion phase; and $Fd_t$ and $Fu_t$ are the likelihoods that the latest change in the CLI came from the contraction phase of the index and the expansion phase of the index, respectively.[5]

Once it has been determined that the economy is in recession, a modified version of equation 1 can be used to calculate the probability that an expansion is imminent. This is done by switching $Fd_t$ and $Fu_t$ and by replacing PL with the *a priori* probability that the CLI has entered its expansion phase, given that a month earlier the CLI was in its contraction phase.

B. The CLI as a Predictor of Business-Cycle Turning Points

Figure 3 plots the probability of imminent recession (during periods when the economy was expanding) and the probability of imminent expansion (during periods when the economy was contracting) obtained by applying equation 1 to real-time, unrevised data.[6] The use of unrevised data is necessary in order to obtain an accurate assessment of the historical forecasting performance of the CLI. This real-time historical performance is likely to be a more accurate guide to the future forecasting ability of the CLI than is an analysis based only upon the latest version of the CLI, since the latest version of the CLI has been fine-tuned with an eye toward fitting the historical data.

Figure 3 shows that the probability of imminent recession was at or above 90 percent--a commonly used critical value--at the start of only one of the past five recessions. Reducing the critical value to 70 percent would have given advance warning of one additional recession (that beginning in 1981), but would also have resulted in a series of false recession-warnings during 1984. Similarly, using a 90-percent critical value, the CLI gave advance indication of only one of the past five recoveries and gave several false recovery signals in the middle of the 1973-75 recession. Lowering the critical value to 70 percent would not have given advance indication of any additional recoveries (though it would have provided a coincident signal of the 1980 recovery).

Figure 4 provides alternative documentation of the inability of the CLI to provide advance warning of business-cycle peaks. Two alternative signaling rules are examined. Under both rules, the analyst issues a recession warning whenever the probability of recession exceeds a specified critical value (either 70 percent or 90 percent). Under rule A, the warning is retracted as soon as the probability drops below the critical value. Under rule B, in contrast, the warning remains in force until it is either proven valid (the economy goes into recession) or until it is proven invalid. A recession signal is proven invalid if the CLI exceeds its previous high without a recession having developed. Under either rule, a signal is said to be "false" if it arrives while the CLI and the economy are both in their expansion phases. The rules were applied to real-time and final-revised data.

For each signaling rule and critical value, Figure 4 gives the total number of months in which false recession warnings were issued and the average lag (again measured in months) with which valid recession warnings followed business-cycle peaks.[7] Notice that for each rule, lowering the critical value yields more timely warning of recessions, at the expense of additional false signals. For instance, when rule B is applied to real-time data with a 90-percent critical value, a valid warning would have come, on average, 3.2 months **after** each recession had actually begun. There would have been no false recession signals. With a 70-percent critical value, the same rule would have issued a valid recession warning that arrived 1.6 months late, on average, with a total of eight false signals.

Several features of the results displayed in Figure 4 are noteworthy. First, none of the signaling rules provide reliable advance warning of recessions. Second, the performance of a signaling rule applied to final-revised data is a very poor guide to how that rule would have performed in real time. Not only does the use of final-revised data understate the lag with which any given rule would have signaled recessions, it also changes the ranking of alternative rules. Thus, when applied to final-revised data, rule A is clearly superior to rule B. On the other hand, when applied to real-time data, rule B appears to have the advantage. The latter result suggests that once analysts issue a recession warning, they should not retract the warning until the CLI begins to set new highs.

Figure 5 is similar to Figure 4, except it documents the inability of the CLI to provide advance warning of business-cycle troughs, rather than the CLI's inability to warn of business-cycle peaks. Again, two alternative signaling rules are examined--rules analogous to those analyzed in Figure 4. Under both rules, the analyst issues a recovery warning whenever the probability of recovery exceeds a specified critical value. Under rule A, the warning is retracted as soon as the probability drops below the critical value. Under rule B, the warning remains in force until either the economy begins to expand or the signal is proven invalid. A recovery signal is proven invalid if the CLI reaches a new cyclical minimum without a recovery having developed. Under either rule, a signal is said to be "false" if it arrives while the CLI and the economy are both in their contraction phases. As in Figure 4, the rules were applied to real-time and final-revised data.

In comparing rules for signaling the beginning of recoveries, just as in comparing rules for signaling recessions, results obtained using final-revised data are misleading. Thus, as shown in Figure 5, the final-revised data suggest that the risk of false signals is negligible even with a 70-percent critical value. Using real-time data, false signals are apparent at both the

70-percent and the 90-percent critical values, and a tradeoff between false signals and the timeliness of recovery signals is revealed. Furthermore, while the final-revised data indicate that rule B is preferable to rule A, the ranking of the signaling rules is reversed when the rules are applied to real-time data. Thus, in predicting recoveries, unlike predicting recessions, analysts should retract their warnings as soon as the probability that the CLI has entered a new phase falls below the chosen critical value.

## III. WHAT MAKES TURNING POINTS SO DIFFICULT TO PREDICT?

That the CLI should provide, at best, coincident warning of business-cycle troughs is, perhaps, not surprising, given that the average gap between CLI troughs and business-cycle troughs is only four months. More troubling is the CLI's failure to signal recessions until several months after they have begun. After all, CLI peaks precede business-cycle peaks by over eight months, on average. What makes recognizing CLI peaks so difficult? In this section, we establish that CLI peaks are significantly more rounded than are CLI troughs, and that this roundedness contributes to the inability of the CLI to provide advance warning of recessions.

### A. Round Peaks and Sharp Troughs

Sichel (1992) has shown that output growth is particularly rapid in the early stages of recoveries. Consequently, business-cycle troughs are "sharper" than are business-cycle peaks. Since the CLI is designed to provide an advance view of movements in economic activity, one might also expect cyclical peaks in the CLI to be more rounded than cyclical troughs. To formally test this proposition, we divided each CLI expansion phase and each CLI contraction phase into three equal segments.[8] We then calculated the mean growth rate of the CLI within each segment, and tested whether growth rates were constant across segments. For comparison, we undertook similar calculations for the Commerce Department's composite coincident index--a broad monthly measure of real economic activity.[9]

As shown in Figure 6, we found a systematic tendency for CLI growth to be higher in the first stage of its expansion than in the later stages of its expansion. Indeed, this tendency is even more pronounced for the CLI than it is for coincident measures of real economic activity. Furthermore, the CLI--unlike the coincident indicators--declines less rapidly in the first stage of contractions than in the later stages of contractions. Chi-square tests establish that these differences in growth rates across expansion and contraction stages are statistically significant.[10] [11] Summarizing, peaks in the CLI are even more rounded, relative to troughs, than are peaks in real economic activity. Not only is CLI growth unusually rapid immediately after troughs in the index, CLI growth is unusually slow immediately after peaks.

B. Roundedness and the Timeliness of Recession Warnings

As a test of whether the roundedness of CLI peaks helps explain why it is so difficult to obtain advance warning of recessions, we ran regressions of the recognition lag at CLI peaks (measured in months) against alternative measures of roundedness. Recognition lags were obtained by applying signaling rules A and B (as defined in Section II) to data extending back to 1948, capturing a total of nine CLI peaks. Using a 70-percent critical value, rule

A yielded longer recognition lags than rule B at two of these peaks (December 1955 and June 1959), so separate sets of regressions were run for each rule. (Using a 90-percent critical value, rules A and B generated identical lags, so only one set of regressions was required.) Roundedness was measured by calculating the percentage change in the CLI in the months just prior to and just following each CLI peak. The larger the pre-peak percentage increase and post-peak percentage decline in the index, the sharper the transition between the CLI-expansion and contraction phases. Two alternative growth horizons were tried: a three-month horizon and a six-month horizon. Regression results are displayed in Table 1.[12]

In the six regressions that include both the pre-peak increase and post-peak decline in the CLI, the estimated coefficient of the pre-peak increase is invariably small in magnitude and statistically insignificant. The coefficient attached to the post-peak decline is, in contrast, consistently large in magnitude and often significant at the ten-percent level. When the pre-peak increase is dropped from the regressions, the magnitude of the coefficient attached to the post-peak decline is, in every case, virtually unaffected. Furthermore, marginal significance levels fall. Indeed, with the 1948 CLI peak included in the sample, the coefficient attached to the post-peak decline is always significant at the ten-percent level, and usually significant at the five-percent level. Considering the small size of our sample (only nine observations), these results are quite striking.

Apparently, then, the time needed to recognize a cyclical peak in the CLI is completely independent of how rapidly the leading index grows in the months just prior to that peak. In contrast, there is substantial evidence that the more slowly the leading index declines in the months immediately following a peak, the longer the delay with which that peak will be recognized. Using a six-month growth horizon, variations in post-peak growth explain anywhere from one third to one half of the variation in the recognition lag. Each percentage-point increase in the post-peak decline subtracts a month from the delay with which a recession warning is issued (Figure 7).

It is worth emphasizing that the difficulties that the roundedness of CLI peaks creates for the Bayesian methodology are not limited to that methodology alone. The timeliness of any technique for translating movements in the CLI into recession signals will suffer due to this roundedness.

The importance of the roundedness of CLI peaks in influencing the timeliness of recession warnings appears to have been overlooked by the Commerce Department in its selection of series to include in the leading index. Although "cyclical conformity" is one of the criterion used to select the components of the CLI, the definition of cyclical conformity excludes any measure of how rapidly a series declines in the months that our analysis suggests are critical--namely, those months immediately following the series' cyclical peaks. In the Commerce Department criteria, the closest thing to a measure of roundedness is the average rate of decline of series over entire peak-to-trough intervals (Hertzberg and Beckman 1989).

C. Roundedness and the Timeliness of Expansion Signals

We have established that cyclical troughs in the CLI are much sharper, on average, than are cyclical peaks. We have also shown that the CLI peaks that are most difficult to recognize are those that are followed by the smallest declines in the CLI. This result suggests that the relative roundedness of CLI peaks may account for the long time it typically takes to recognize CLI peaks as compared to CLI troughs. To shed further light on the relationship between roundedness and the recognition lag at cyclical turning points, we repeated the regressions reported in Table 1, this time for CLI troughs rather than CLI peaks. Results are presented in Table 2.

In each regression, the dependent variable is the lag with which rule A or rule B, evaluated at either the 70-percent or the 90-percent critical value, signals cyclical troughs in the CLI.[13] The independent variables include measures of the rate of **decline** of the CLI in the months immediately **preceding** a CLI trough and the rate of **increase** of the CLI in the months immediately **following** a CLI trough. Results for both three-month and six-month growth rates are displayed.

As in Table 1, the growth rate of the CLI in the months preceding a turning point appears not to have any effect on how many months it takes to recognize that a turning point has occurred. Thus, in every regression, the estimated coefficient on the pre-trough percentage decline in the CLI fails to attain statistical significance. In contrast, the post-trough percentage increase in the CLI is significant at the ten-percent level in fourteen of sixteen regressions, and is often significant at better than the five-percent level. Using a 90-percent critical value, variations in post-trough roundedness explain between one half and three quarters of the variation in the recognition lag. Each additional one-percentage-point increase in the CLI during the first three-to-six months following a CLI trough subtracts a half a month, or more, from the delay with which an expansion signal is issued.

The results presented in Table 2 confirm that the rate of growth in the CLI during the months immediately following a CLI turning point are an important determinant of how quickly that turning point will be recognized as such. Since cyclical peaks in the leading index are, on average, followed by declines in the CLI that are very small (in magnitude) compared to the increases in the CLI that follow troughs, it should not be surprising that it typically takes much longer to recognize CLI peaks than it does to recognize CLI troughs.

## IV. DISCUSSION

Reading press accounts or looking at a standard time-series plot, one can easily obtain the impression that the government's composite index of leading indicators provides reliable advance information on the direction of economic activity. This impression is inaccurate. Because of a one-month publication delay, numerous revisions, and the difficulty--in real time--of knowing whether the index has or has not reached a cyclical turning point, the CLI provides no better than a coincident signal of recessions and expansions. Even then, there are months in which the CLI signals that a recession or expansion is developing when, in fact, one does not materialize.

The CLI--unlike coincident measures of economic activity--typically declines much more slowly in the early months of its contraction phase than in the later months of its contraction phase. As a result, the transition from the expansion phase of the CLI to the contraction phase is often not sharp or distinct, complicating recognition of cyclical peaks. Although there is a shift from very low to very high average growth rates as the CLI moves from its contraction into its expansion phase, cyclical troughs in the leading index often precede cyclical troughs in the economy by only a few months. Thus, even timely recognition of troughs in the leading index fails to provide advance warning of turnarounds in the general level of economic activity.

That the government's composite index of leading indicators has failed to provide reliable advance warning of business-cycle turning points does not necessarily mean that the CLI is of no use to policymakers. It may still be the case, for example, that the CLI provides earlier information on turning points than is available from other sources. Indeed, the failure of the CLI to warn of business-cycle turning points may simply indicate that policymakers are already fully utilizing the information contained in the CLI. After all, the more successfully any leading index is used as a guide to counter-cyclical policy, the less reliable that index will come to appear.

Finally, our results provide direction on how best to interpret movements in the CLI as that index is currently constructed, and on how the forecasting performance of the CLI might be improved. On the first point, our findings suggest that once the CLI signals that a recession is about to begin (or has already begun), the signal should not be considered invalid unless the CLI begins to set new highs. On the second point, our findings suggest that in evaluating series for inclusion in the CLI, as much weight should be placed on the sharpness of the series' cyclical turning points as on the timing of those turning points relative to turning points in economic activity.

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TABLE 1

**Roundedness of CLI Peaks and the Timeliness of Recession Warnings**

Recognition Lag = a + b·Pre-Peak CLI Increase + c·Post-Peak CLI Decrease

| Rule | 1948 Peak? | Growth Horizon | a | b | c | $\bar{R}^2$ |
|---|---|---|---|---|---|---|
| A: 70% | yes | 3 mo. | 11.28 (.004) | .05 (.972) | - 3.13 (.060) | .30 |
| | yes | 3 mo. | 11.32 (.001) | -- | -3.13 (.040) | .40 |
| | no | 6 mo. | 10.86 (.097) | .04 (.972) | -1.29 (.246) | .25 |
| | no | 6 mo. | 11.04 (.002) | -- | -1.31 (.064) | .37 |
| | yes | 6 mo. | 11.15 (.000) | -- | -1.38 (.027) | .46 |
| B: 70% | yes | 3 mo. | 7.50 (.006) | 1.02 (.321) | -2.09 (.060) | .29 |
| | yes | 3 mo. | 8.32 (.001) | -- | -1.93 (.086) | .27 |
| | no | 6 mo. | 7.89 (.111) | .09 (.920) | -.79 (.341) | .13 |
| | no | 6 mo. | 8.28 (.002) | -- | -.85 (.105) | .27 |
| | yes | 6 mo. | 8.37 (.001) | -- | -.90 (.050) | .37 |
| A&B: 90% | yes | 3 mo. | 12.30 (.003) | -.23 (.874) | -2.95 (.083) | .24 |
| | yes | 3 mo. | 12.11 (.001) | -- | -2.99 (.056) | .35 |
| | no | 6 mo. | 10.60 (.137) | .26 (.851) | -1.07 (.378) | .13 |
| | no | 6 mo. | 11.67 (.002) | -- | -1.23 (.109) | .27 |
| | yes | 6 mo. | 11.68 (.001) | -- | -1.24 (.027) | .33 |

Note: Marginal significance levels appear in parantheses.

**TABLE 2**

**Roundedness of CLI Troughs and the Timeliness of Recession Warnings**

Recognition Lag = a + b·Pre-Trough CLI Decrease + c·Post-Trough CLI Increase

| Rule | Growth Horizon | a | b | c | $\bar{R}^2$ |
|---|---|---|---|---|---|
| A: 70% | 3 mo. | 4.52 | .22 | -.65 | .35 |
| | | (.009) | (.44) | (.046) | |
| | 3 mo. | 4.96 | -- | -.61 | .38 |
| | | (.002) | | (.040) | |
| | 6 mo. | 5.09 | .05 | -.38 | .31 |
| | | (.009) | (.814) | (.065) | |
| | 6 mo. | 5.24 | -- | -.36 | .40 |
| | | (.002) | | (.040) | |
| B: 70% | 3 mo. | 2.97 | .21 | -.37 | .31 |
| | | (.008) | (.253) | (.067) | |
| | 3 mo. | 3.40 | -- | -.33 | .26 |
| | | (.002) | | (.094) | |
| | 6 mo. | 3.03 | .07 | -.17 | -.01 |
| | | (.111) | (.651) | (.216) | |
| | 6 mo. | 3.24 | -- | -.15 | .10 |
| | | (.006) | | (.210) | |
| A: 90% | 3 mo. | 6.69 | .13 | -.94 | .63 |
| | | (.001) | (.615) | (.008) | |
| | 3 mo. | 6.95 | -- | -.91 | .67 |
| | | (.000) | | (.004) | |
| | 6 mo. | 7.31 | .07 | -.59 | .74 |
| | | (.000) | (.630) | (.003) | |
| | 6 mo. | 7.53 | -- | -.57 | .77 |
| | | (.000) | | (.001) | |
| B: 90% | 3 mo. | 5.80 | .21 | -.84 | .54 |
| | | (.002) | (.446) | (.015) | |
| | 3 mo. | 6.21 | -- | -.80 | .56 |
| | | (.000) | | (.012) | |

TABLE 2 -- Continued

| | | | | |
|---|---|---|---|---|
| 6 mo. | 6.37<br>(.003) | .03<br>(.868) | -.47<br>(.030) | .47 |
| 6 mo. | 6.47<br>(.001) | -- | -.46<br>(.014) | .54 |

Note: Marginal significance levels appear in parantheses.

Appendix

TABLE A.1

**Means of Percentage Changes in the Composite Leading and Coincident Indexes Over Business-Cycle Stages 1948:2-1991:5**

| Expansion Stage | Leading Index Coeff. | Leading Index t-statistic | Coincident Index Coeff. | Coincident Index t-statistic |
|---|---|---|---|---|
| E1 | .94 | (10.87) | .69 | (10.33) |
| E2 | .48 | (6.65) | .45 | (6.82) |
| E3 | .30 | (4.51) | .32 | (4.91) |

| Contraction Stage | Leading Index Coeff. | Leading Index t-statistic | Coincident Index Coeff. | Coincident Index t-statistic |
|---|---|---|---|---|
| C1 | -.38 | (-4.23) | -.81 | (-9.93) |
| C2 | -.71 | (-6.22) | -.85 | (-7.09) |
| C3 | -.91 | (-5.54) | -.93 | (-4.04) |

Chi-Square statistics for mean equality:

| Leading Index Test | $\chi^2$ | Coincident Index Test | $\chi^2$ |
|---|---|---|---|
| E1 = E2 | 16.84*** | E1 = E2 | 6.57*** |
| E1 = E3 | 34.26*** | E1 = E3 | 15.25*** |
| E2 = E3 | 3.28* | E2 = E3 | 1.82 |
| E1 = E2 = E3 | 34.73*** | E1 = E2 = E3 | 15.71*** |
| C1 = C2 | 4.97** | C1 = C2 | 0.75 |
| C1 = C3 | 7.83*** | C1 = C3 | 0.21 |
| C2 = C3 | 1.00 | C2 = C3 | 0.78 |
| C1 = C2 = C3 | 9.93*** | C1 = C2 = C3 | 0.25 |
| E1 = C3 | 99.55*** | E1 = C3 | 45.83*** |
| E3 = C1 | 36.93*** | E3 = C1 | 117.03*** |

*** reject null hypothesis of equality at .01 significance level
** reject null hypothesis of equality at .05 significance level
* reject null hypothesis of equality at .10 significance level

Chi-Square statistics distributed with one degree of freedom for two-stage tests and with two degrees of freedom for three-stage tests.

## Endnotes

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1. Other prominent leading indexes include the National Bureau of Economic Research (NBER) experimental recession index and the Columbia University Center for International Business-Cycle Research (CIBCR) long-leading index.

2. Important procedural changes were made in 1969, 1975, 1979, 1982, 1983, 1987, and 1989. Detailed descriptions of these changes can be found in the September 1969, May 1975, March 1979, February 1983, March 1987, and January 1989 issues of the Business Conditions Digest. Koenig and Emery (1991) present a general description of the current version of the Commerce Department index and an analysis of the relative importance of data revisions and methodological revisions.

3. The CLI's extended publication record (the index was first published in November 1968) gives us a long interval over which we can evaluate the index's real-time forecasting performance. In contrast, the NBER experimental recession index and Columbia University's long-leading index are products of hindsight. Their historical record is unlikely to be an accurate guide to their future performance. In their first out-of-sample test (the 1990 recession), neither alternative index distinguished itself. Thus, as late as November 1, 1990--over three months **after** the economy's official cyclical peak--the NBER was proclaiming that the "chances of a recession in 1990 remain low." The Columbia University index did not register three consecutive declines (a popular rule-of-thumb recession signal) until a release dated June 5, 1990--only one month before the economy's official cyclical peak. For descriptions of the NBER and Columbia University indexes, see Stock and Watson (1991, 1992) and Moore (1991). For a discussion of the importance of using real-time data to evaluate leading indexes, see Diebold and Rudebusch (1991).

4. The dates of cyclical troughs are not known until some time after the fact. In practice, the interval between CLI troughs and peaks is sufficiently long that the failure to immediately recognize a trough is of no importance.

5. Following Diebold and Rudebusch (1989), we make three adjustments to the original Neftci paper. First, we make use of the fact that the a priori transition probability (PL) is not, in the real world, a function of the current length of the expansion (Diebold and Rudebusch, 1990). In practice, then, PL is set equal to the number of months in the past in which the CLI made the transition from expansion to recession, divided by the total number of months in which the CLI was expanding. Second, we assume that changes in the CLI during its expansion and contraction phases are normally distributed, instead of deriving the distribution of changes in the CLI directly from historical data. Finally, in calculating the probability that the current CLI observation is signaling a recession, if the Neftci formula says that the probability of a recession last month was greater than 95 percent, we set last month's probability equal to 95 percent. This modification is meant to prevent the probability of a recession from becoming stuck at unity.

6. The graph reflects the one-month delay with which the CLI is released by the Commerce Department. Data start in 1968 because the CLI was first published in November of that year.

7. These warning lags incorporate the one-month delay with which the CLI is published.

8. For the purposes of the analysis that follows, we examined the behavior of the current version of the CLI, incorporating revisions to both data and methodology. Consequently, our analysis, if anything, **understates** the difficulty of recognizing turning points in the leading index. By using the current version of the leading index we avoid ambiguities that would otherwise arise in the dating of the peaks and troughs of the CLI. Furthermore, we are able to extend our sample back an additional twenty years, to 1948.

9. Movements in the composite coincident index reflect movements in industrial production, non-farm employment, real personal income, and real manufacturing and trade sales.

10. See Table A.1 in the appendix. For further details, see Emery and Koenig (1992).

11. Similarly, we calculated the **variance** of CLI growth within each segment of the expansion and contraction phases of the index. We found a tendency for the variance to be significantly higher both just before and just after CLI troughs than at other times. Real economic activity, as measured by the composite coincident index, is more volatile just before business-cycle troughs than at other times. See Emery and Koenig (1992) for details.

12. Lack of data made calculation of CLI growth over the six months preceding the June 1948 peak impossible. Consequently, some of the regressions reported in Table 1 are based on eight observations, others on nine observations.

13. A total of nine CLI troughs were included in the sample.

**Figure 1**
**The Commerce Department's Composite Leading Index**
Index, 1982 = 100

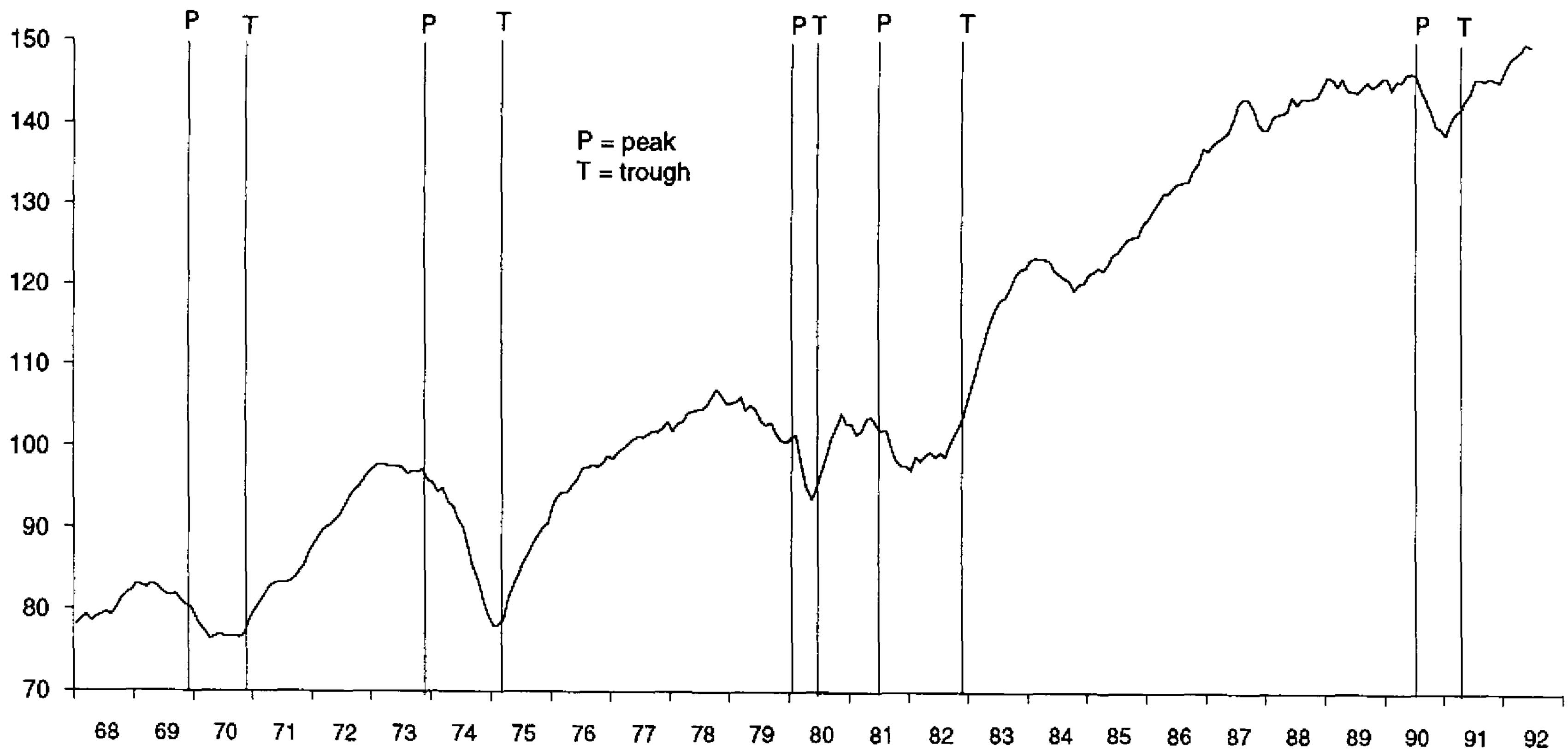


**Figure 2**
**Leading Index Revisions**

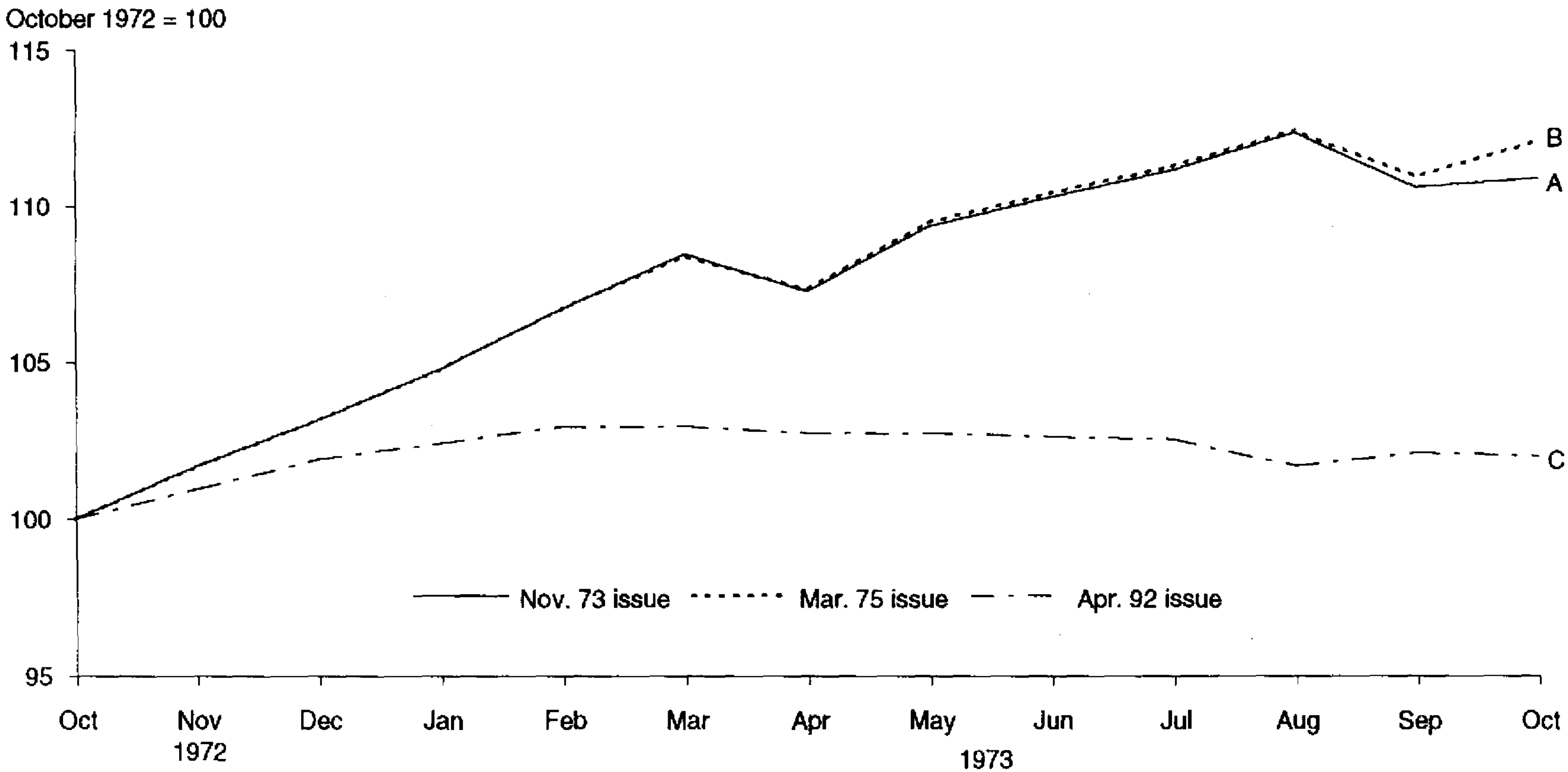


**Figure 3**
**Predicting Recessions and Expansions: Neftci Probabilities**

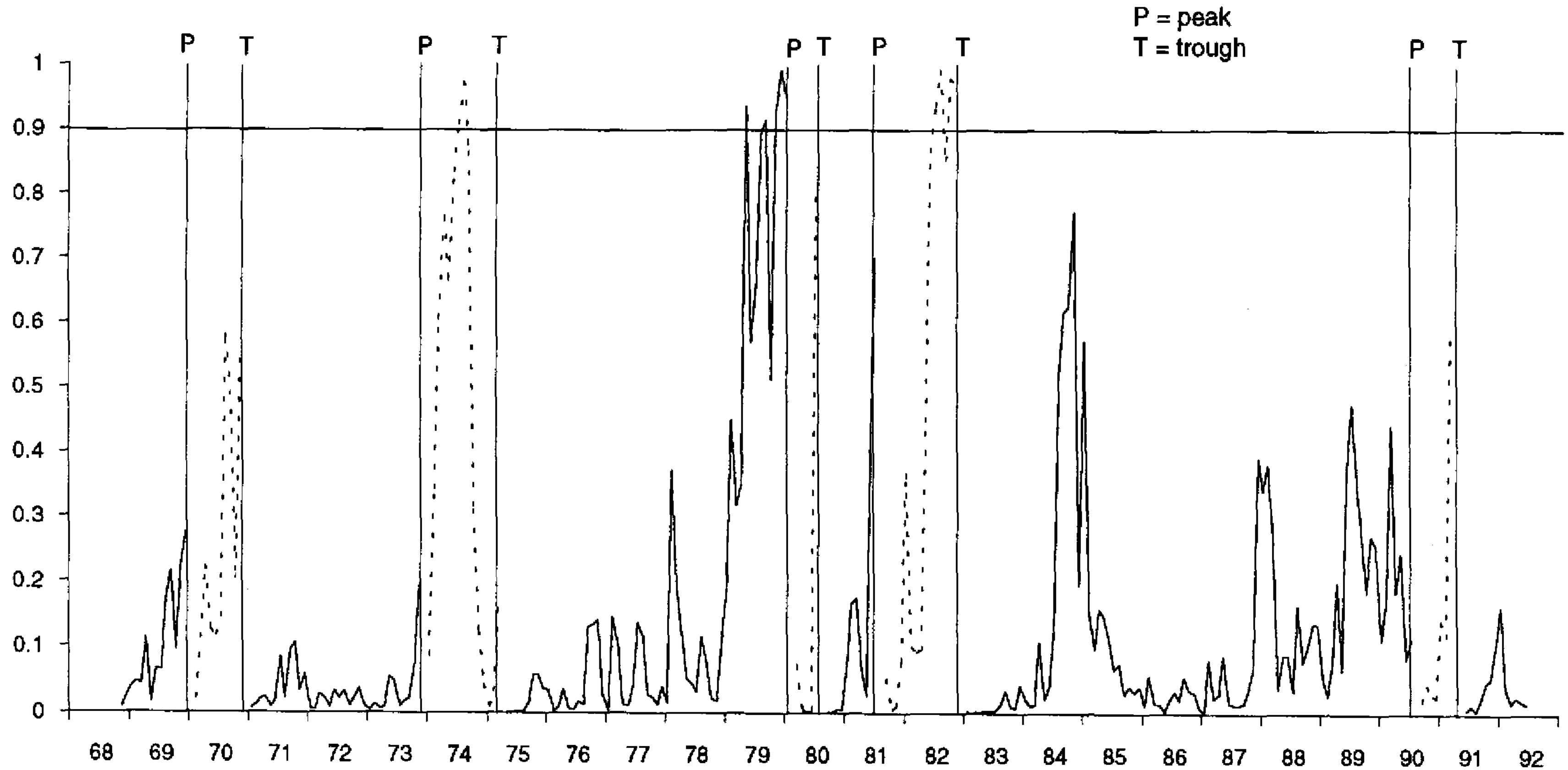


**Figure 4**
**Predicting Recessions: Neftci Formula**

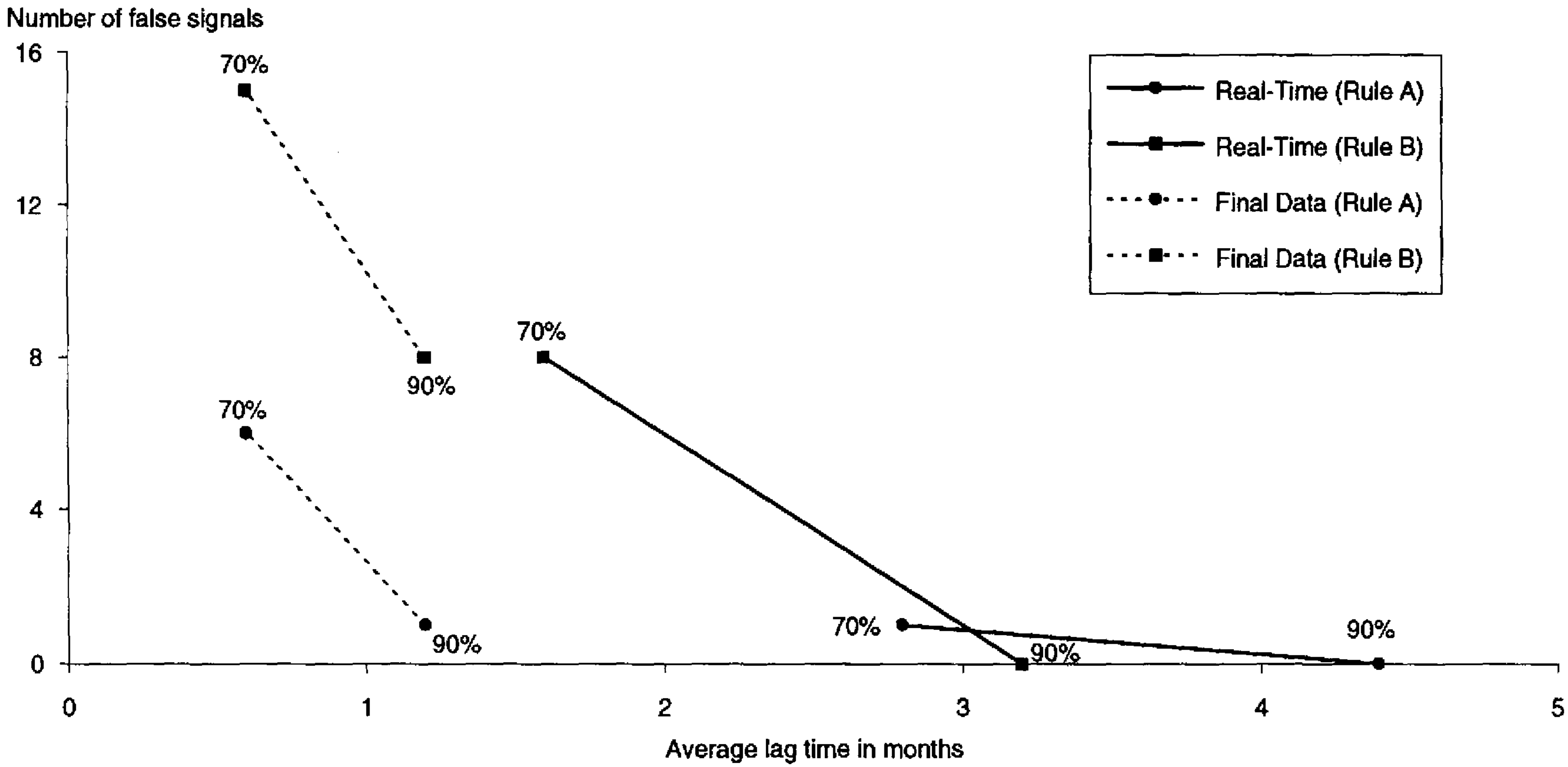


**Figure 5**
**Predicting Expansions: Neftci Formula**

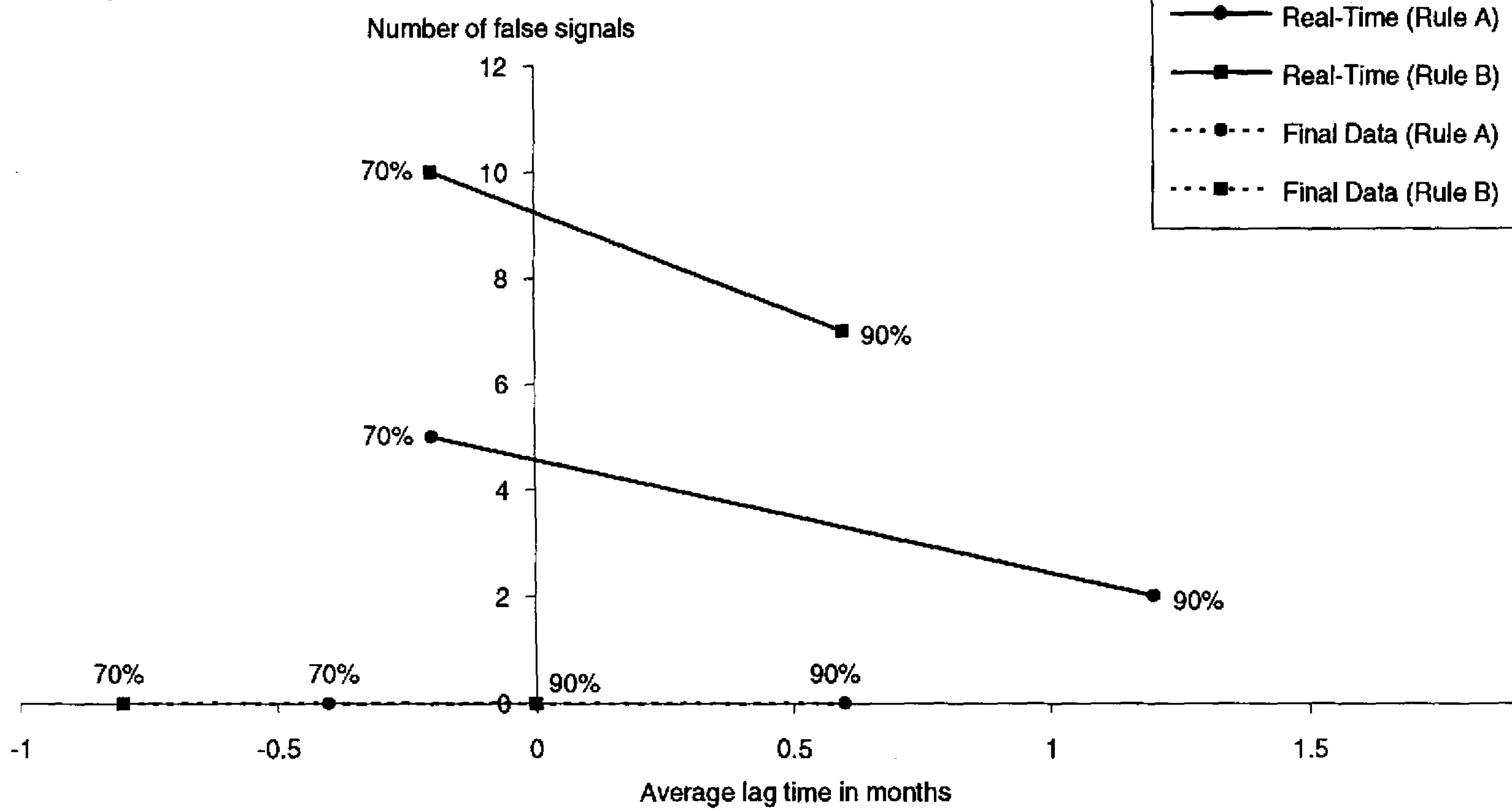


**Figure 6**
**Growth of the Leading and Coincident Indexes Over the Business Cycle**

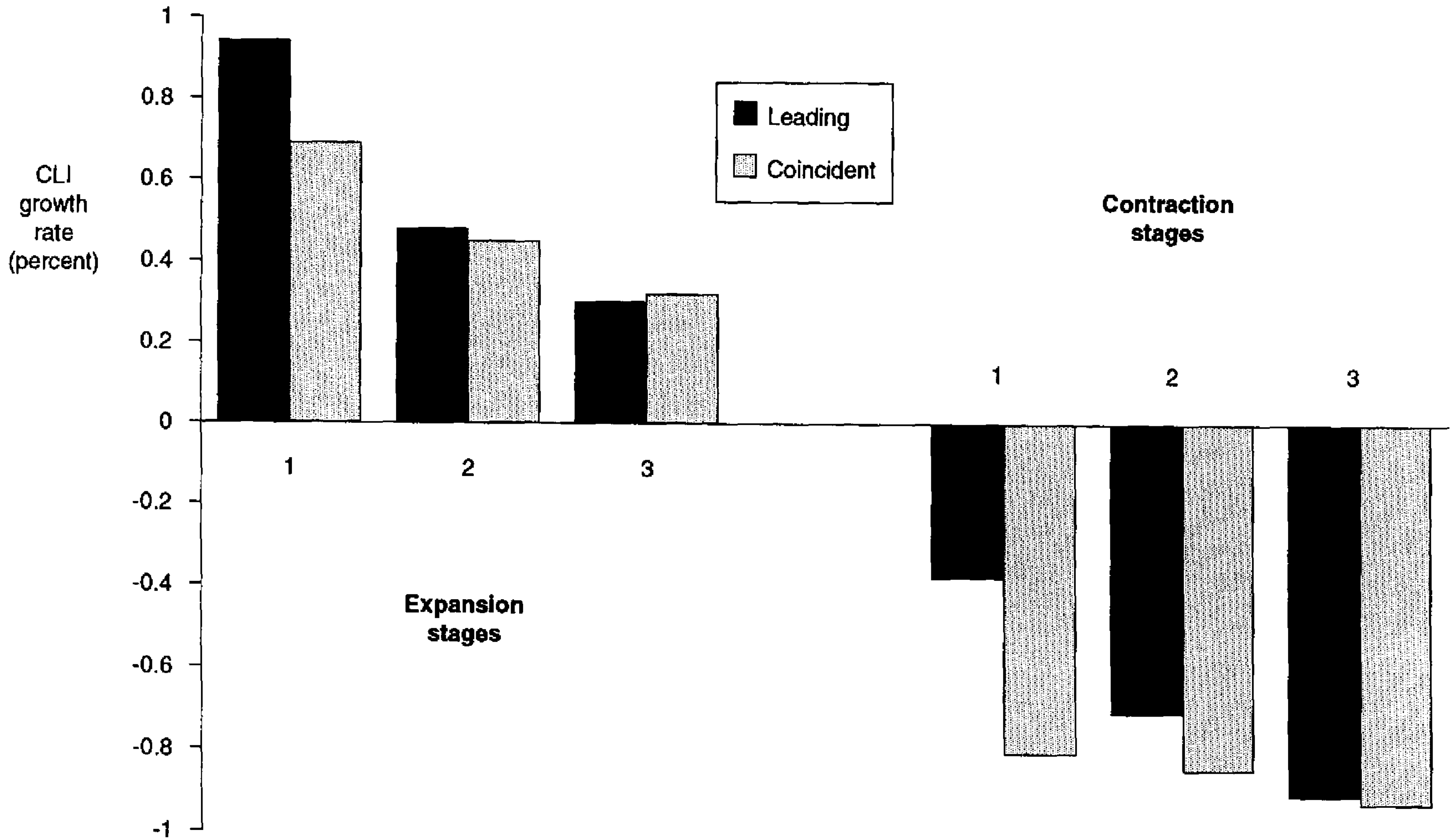
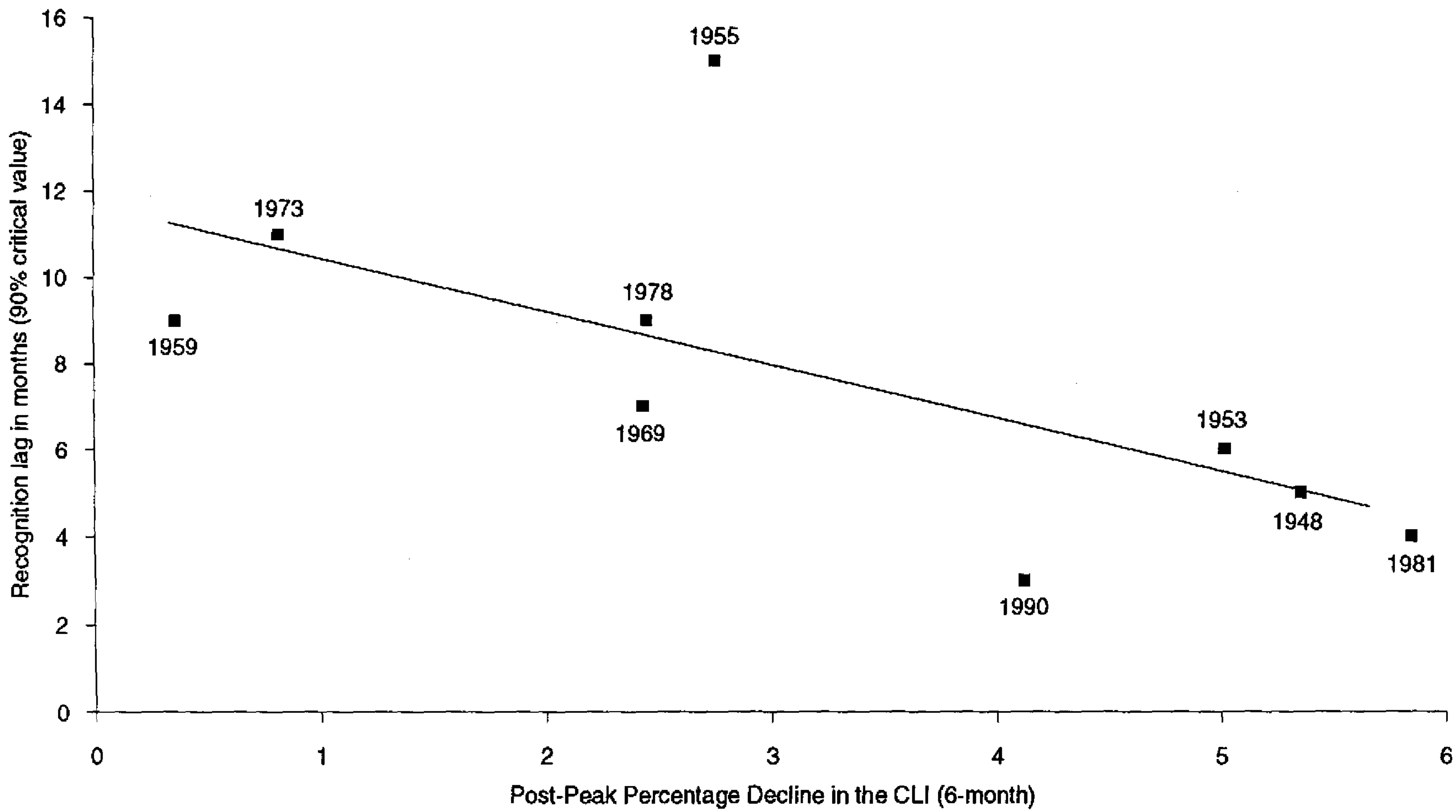


**Figure 7**
**Roundedness and the Timeliness of Recession Warnings**
**Rules A and B**



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