Using Monetary and Financial Variables to Predict Cyclical Downturns

Economists rely on several methodologies to predict business cycle turning points, with the indicator approach most commonly used Various monetary and financial variables are employed within this framework, very popular are the money supply, interest rates, and the volume of credit This article evaluates how well these monetary and financial variables predict imminent recession Of particular interest is their performance during the past several years Considering the extensive deregulation and the many innovations in financial markets and the banking industry, it is only natural to suspect that their value as leading indicators has changed, most likely for the worse during this time of flux, and perhaps permanently.

To evaluate the performances of these variables, we adopt a new approach to the prediction of cyclical downturns developed by Salih Neftçi [1] In formulating his approach, Neftçi applied to macroeconomic forecasting a branch of statistics called sequential analysis With this stronger statistical framework, we feel we can analyze the properties of indicator variables better than has been done in the past [2]

The authors would like to give special thanks to Ted Sikorski for excellent research assistance

[1]Salih N Neftçi, "Optimal Predictions of Cyclical Downturns", *Journal of Economic Dynamics and Control* (1982), pages 225-241

[2]This study, however, is not the first attempt to use advanced statistical methods to evaluate leading indicators, for example, Hymans used spectral analysis Saul H Hymans, "On the Use of Leading Indicators to Predict Cyclical Turning Points", *Brookings Papers on Economic Activity II* (1973), pages 339-384

We begin by illustrating how his method works by applying it to the Composite Index of Leading Indicators. The results suggest that the Composite Index yields more useful information than is commonly believed Thus, the Composite Index's poor reputation seems largely undeserved and is due to the faulty rules-of-thumb used to determine when it actually signals recession

Next, we test the leading indicator properties of the monetary aggregates, total debt, and short-term interest rates We find that the monetary aggregates did very well in the 1950s through the 1970s, but seem to have lost virtually all of their power as leading indicators in the 1980s This, of course, fits with the judgment of many economists that innovation and deregulation have been distorting the aggregates significantly. Total debt and short-term interest rates do not generally perform as well as the monetary variables, but lately they have provided correct signals Apparently innovation and deregulation have not been harming their ability to predict downturns

Finally, since no individual variable is entirely satisfactory, we also pool the forecasts obtained from the money supply, the commercial paper rate, Total Debt, and the Index of Leading Indicators in a way Okun suggested several years ago.[3] The results from this broader perspective look promising false or premature signals of recessions and failures to signal are sharply reduced Moreover, the advantage of relying on a com-

[3]Arthur M Okun, "On the Appraisal of Cyclical Turning Point Indicators", *Journal of Business* (April 1960), pages 101-120

bination of financial and nonfinancial variables is in accord with monetary policy's current "tripartite" approach, involving the monetary aggregates, the economy itself, and short-term interest rates [4]

Criteria for judging leading indicators

To evaluate the leading indicator properties of a financial variable (or any economic variable), analysts essentially favor these characteristics [5]

- A leading indicator should be accurate, with a record of anticipating all actual turning points in the economy while avoiding "false" predictions This is the foremost criterion by which to judge an indicator
- The lead time between the "signal" and the actual turning point should not vary too much
- The lead time should not be too long or too short
- Given the diverse forces influencing the economy, a multiplicity of indicators is likely to perform better than just one
- A leading indicator, or composite of indicators, should be chosen partly on theoretical considerations, otherwise, the reliability of a signal will always be in doubt

Clearly, the second and third criteria require some subjective view on how much variability in lead time is too large, and what lead time is too long or too short No consensus has emerged on these issues. Some analysts point out that a precise answer depends on such factors as the horizon of decisionmakers and the lag between perceiving an ensuing turning point and taking any action in consequence [6] Considering these two factors, we will accept a signal with a lead time of between zero and 12 months as valid Our lower bound, no true lead time, is based on the fact that it often takes several months to recognize that a downturn has indeed occurred, so such a signal can be genuinely useful to a decisionmaker.[7] Our upper bound in effect puts a cap on the acceptable variability of lead time

[4]Anthony M Solomon, "Some Problems and Prospects for Monetary Policy in 1985", this *Quarterly Review* (Winter 1984-85), pages 1-6

[5]Geoffrey H Moore and Julius Shiskin, *Indicators of Business Expansions and Contractions*, National Bureau of Economic Research (1967), and D J Daly, "Forecasting with Statistical Indicators", in Bert G Hickman, ed , *Econometric Models of Cyclical Behavior*, Volume 2 (1972), pages 1159-1194

[6]Okun, *op cit* , page 102

[7]See the comments of Alan Greenspan following Hymans' paper, *op cit* , pages 376-378

Perhaps the most serious problem with variables used as leading indicators is their tendency to produce false signals There appear to be two main reasons why they occasionally do so One is that the rule used to evaluate the movements of the indicator variables is not sufficiently powerful to avoid making mistakes Another is that the indicators themselves, particularly those calculated as rates of change, cannot discriminate between economic slowdowns and recessions [8]

We define a false signal as any two-month or longer reversal of a recession signal before a recession begins. (Because economic data are noisy, temporary one-month reversals are tolerated and not classified as false signals, following Hymans [9]) As we will show, the difficulty with false signals is much less severe in our analysis than is typical This is because the Neftci approach is better grounded in statistical theory than the popular rules-of-thumb, and apparently is powerful enough to succeed often in interpreting the movements of the variables we test as leading indicators

Neftçi's formula

In essence, Neftçi's approach reduces to a formula that takes monthly observations on a selected variable and estimates the probability of an imminent recession for the latest month When the estimated probability exceeds a critical value—say 90 percent, a standard cut-off value in statistics, which keeps the probability of a "false alarm" at 10 percent—an imminent recession is predicted A lower critical value would provide more lead time, a higher critical value would reduce the frequency of false signals. Note that the formula, unlike econometric models, produces no specific forecast of the level or growth rate of real GNP

Neftci's formula derives from a branch of statistics called sequential analysis [10] Sequential analysis recognizes that in many situations a decision does not have to be made immediately, but can be delayed until additional information has been acquired Sequential analysis seems particularly applicable to the problem of predicting turning points in the business cycle Each month during an expansion, a forecaster must weigh the information in the newly released data to determine whether there are sufficient signs of a nearby recession But the forecaster can always postpone a recession prediction for another month and await additional information. In this situation, sequential analysis can provide a "stopping rule", whereby the forecaster (given a pre-

[8]Sidney S Alexander, "Rate of Change Approaches to Forecasting—Diffusion Indexes and First Differences", *Economic Journal* (June 1958), pages 288-301

[9]Hymans, *op cit* , page 351

[10]G Barrie Wetherwill, *Sequential Methods in Statistics* (1976)

scribed margin for error) neither unnecessarily delays nor prematurely announces the prediction of an imminent downturn This approach should lead to more reliable projections than purely judgmental ones or those based on a rule-of-thumb Moreover, since a precise statistical basis is intrinsic to the approach, the forecaster can determine the probability of a false alarm (or type I error) that is to be tolerated

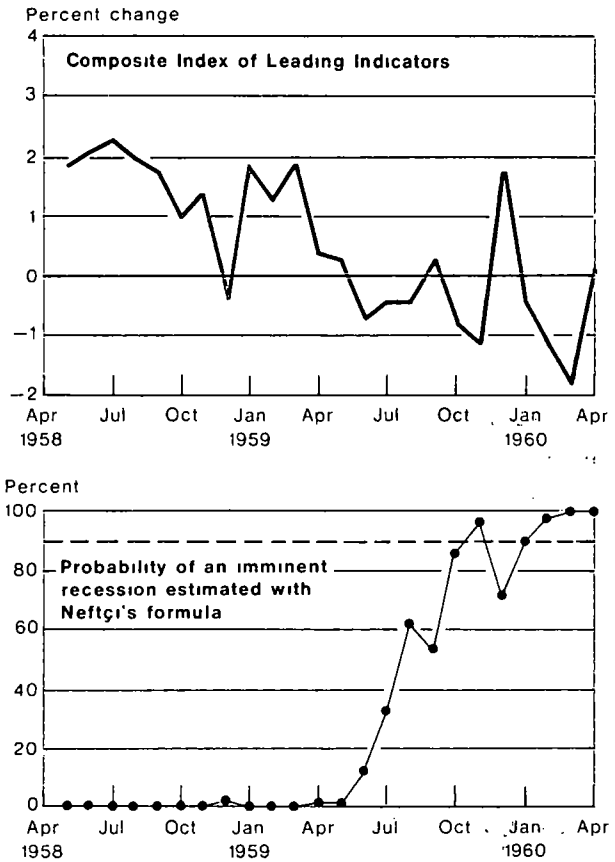
Three pieces of information go into the formula (appendix) The first is the likelihood that the latest observation on an indicator variable came while the economy was (or was soon to be) on a downswing versus the likelihood that it came while the economy was still on an upswing The likelihoods are estimated by smoothing the frequency distributions of an indicator's historical record, after splitting the data on the indicator variable into periods of expansion and recession [11] By this method extreme values naturally receive either very low or very high likelihoods of occurring while the economy is in recession, intermediate values are given moderate likelihoods For example, a two percentage point fall in the Commerce Department's Composite Index of Leading Indicators (CLI) would be assigned a nearly 100 percent likelihood of being associated with a recession, and a two percentage point rise would get a near-0 percent likelihood Meanwhile, a 0 2 percentage point rise is only a little more likely to be associated with recession than with expansion

When it is likely that the latest observation implies recession, the formula raises the estimated probability of a nearby recession Conversely, when the likelihood is low, the estimated probability drops For instance, the CLI fell 0 8 percent in June 1984, by past experience, a moderately large decline in the CLI like this has an 84 percent likelihood of being associated with a recession Consequently, the probability of a nearby recession, as estimated by the formula, jumped from 3 percent to 18 percent In another case, May 1979, the CLI rose 0.8 percent, a value clearly linked with continued expansion, and so the estimated probability of recession dropped from 63 percent to 30 percent

The second piece of information is the likelihood of an imminent recession based on the length of the recovery to date compared with the average length of postwar recoveries This simply reflects the "life expectancy" of the current recovery in an actuarial sense, not any specific information on the economy's current state [12] Historically, after 22 months into a recovery, the likelihood of a recession beginning in the very next month is only 2 percent, since postwar recoveries average much longer, 48 months But after 73 months, the likelihood of a recession setting in immediately climbs to 10 percent, because a recession is overdue In general, the formula's estimated probability will rise slightly in each successive month—apart from the new values of the indicator variable—as the recovery's life expectancy shortens

The third piece of information is the probability of recession estimated in the previous month This makes the formula recursive, with the estimated probability

Forecasting the 1960 Recession Using the Composite Index of Leading Indicators



Source United States Department of Commerce

[11] As in Neftçi's paper, the data were split into the two groups using judgment Of course, this means different researchers can get different results even though they use the same indicator variable In our work, we also tried using a specific rule to split M1 data into the two periods, the results were not appreciably different from using judgment

[12] We conjecture that substituting a measure of excess capacity in the economy would provide a better *a priori* probability, and would improve the power of Neftçi's formula Our thought is that the likelihood of recession is related more to the amount of room left for the economy to grow than to a notion of typical length of recovery

revised each month according to the likelihood that the new observation on the indicator variable points toward recession (In addition, the estimated probability is pushed up slightly each month as the recovery ages) This way, the estimated probability depends not only on the new observation, but also on all previous observations on the indicator variable. Earlier observations, in other words, can either reinforce or cancel the new reading's importance

Illustration: Composite Index of Leading Indicators

To illustrate Neftçi's approach, we insert the CLI into his formula and examine its ability to predict the seven postwar recessions plus the 1967 slowdown, which is often treated as a true recession To begin, we split the data covering the years 1947 through 1978 into periods of recession and expansion, and then estimate the likelihood, for any sized percentage change in the CLI, that the observed change was due to a downswing [13] We find that declines and small increases (up to 0 2 percent) are more often associated with recession than with continued expansion, with declines of 1 4 percent or greater occurring almost exclusively in recessions Increases in the CLI of 0.4 percent or more were usually associated with continued expansion Then, taking (1) Neftçi's formula and (2) his estimate of the likelihood of a recession based solely on the expansion's age, we calculate the probability of an imminent recession for each month from November 1949 through early 1985.[14]

The interval from May 1958 (trough) to April 1960 (peak) provides a clear example In May 1958, one month after the trough, the CLI registered a sizable 1 9 percent gain and the estimated probability of recession was 0 percent (chart) The probability remained near zero through February of 1959, but climbed to 62 percent in August following three consecutive moderate declines in the CLI In September, a small increase in the CLI reduced the recession probability a bit, but large decreases in October (−0 8 percent) and November (−1 1 percent) pushed the probability up to 97 percent After dropping to 72 percent because of an unusual 1 8 percent increase in December, it went back above 90 percent in January when the CLI fell once more. For the next three months, the probability exceeded 90 percent, and in April a peak in the cycle was identified Thus, the CLI gave a warning with a lead time of five months, counting back to November 1959 or, because the probability dipped below 90 percent in December, three months counting back to January 1960

Table 1

Performance of the Composite Index of Leading Indicators (1950-83)

Peak in business cycle	Amount of lead time provided (in months)
7/53	1
8/57	Premature (14)
4/60	5
12/66	6
12/69	1
11/73	3
1/80	6
7/81	No signal

False signals April 1951 through May 1952

In Table 1, we summarize the results for the period 1949-83 The much-maligned CLI, we find, can predict turning points substantially better than is generally recognized In six of eight recessions, the CLI provides a useful signal a prediction zero to 12 months before the downturn In two cases, however, the CLI fails to provide a useful signal First, it gave no prior warning of the 1981 recession, the probability computed by the formula did not exceed 90 percent until two months after the recession began Second, before the 1957 recession, it gave a premature signal, a warning 14 months in advance In defense of the CLI, the economy was teetering on the brink of recession beginning in 1956-III. Thus, while indeed the CLI erred here, it was not as grievous an error as, say, signaling recession when the economy instead boomed for two more years Aside from these two errors, the CLI gave one totally false signal it predicted recession continuously for 14 months (from April 1951 to May 1952) with no nearby recession

During 1984, the CLI indicated a significant probability of recession, but the probability was never high enough to warrant predicting an imminent recession. The estimated probability peaked in July at 67 percent and again in December at 55 percent (Table 2) Through April 1985, the probability stayed below 20 percent

[13] An assumption underlying Neftçi's approach is that the economy's behavior in recession is basically different from its behavior in expansions This assumption would mesh with some theories of the business cycle but not with others For a recent survey on the business cycle literature, see Victor Zarnowitz, "Recent Work on Business Cycles in Historical Perspective Review of Theories and Evidence", *Journal of Economic Literature* (June 1985), pages 523-580

[14] When we calculate the probability of an imminent recession at each month from 1949 through 1984, the results obtained up to 1978 are analogous to an in-sample simulation performed with a regression model The data through 1978 are used twice first, to estimate the model, and second, to test the model The results obtained after 1978 are thus analogous to an out-of-sample simulation, since these data were not used in model estimation

These estimates are based on the data available at the time of the release of the April 1985 figure; the 1984 data were revised several times subsequent to their original release Using the data available at the time of the release of the December 1984 figure, the estimated probabilities were higher. 85 percent in August, 88 percent in October, and 89 percent in December. The CLI came within an eyelash of predicting recession Obviously, the lesser reliability of originally-released data creates the same difficulties for Neftçi's method as it does for virtually all methods of economic analysis, and argues against relying on a single indicator when forecasting.

Comparison of results using other rules

The results from Neftçi's approach can be compared with those from some traditional rules for determining when the CLI signals an imminent recession. We tested how three such rules predicted economic downturns in the postwar period·

- When the CLI in a given month is judged to be at a peak for two or more subsequent months
- Two months of decline
- Three months of decline

In its avoidance of misleading signals, the Neftçi approach dominates all the others It is powerful enough to filter out almost all false signals without losing the lead time of genuine signals While the three *ad hoc* rules incorrectly predict between seven and 12 downturns, the Neftçi formula (as mentioned above) does so only once, in 1951 (Table 3). We believe the key factor is that Neftçi's approach does what Juster suggested. it takes into account the size of movements in the CLI, not just the direction of the change.[15]

In sum, Neftçi's technique appears clearly superior to traditional ways of interpreting the leading indicators. Moreover, when Hymans applied spectral analysis to the CLI, he too found that most false signals of peaks could be filtered out.[16] This reinforces the view that strong statistical methods can make the CLI more useful Both Hymans' results and ours show that much of the CLI's reputation as an unreliable predictor of turning points in the economy may have less to do with the CLI itself and more to do with the rules used to interpret its meaning.

Table 2

Performance of the Composite Index of Leading Indicators in 1984 and 1985

In percent

Month	Change in the Index	Probability of recession given by the formula
1984		
January	0 7	0
February	1 2	0
March	0 4	1
April	0 5	1
May	0 1	3
June	−0 8	18
July	−1 8	67
August	0 4	60
September	0 9	12
October	−1 0	46
November	0 7	17
December	−0 6	55
1985		
January	1 3	5
February	0 7	2
March	0 1	5
April	−0 2	19

Table 3

Comparison Between Neftçi Approach and *Ad Hoc* Rules Relating the Composite Index to Business Cycle Peaks

	Amount of lead time provided (in months)			
Peak in business cycle	Neftçi approach	Peak in Composite Index	Two consecutive months of decline	Three consecutive months of decline
7/53	1	4	4	4
8/57	Premature (14)	Premature (23)	2	2
4/60	5	11	11	11
12/66	6	9	9	9
12/69	1	8	3	3
11/73	3	8	8	6
1/80	6	10	Premature (15)	8
7/81	No signal	3	3	3
False signals	4/51	8/50	8/50	8/50
		3/62	1/51	1/51
		3/68	11/55	11/55
		6/78	4/56	11/56
		10/78	11/56	5/59
		11/80	3/62	3/62
		5/84	3/63	4/69
			1/67	11/80
			4/69	
			5/71	
			11/80	
			5/84	

[15]See Thomas Juster's comment on the Hymans paper, *op cit*, page 383

[16]Hymans, *op cit*, pages 369-373

Performance of financial variables

We now use Neftçi's approach to analyze the leading indicator properties of financial variables. In particular, it is of interest to see whether the many innovations and regulatory changes taking place in the banking industry and financial markets over the past ten years have adversely affected the leading indicator properties of financial variables. The intermediate target approach to monetary policy emphasizes that a good target should lead movements in the ultimate objectives [17]

We evaluate over the 1950-84 period those financial variables most closely watched for clues of the economy's future course: the money supply, short-term interest rates, and the volume of credit. Before applying Neftçi's formula, we transform the variables to increase their ability to signal recession. For the three monetary aggregates and total debt, we calculate in each case the trend rate of growth over a 24-month interval and then measure the deviation from the continuation of that trend six months later.[18] Focusing on the deviation from trend, rather than on the raw data, reflects the theory that sharp decelerations in monetary (or credit) growth precede cyclical peaks. Similarly for short-term interest rates, represented by the commercial paper rate, we use the relative (or percentage) change from its level 12 months earlier. The rationale here is that sharp rises in short-term interest rates can precipitate recessions.

The results suggest that each variable has some legitimate claim as a leading indicator of business cycle peaks (Table 4). Each usually warned of coming recession. Nevertheless, we must emphasize that each variable's performance was far from perfect. All five produced instances of premature signals, failures to provide a signal, or both.

Of the variables we tried, M1's performance is appreciably the best during the 1950s and 1960s. It never gave a totally false signal and provided a warning before each of the five recessions in this period. To be sure, the signal before the 1957 recession came too early, 14 months ahead of the recession. But as we noted in the section on the CLI, a premature signal in this instance should probably not be judged too severely—the economy flirted with recession beginning in 1956-III.

What is most striking and most significant for the present, however, is that M1 seemingly lost all its leading indicator properties in the 1970s and 1980s. It failed to signal the 1973, 1980, and 1981 recessions. (Shift-adjusted M1, constructed to offset the effect of authorizing NOW accounts nationwide, did not do so badly in 1981. It gave an 82 percent probability in July, at the cyclical peak, and a 97 percent probability the next month.) Even worse, M1 emphatically predicted recession during the last three quarters of 1984. As many have argued, financial innovation and deregulation have apparently (but not conclusively, as we will discuss later) so distorted the relationship between money and economic activity that money is no longer a reliable guide to the economy's course. The deterioration of M1's performance also coincides with the Federal Reserve placing greater emphasis on monetary targets. These developments do not imply, however, that M1 will never again be a useful indicator.

The broader monetary aggregates, M2 and M3, are about as accurate as M1. Both missed the 1953 downturn and prematurely predicted recession in 1957. In addition, M2 gave a false signal in 1964. So far in the 1980s, M2 and M3, like M1, have performed poorly. In 1981 both failed to signal and in 1984 both predicted recession, M2 was also too early for the 1980 decline.

M2's 1980 error can be traced to the reversal of the disintermediation that took place in 1973 and 1974. During 1975 and 1976, M2 grew very rapidly, spurred by the return of deposits into savings and small time accounts following a decline in interest rates from their 1974 peak levels. In 1977, with the reintermediation more or less complete, M2 growth slowed significantly, and consequently it gave an unwarranted recession signal in 1978. Although the deregulation of deposit rates has eliminated the problem of disintermediation, it may not have made M2 a better indicator variable in Neftçi's approach. Deregulation may have significantly and permanently altered the behavior of M2 such that its historical record—upon which Neftci's approach relies—may not be useful for interpreting its current movements.

Total Nonfinancial Sector Debt—the debt aggregate currently monitored, but not targeted by the FOMC—performed decently, but not as well as M1 until recently. From 1959 (when the data begin) to the present, this debt measure neither falsely signaled nor prematurely predicted recession. But it failed to call the 1960 and 1973 downturns. Importantly, Nonfinancial Sector Debt has excelled in the 1980s, just when the monetary aggregates failed. Debt clearly signaled the last two recessions, and in 1984 did not call for an imminent recession. Perhaps this success indicates that such a broad credit aggregate was less affected by financial

[17] Richard G. Davis, "Monetary Targeting in a Zero Balance World", Proceedings of Asilomar Conference on Interest Rate Deregulation and Monetary Policy, sponsored by the Federal Reserve Bank of San Francisco (November 1982), page 38.

[18] That is, the trend is measured over a 24-month span, this trend is extended an additional six months. At this point, the actual level of M1 (M2, M3, or total debt) is compared with the extrapolated level to measure (in percent) the deviation from trend. This is similar to Poole's method. William Poole, "The Relationship of Monetary Decelerations to Business Cycle Peaks: Another Look at the Evidence", *The Journal of Finance* (June 1975), pages 697-712.

deregulation and innovation, and so retained its informative value. Our results thus support the view that a debt or credit aggregate can provide policymakers valuable information about the economy.[19]

The commercial paper rate certainly has the weakest performance of this group. Not only did the rate give two totally false signals, it often sent out recession signals prematurely. Moreover, it failed to signal recession in 1953. The errors may not, of course, be the fault of the variable, but the fault of the transformation used. Nevertheless, these errors deserve some comment. First, for 1951 and 1964, when the paper rate falsely signaled recession (as did the CLI in 1951 and M2 in 1964), economic growth, in fact, slowed sharply, particularly in the private nonfarm sector. These two misses suggest that the behavior of short-term interest rates cannot reliably distinguish between recessions and slowdowns, although rates did not signal falsely on other occasions when economic growth decelerated significantly but did not halt. Second, the paper rate's premature signals in 1955 and 1978 may reflect expected increases in inflation that somewhat offset the impact of the rise in nominal interest rates. (The rate of increase in the GNP deflator [fourth quarter to fourth quarter] jumped by one percentage point per year in 1955 and 1956 and by over two percentage points in 1978.) Implied here is that both nominal and real short-term rates matter. Third, the 1953 prediction miss demonstrates that interest rates are not the only important influence on the economy. In particular, the 1953 downturn may largely have been a result of an inventory correction following the unwinding of the lagged effects from the Korean War—a development that had little to do with interest rates. Considering these limitations, the commercial paper rate may at best have a secondary role in a scheme where several indicators are used. But some economists argue with good reasons that financial innovation and deregulation have made interest rates a better barometer of financial market conditions, which means that interest rates should play a more prominent role.

The data through 1984 for the monetary aggregates and total debt (and the CLI) have been refined and revised several times. We would expect them to be less reliable in practice, when initially-reported or first-revision data must be used. Of course, since interest rate data undergo no revisions, they would not do worse in practice.[20]

Earlier, we gave an example of how data revisions lowered the estimated probabilities of recession derived from the CLI in 1984. The large benchmark and seasonal factor revisions to M1 in 1983 raises the possibility that the estimated probabilities derived from initially-reported M1 at that time could easily have provided a false signal. The initially-reported data showed M1 growth to be 13.3 percent in the first half of 1983,

[19]Benjamin Friedman, "Time to Re-examine the Monetary Targets Framework", *New England Economic Review*, Federal Reserve Bank of Boston (March/April 1982), and Albert M. Wojnilower, "The Central Role of Credit Crunches in Recent Financial History", *Brookings Papers on Economic Activity II* (1980).

[20]Another consideration affecting all but M1 and interest rates is the lag until the data are released.

Table 4

Summary of Results for Monetary and Financial Variables

In months

Peak in business cycle	Amount of lead time provided					
	M1	M2	M3	Total Debt	CP rate	Leading Indicators
7/53	2	No signal	No signal	*	No signal	1
8/57	Premature (14)	Premature (19)	Premature (19)	*	Premature (24)	Premature (14)
4/60	2	5	5	No signal	12	5
12/66	2	5	5	2	6	6
12/69	3	7	8	3	6	1
11/73	No signal	6	0	No signal	7	3
1/80	No signal	Premature (27)	10	6	Premature (24)	6
1/81	No signal	No signal	No signal	8	12	No signal
False signals	None	6/64-9/64	None	None	2/51-5/52 5/64-6/64	4/51-5/52

*Data for Total Debt are not available

slowing to 5.5 percent in the second half. On this and other information, several economists warned of a nearby recession The benchmark and seasonal adjustment factor revisions made in early 1984 moderated the deceleration: 12.4 percent in the first half; 7 2 percent in the second half. (There have been further revisions since.) These revisions led many economists to quickly back away from predicting recession.

Surprisingly, the revisions had little impact on the estimated probabilities. Using a 24-month interval to measure the trend rate of growth of M1, the estimated probability of recession based on the originally released data was 0 percent from January to December 1983, and 1 percent in January 1984 (The revisions were made in February 1984.) Based on revised data, the probability was 0 percent throughout 1983 and still 0 percent in January 1984, the revisions made little difference. If a 12-month interval is used instead to measure trend growth, the estimated probability was 100 percent in November and December before and after revisions; again the revisions made little difference. This example, however, is not being used to argue that the estimated probabilities derived from M1 are generally insensitive to even major revisions. Indeed, we believe they are somewhat sensitive Instead, we are simply sharing the unexpected finding that in 1983 the revisions made little difference.

Assessing the results from the 1980s

The poor performance of the monetary aggregates in recent years suggests that innovation and deregulation have harmed their leading indicator properties. But countering this argument is the CLI's weak performance since 1980. It signaled the 1981 recession two months late (although M1 was never able to detect the recession), and in 1984 it estimated (with revised data) the probability of recession to be as high as 67 percent. The trouble the CLI has had raises the possibility that the swings in economic activity during the past few years have been unusual and, in turn, caused the breakdown of the leading indicator properties of the monetary aggregates.

This leaves some questions open. What exactly has been so strange about the economy's behavior lately? Have innovation and deregulation indeed appreciably distorted the monetary aggregates? Curiously, financial innovation and deregulation—which have taken many forms in the banking industry and financial markets—damaged the leading indicator performance of the monetary aggregates, but not the debt aggregate or short-term interest rates One might think that the new developments would have affected the relationship between the economy and all financial and monetary variables Therefore, the performance of interest rates and total debt in Neftçi's method should also have changed, since an assumption of an invariant relationship over time between an indicator variable and the economy underlies his method.[21] Nonetheless, the results do not bear this out; more work on these issues is needed.

Combining the forecasts from several indicators

Although each financial variable by itself has proved to be quite fallible as a leading indicator, the ability to predict recession may improve if the variables' signals are combined in some way. Such an approach would pool the specific information from each variable (but not pool the variables themselves) to cover the forces influencing the economy better and allow for several causes of a recession. An advantage of this approach is that the signal from one variable may be confirmed or disputed by that from another variable. For instance, a recession signal from M1 without confirmation from interest rates or the debt aggregate would be interpreted simply as a downward shift in money demand, certainly not a threat to continued expansion. A grouping of signals from a variety of variables, financial and perhaps nonfinancial, could go a long way toward meeting the evaluative criteria of a leading indicator listed above

But how should such a grouping be assembled? One strategy, proposed years ago by Okun, is to form a group of indicators, all of which are treated equivalently.[22] The group is said to signal a recession when a predetermined number of the indicators (presumably, more than one and fewer than the total in the group) first indicates recession In this way, one or more of the other indicators must echo the earliest signal before the forecaster makes a recession prediction Which indicators signal earliest will depend on the cause or causes of each prospective recession.

The results of using this group approach are shown in Table 5. Variables included are M1, the commercial paper rate, Total Debt, and the CLI. (The CLI contains some financial variables and overlaps M1 and Total Debt.) Overall, the performance of the "first n indicators" approach looks good. There is only one false signal; premature signals are reduced to one before the 1957 recession, which we argued earlier is not such a serious error. And only in 1973 and 1981 do some of the combinations

[21]The point that innovation and deregulation may have changed the relationship between interest rates and the economy has been made by M A Akhtar, *Financial Innovations and Their Implications for Monetary Policy An International Perspective*, Bank for International Settlements, Economic Papers No 9 (December 1983), the effects were illustrated by John Wenninger, "Financial Innovation—A Complex Prob'em Even in a Simple Framework", this *Quarterly Review* (Summer 1984), pages 1-8

[22]Okun, *op cit*, pages 113-119

fail to signal recession. Moreover, the lead times are less variable than those of individual variables

Although several combinations of variables we examined perform very well, there have not been many occasions in the past 40 years on which to conduct these tests; there have been only eight postwar recessions (including 1967) Nevertheless, there are reasons for expecting some combinations to be more accurate predictors than others. In particular, the combination of the commercial paper rate, Total Debt, and the CLI covers a wide range of possible causes of recession, including both real and financial sector disturbances On the financial side, both a price and a quantity variable are included (supplemented by the quantity variables in the CLI) Moreover, the broad-based debt measure may not have been seriously affected by financial deregulation and innovation, as M1 has been. The CLI represents the nonfinancial side of the economy (although not exclusively).

Because of recent problems with M1 and the desirability of including a direct indicator of the nonfinancial side of the economy, this combination may be preferable to that of the commercial paper rate, Total Debt, and M1—even though both combinations have about the same record in the past. M1 is likely to become a reliable leading indicator again if and when its relationships with the economy and interest rates become tighter. Until then, our analysis suggests that the narrow monetary aggregate should play a secondary role in anticipating economic downturns.

Conclusion

Our analysis has important implications for macroeconomic forecasting as well as for monetary policy. In broad terms, our results indicate that many problems associated with the CLI, or other variables examined for clues of imminent turning points in the economy, arise because of the rule used to evaluate their information, not because of the variables themselves. Nevertheless, even with a rule as sophisticated as Neftçi's, false and premature signals as well as failures to signal do occur, although less frequently. Apparently, the economy and the indicator variables are subject to too many independent influences for any single indicator variable to be infallible We have shown, though, that a broad enough grouping of three or four variables, comprised of measures of the price and quantity of credit and the strength of the economy's real sector, has been quite accurate to date.

As for the individual financial variables, none has proved to be a totally reliable leading indicator. Movements in short-term interest rates have signaled prematurely, been offset by changes in inflation expectations, and had difficulty distinguishing between economic slowdowns and downturns. The monetary aggregates have apparently been affected by recent financial innovations and deregulation. Thus, their historical relationship to the economy is no longer a reliable guide. Finally, the nonfinancial sector debt aggregate, while performing well so far in the 1980s, erred on occasion in the earlier decades, and cannot be considered entirely reliable.

Table 5

Amount of Lead Time Provided by the "First n Indicators" Approach

In months

Peak in business cycle	M1 CP rate Total Debt	M1 CP rate CLI	CP rate Total Debt CLI	First 2 among: M1 CP rate Total Debt CLI	First 3 among: M1 CP rate Total Debt CLI
7/53	*	1	*	*	*
8/57	*	Premature (14)	*	*	*
4/60	2	5	5	5	2
12/66	2	6	6	6	2
12/69	3	3	3	3	3
11/73	No signal	3	3	3	No signal
1/80	6	6	6	6	6
7/81	8	No signal	8	8	No signal
False signals	None	None	4/51-5/52	4/51-5/52	None

*Data for Total Debt are not available

This mixed performance illustrates once again the risk of focusing solely on one target in conducting monetary policy. Moreover, the superior results obtained by grouping several variables, financial and nonfinancial, demonstrate the advantages of a wide-ranging view Indeed, they mesh with what has been called a tripartite approach to monetary policy, involving the monetary aggregates, the economy itself, and short-term interest rates

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Neftçi's Formula

Neftçi's formula is as follows *

$$\Pi_{k+1} = \{\Pi_k + [P_{k+1} \cdot (1 - \Pi_k)]\}p^1_{k+1} \Big/ (\{\Pi_k + [P_{k+1} \cdot (1 - \Pi_k)]\}p^1_{k+1} + [(1 - \Pi_k)\, p^0_{k+1}\, (1 - P_{k+1})])$$

where Π is the estimated probability of a nearby recession, assumed to be zero at the beginning of an expansion,

P is the probability (or likelihood) of a nearby recession based on the length of the recovery to date;

p^0 and p^1 are the likelihoods that the latest observation came while the economy was in, or about to be in, expansion and recession, respectively, more technically, they are the values of the conditional densities of the indicator variable during expansion and recession intervals, and

k is a time parameter, set at zero at the beginning of an expansion

Values for P are found in Neftçi, and values for p^0 and p^1 must be estimated

*Salih N Neftçi, *op cit*, page 231