Tests on the Rationality of Professional Business Forecasters with Changing Forecast Horizons

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Abstract

This paper tests the rationality (unbiasedness and efficiency) of business forecasts (*Blue Chip Financial Forecasts*). One quarter ahead forecasts of the Fed Funds rate are found to be both unbiased and efficient. The two, three, and four quarter ahead forecasts of the Fed Funds rate did not conform to the rationality conditions. The results for the forecasts of M1 growth and the rates of change of the CPI and real GNP also are mixed.

Introduction

This study focuses on forecast rationality by analyzing a recent set of survey data generated by the monthly newsletter, *Blue Chip Financial Forecasts*. In this nationally compiled and distributed newsletter, various professional business economists provide monthly forecasts of several important macroeconomic variables over multiple time horizons. Because these forecasts represent the expectations of sophisticated observers of the economy, the data set provides a meaningful opportunity to test observable expert expectations data for conformity with the rational expectations hypothesis. In order to allow weak form tests of expectations adjustment, the data also are analyzed using the adaptive expectations model.

Expectations (forecasts) that conform to the requirements of the rational expectations hypothesis are conditioned by all relevant information existing when the forecast is made. In terms of this study, the hypothesis predicts that utility-maximizing business forecasters will not make systematic errors when predicting future macroeconomic variables. Because the costs associated with systematic error are large, the hypothesis also predicts that these forecasters will have strong incentives to change their forecasts as revisions in the economic environment (and their information sets) occur.

0747-5535/91/1300-0028 $01.00

Because this paper explicitly examines rationality over a moving forecast horizon, so-called iterative forecast rationality can be isolated and analyzed. The question behind iterative forecast rationality is straightforward: Can informed macroeconomic forecasters produce rational forecasts when information is updated in a sequential manner?

This study poses the following questions. Are these predictions rational? That is, the consumers of the forecasts are interested in how well these expert predictions fare over time. Does the information the forecasters assimilate and process enable them to forecast rationally? Which macroeconomic variables are easier to predict using the rationality criteria? Which are more difficult? Also, what happens to individual variable rationality as the forecast horizon is lengthened?

The hypotheses to be tested in this paper are:

- Forecasts are unbiased predictors of subsequent realized values;
- Forecasts should make efficient use of readily available relevant information;
- Forecast errors should exhibit no serial correlation;
- Forecasts exhibit adaptive behavior;
- Forecast rationality is influenced by the time horizon under consideration.

Survey Data on Expectations

Testing hypotheses about how expectations are formed is difficult because expectations cannot be observed. Wide ranging, reliable time series data on expectations do not exist. It would be prohibitively expensive to generate such data. Even if a large scale effort to measure expectations were to be conducted, serious reliability problems would emerge. One problem is that actual market expectations are not identical to sample surveyed expectations. For instance, Hafer and Resler (1982) address the issue of surveys of experts who are not engaged in those market activities to which their forecasts pertain. ". . . economic theory typically calls for the use of the market's expectations. Thus, only the expectations of those participating either directly or indirectly in the market should be considered appropriate" (Hafer and Resler, 1982, p. 1050).

A related problem is that not all respondents are equally interested or equally equipped to provide consistent responses. For one respondent, expectations about the price level one year hence may be of intense interest, and much calculation may go into the formation of his or her expectation. For another respondent, prices may be of only limited interest, and the forecast may be made casually.

Yet the predictions of both are weighted equally. These and other problems may exist with respect to survey data.

Furthermore, the more homogeneous the surveyed groups, the less severe the criticism of survey data. Most of the empirical tests of rationality based on survey data utilize responses from a relatively similar set of respondents. For instance, the most widely known set of expectations survey data is the Livingston index, in which professional business economists are surveyed twice yearly for inflationary expectations.

McNees (1985), using the mean absolute errors and the root mean square error, compares the rationality of forecasts generated by the Bureau of Economic Analysis, Chase Manhattan, Data Resources Incorporated, Georgia State University, and Wharton Econometrics. He finds no tendency for a best forecast or best model.

Using survey data generated by Money Market Services, Pearce and Roley (1985) find unbiased forecasts of M1, the Consumer Price Index (CPI), Producer Price Index (PPI), and unemployment rate. Forecasts of the Industrial Production Index (IPI), however, were biased. Brocato, Kumar, and Smith (1989) find biased forecasts of spot oil prices generated by a group of oil industry executives.

The rationality of expectations based on survey data is, at best, mixed.

The data set analyzed in the present study will utilize the consensus forecast of panelists surveyed by the interest rate forecast newsletter *Blue Chip Financial Forecasts*. A consensus forecast is the average of a set of individual forecasts. Several articles (Zarnowitz, 1979, 1984; Makridakis and Winkler, 1983; and McNees, 1987) have addressed forecast rationality of consensus forecasts *vis a vis* the individual forecasts of which they are composed. Findings indicate that consensus forecasts "are more accurate than most, sometimes virtually all, of the individual forecasts that constitute the consensus" (McNees, 1987, p. 15). The consensus forecast can be thought of as a vehicle by which various judgmental forecasting methods of numerous individuals are incorporated into one information set. Hence, the consensus forecast should be more accurate (as well as unbiased and efficient) relative to most--if not all--of the individual forecasts.

Using graphic analysis, Bernstein and Silbert (1984) show that the *Blue Chip Economic Indicators* move toward the actual values of real GNP and the inflation rate as the forecast horizon shortens. Their results for GNP are not consistent with the current results, although those of the inflation rate are consistent.

Methodology

Data

The survey data on forecasts for this study are obtained from the monthly newsletter *Blue Chip Financial Forecasts*. The publication is devoted primarily to forecasts of various interest rates. In addition, however, a handful of other macroeconomic variables are forecasted on the grounds that they are key assumptions underlying the interest rate forecasts. This study conducts rationality tests on one of the interest rate forecasts--the Federal Funds rate (FFR)--and three of the key assumption variables: percentage changes (annual rates) in M1, in the CPI, and in real GNP.

The forecast data are organized in the following manner. Respondents are asked to forecast selected variables over expanding time horizons; specifically, respondents make monthly forecasts of quarterly data one through four quarters ahead. The participants are approximately 40 to 45 professional business economists employed by various companies, primarily large commercial banks and other financial institutions. The monthly mean of individual forecasts constitutes the *Blue Chip* consensus forecast used in this study.

Because previous studies indicate that a consensus or group mean displays superior predictive accuracy to most of the individuals within the group, a reasonable *a priori* assumption is that the *Blue Chip* consensus will be more rational relative to most of the individual forecasts it comprises. This study will analyze the one to four quarter ahead consensus forecasts of the four variables mentioned above.

The Information Set

For any forecast, the information set at the time the forecast is made is critical if a determination about rational expectations is to be made. For the four variables in this study, the relevant information set varies. Data on the FFR are available on a daily basis. No revision of these data is made. M1 data are available on a weekly basis and are revised weekly only for three to four weeks following the initial announcement. The CPI data are announced monthly and are not revised. Real GNP numbers are announced quarterly and are revised several times. Although the data on the four variables are announced at various intervals, this study tests the quarterly forecast rationality of these variables.[1]

[1]The importance of the information set is stressed because any test of rational expectations is a test based upon past knowledge of the variables being forecast. Because this paper deals with quarterly forecasts, the forecasters have an up-to-date information set on the Fed Funds rate (daily data without any

The relevant forecasts are those made nearest the beginning of each quarter. As a result, the forecast figures are obtained from the January 1, April 1, July 1, and October 1 editions of the *Blue Chip* newsletter. Thus, a one quarter ahead consensus forecast reported January 1 represents the forecast for the first quarter of that year; a two quarter ahead forecast represents the forecast for the second quarter of that year; et cetera. Forecasts for the FFR and M1 are obtained beginning with the April 1, 1983 issue of the *Blue Chip* newsletter. Forecasts for CPI and real GNP commence with the July 1, 1984 issue; hence, forecasts for these variables are obtained from the July 1, 1984 through July 1, 1988 issues. Actual data are quarterly from 1983:2 to 1988:3 for FFR and M1, 1984:3 to 1988:3 for CPI and GNP.

Analysis of multiple time horizons should provide some of the most interesting results. It is reasonable to hypothesize at the outset that forecast rationality should decay as the horizon lengthens. Thus, this study also allows for a test to determine if these priors hold for the variables selected from this particular data set.

Properties of Rational Expectations

As a formal definition, expectations are said to be rational if the conditional expectation of the variable in question conforms to the mathematical expectation of the actual value of the variable. The theory suggests that the expectation or forecast of a variable X for time t, given all the relevant information (I) readily available in time t-1, should be correct, on average. This may be expressed as

$$(1)\quad E(X_t \mid I_{t-1}) = X_t.$$

Should the forecaster possess perfect foresight, the information contained in I_{t-1} will not only be information that is readily available, but all possible information concerning the variable in question will be perfect information. In this case, the actual value, on average, will equal the expected value. Without perfect information, some random error should accompany expectations, i.e., the forecaster will make efficient use of all information contained in I_{t-1} such that

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revisions), M1 growth (the changes are announced weekly with no revision after four weeks), and the CPI (which is announced monthly without revision). The case for real GNP growth is not as clear. Real GNP growth is announced quarterly with revisions. Evidence is found, however, of unbiased forecasts at the three and four quarter ahead forecasts. This suggests that the information set for real GNP growth is current. The authors wish to thank an anonymous referee for emphasizing the currency of the information set.

any deviations of expectations from actual values are attributable to some nonsystematic or random influence. This may be expressed as:

(2) $X_t = E(X_t \mid I_{t-1}) + \varepsilon_t$

where ε_t represents a random error term. Furthermore, the expected value of the error term is zero. That is, if

(3) $\varepsilon_t = X_t - E(X_t \mid I_{t-1})$

then

(4) $E(\varepsilon_t \mid I_{t-1}) = E(X_t \mid I_{t-1}) - E(X_{t-1} \mid I_{t-1}) = 0.$

For expectations to be rational, all deviations of actual X from predicted X must be captured in the error term. If not, this indicates the presence of systematic error in the forecasts--readily available information on which predictions of X are based is not being used efficiently.

A further implication of rational expectations is that all errors made in previous forecasts constitute readily available information and, as such, should be integrated into the information set available to the forecaster, i.e., ε_{t-1} should be integrated into I_t. This leaves any forecast error on X_t attributable to ε_t alone. Thus, errors made in time t should be orthogonal to both information available in time t-1 and errors made in time t-1. This may be expressed as

(5) $E(\varepsilon_t * I_{t-1} \mid I_{t-1}) = 0$

and

(6) $E(\varepsilon_t * \varepsilon_{t-s}) = 0$, where $t > s$.

The focal question of this study--Are the expectations of the surveyed forecasters rational?--may be posed in another way: Do these forecasters make systematic (nonrandom) mistakes in their predictions? To be considered rational, the *Blue Chip* consensus forecasts should be consistent with the properties outlined above.

Statistical Tests for Rationality

Several standard statistical tests for the properties of rational expectations exist. The primary tests are for unbiasedness, efficiency, and absence of autocorrelation among the error terms.

1. Unbiasedness. From equation (4), it follows that a forecast, $E(X_t)$, is an unbiased estimator of the actual value (X_t) if a regression equation is of the form

$$(7) \quad X_t = \alpha + \beta E(X_t) + \varepsilon_t,$$

where

$$\alpha = 0, \beta = 1.$$

That is, $E(X_t)$ is an unbiased predictor of X_t if the joint null hypothesis $(\alpha,\beta) = (0,1)$ cannot be rejected.

2. Efficiency. From equation (5), it follows that forecast errors generated in time t that are correlated with information in time t-1 indicate an inefficient use of readily available relevant information. Theoretically, such information should have been incorporated into the forecast for time t to render a more accurate prediction. Efficiency tests attempt to discover whether information is being processed fully by forecasters.

Efficient incorporation of readily available relevant information suggests that the way the actual process by which X is generated is equal to the process by which forecasts are generated. That is, if Xt behaves over time as

$$(8) \quad X_t = \alpha_0 + \alpha_1 X_{t-1} + \ldots + \alpha_i X_{t-i} + \varepsilon_t$$

then $E(X_t)$ similarly should evolve as

$$(9) \quad E(X_t) = \beta_0 + \beta_1 X_{t-1} + \ldots + \beta_i X_{t-i} + \upsilon_t, \; i = 1, \ldots, n$$

such that $\alpha_i = \beta_i$, for all i. Subtract equation (9) from equation (8) to get

$$(10) \quad X_t - E(X_t) = \gamma_0 + \gamma_1 X_{t-1} + \ldots + \gamma_i X_{t-i} + \xi_t, \; i = 1, \ldots, n.$$

A weak form efficiency test regresses forecast errors of X, $(X_t - E(X_t))$, on lagged actual values of X. In this instance, the forecast is weak form efficient if H_0: $\gamma_1 = \gamma_2 = \ldots = \gamma_i = 0$ cannot be rejected. If H_0 is rejected, then efficiency is rejected. That is, "any nonzero coefficients indicate that information was

available at the time the forecasts were made which could have reduced forecast errors, but was not properly incorporated into expectations" (Figlewski and Wachtel, 1981, p. 3).

3. Nonautocorrelation of error terms. Equation (6) suggests that the forecast error generated in time t should be serially uncorrelated with past forecast errors. Autocorrelation indicates systematic errors by forecasters. As a result, the presence of autocorrelation in the unbiasedness regression equation (7) constitutes sufficient evidence for rejection of rationality.

Adaptive Expectations

The *Blue Chip* forecast data set also will be tested to determine the extent to which the consensus forecasts of the four selected variables are formed adaptively. The adaptive expectations hypothesis asserts that individuals revise their forecasts based upon their observations of past forecasting errors. The adaptive model in general is expressed as

$$(11) \qquad E(X_t) = E(X_{t-1}) + \lambda(X-E(X))_{t-1}$$

where X and EX are the realized and forecasted values of the variable, respectively. λ represents the learning coefficient, i.e., indicates the degree to which the forecaster adjusts his or her forecast to prior observed forecast error. A learning coefficient of zero indicates that past errors have no influence on forecast revision. The greater the value of λ, the greater the sensitivity of subsequent forecasts to past forecast errors. A negative value of λ indicates that forecasts tend to exhibit regressivity, i.e., "survey respondents expect past errors or actual changes to be reversed" (Urich and Wachtel, 1984, p. 191).

Statistical investigation of adaptive influences is facilitated by transforming equation (11) into the following expression:

$$(12) \qquad E(X_t) - E(X_{t-1}) = \lambda(X - E(X))_{t-1}$$

i.e., forecast revisions are regressed upon past forecast errors. A value of λ statistically different from zero indicates adaptive influences, the degree of which depends upon the size of λ.

Results

Preliminary Accuracy Measures

Examination of Table 1 provides a preliminary indication of the forecast accuracy of the *Blue Chip* consensus for the four variables analyzed in this study. In Table 1 the mean error (ME), mean absolute error (MAE), root mean square error (RMSE), and root mean square error divided by the standard deviation of actual values (RMSE/SD) are presented for each variable for each of the one through four quarter forecast horizons. On the basis of the first three measures, forecasts of M1 growth appear to be the most inaccurate. This is somewhat misleading, however, because the variance of M1 is substantially greater than that of the other variables. It is clearly more difficult to predict accurately a variable whose actual values jump around a great deal than it is to predict one whose actual values exhibit relatively little variability. As a result, the RMSE/SD measure best facilitates cross-variable comparisons. The FFR forecasts perform best over the one through three quarter ahead time horizons. The RMSE/SD for real GNP growth is lowest among the four quarter ahead forecasts. M1 growth forecasts improve dramatically after accounting for the variability of actual values.

The most interesting conclusion from Table 1 concerns the question of what happens to accuracy as forecast horizons lengthen. The multiple horizon predictions of the *Blue Chip* consensus present an opportunity to investigate the reasonable hypothesis that forecast accuracy decays (forecasts become increasingly biased) as forecast horizons expand. Table 1 presents preliminary evidence to show that this may not hold for all variables. For Fed Funds, M1, and CPI forecasts, the hypothesis holds--accuracy deteriorates as forecast horizons lengthen. This is not the case for forecasts of real GNP growth. Forecast accuracy improves as horizons lengthen for this variable, on the basis of the MAE, RMSE, and RMSE/SD measures.

This result is consistent with previous findings. Although it is true that, in general, forecast accuracy worsens as time horizons lengthen, there are some variables (such as both nominal and real GNP) that tend to exhibit the opposite property. The reasoning behind this is that such variables often are characterized by error offset, as opposed to error buildup. McNees characterizes the phenomenon in this way:[2]

[2]In only five of the 17 observations for real GNP growth did the actual numbers rise (or fall) on successive observations. This makes tracking real GNP growth difficult for forecasters. This is why little evidence is found of adaptive expectations later in the article. What evidence found is of regressivity. Similar results hold for the rate of change in the CPI (eight of 17 observations are

> Often, a surprise in real GNP growth in one quarter portends a surprise in the opposite direction in the next quarter. Recall, for example, the unexpected declines in real GNP for the second quarters of both 1979 (energy shortage) and 1980 (credit controls). In each case, the unexpected weakness was followed by unexpected strength in the subsequent quarter. Forecasts of the half-year time span that included both quarters were more accurate than those of either quarter alone, thanks to errors of opposite signs in the quarterly pattern (McNees, 1988, p. 23).

Conversely, forecast errors of other variables tend to accumulate, i.e., an unexpected change in one quarter often is followed by an unexpected change in the next quarter in the same direction, such that a one quarter ahead forecast error derived from the first unanticipated change is less than a two quarter ahead forecast error that is composed of the cumulative changes of both periods.

The results arrayed in Table 1 provide a preliminary indication of how accurate the *Blue Chip* consensus forecasts are for the four selected variables. The next two sections present the results of tests designed to determine whether the *Blue Chip* forecasts conform to the specific properties, outlined above, of rational expectations.

Unbiasedness and Error Orthogonality

The necessary conditions for rationality include unbiased forecasts, efficient use of readily available information, and orthogonality of forecast error terms.

Table 2 presents the OLS unbiasedness test results. Recall from equation (7) that forecasts are unbiased predictors of actual values if the joint null hypothesis $(\alpha,\beta) = (0,1)$ cannot be rejected. Significant F-statistics in Table 2 warrant rejection of the joint null hypothesis, i.e., rejection of unbiasedness.

Results for the FFR and M1 growth are mixed. For both, the F-statistics indicate rejection of unbiasedness for the three and four quarter ahead forecasts, while the one and two quarter ahead forecasts cannot be rejected. The Durbin-Watson statistic, however, indicates significant autocorrelation for both variables for all time horizons, with the exception of the one quarter ahead Fed Funds forecast. Because OLS F-statistics are not reliable when autocorrelation is present, no meaningful conclusions regarding unbiasedness legitimately can be

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followed by numbers in the same direction). The numbers for the Fed Funds rate and M1 growth are 12 of 22 observations for both variables. This error buildup, as McNees calls it, makes tracking the Fed Funds rate and M1 growth more accurate.

drawn. Yet at the same time, the presence of serial correlation violates a necessary condition for rationality.

Like the FFR and M1 growth, unbiasedness unambiguously is rejected for the three and four quarter ahead forecasts of CPI, but cannot be rejected for the shorter one and two quarter ahead forecasts. The opposite conclusions are drawn for real GNP. As discussed above, the longer horizon three and four quarter ahead forecasts are more rational than the shorter-term one and two quarter ahead forecasts because of the previously discussed error offset. The OLS results reinforce this finding; the one and two quarter ahead forecasts are biased, while the three and four quarter ahead forecasts are not. The CPI change and real GNP growth forecasts also meet the error orthogonality criterion of rational expectations; the Durbin-Watson statistics contained in Table 2 indicate the absence of any significant serial correlation.

Because the OLS test statistics are invalid in the presence of serial correlation, the hypothesis for the FFR and M1 growth were retested using generalized least squares (GLS) in the manner suggested by McNees (1978). An estimate of the first order autocorrelation coefficient, ρ, was obtained using the GLS procedure. The data set was transformed by ρ to filter the data. This process reduced, but did not eliminate, the autocorrelation present in the residuals of the afflicted regressions (see Table 3). The Durbin-Watson statistic improved in each case in which first order autocorrelation is present, but not enough to reject the hypothesis of autocorrelation.

Using the GLS procedure as a first approximation for correction of autocorrelation, Table 3 indicates a greater likelihood of acceptance of the unbiasedness criterion for M1 (no significant change in results for Fed Funds). Undue emphasis should not be placed on these results, however, as the presence of autocorrelation is sufficient evidence for rejection of rationality. Systematic error is prevalent for the two through four quarter ahead Fed Funds forecasts and for the one through four quarter ahead forecasts of M1 growth.

In summary, the OLS unbiasedness tests are satisfactory and highly illuminating for CPI and real GNP. Findings suggest that unbiasedness is rejected (not rejected) for the three and four quarter ahead (one and two quarter ahead) CPI change forecasts and the one and two quarter ahead (three and four quarter ahead) real GNP growth forecasts. There is no evidence of significant serial correlation, indicating that the criterion of orthogonality among the error terms is met for these two variables.

Results for FFR and M1 forecasts are less clear. OLS estimates indicate substantial serial correlation for all M1 forecasts, as well as the two through four quarter ahead Fed Funds forecasts.

Efficiency

Weak form efficiency is tested by regressing the current forecast error on lagged forecast errors. If forecasters are efficient, they are processing historical information on these errors correctly. Thus, the coefficients on the past forecast errors should not be jointly significant. The form of the efficiency test is as follows:

$$(15) \quad (X\text{-}E(X))_t = \delta_0 + \delta_1(X\text{-}E(X))_{t-1} + \delta_2(X\text{-}E(X))_{t-2} + \delta_3(X\text{-}E(X))_{t-3}$$

where $(X\text{-}E(X))_t$ is the forecast error of each respective variable, regressed upon three lagged values.

OLS results for this test are shown in Table 4. With one exception, the efficiency hypothesis (H_0: $\delta_1 = \delta_2 = \delta_3 = 0$) is rejected upon the basis of F-values at the 5 percent level. It is the one quarter ahead forecast of the FFR that meets the efficiency criterion. This is consistent with the earlier results of unbiasedness for the same forecast. Inefficiency holds for all other forecasts of the FFR and M1 growth. This is also consistent with the earlier bias results for the two, three, and four quarter ahead forecasts of the FFR and all four forecasts of M1 growth.

Because of the movements of the CPI change and real GNP (referred to in footnote 2), the tests for efficiency of these variables preclude any finding other than efficiency. That is, a regression of this period's forecast error on past forecast errors will yield insignificant coefficients. This is due to the condition that the rates of growth of the CPI and real GNP change direction frequently. Thus, the offsetting errors tend to indicate no relationship. Therefore, the efficiency tests for these two variables are omitted.

Adaptive Expectations

Table 5 presents the results for a test of the hypothesis that the *Blue Chip* consensus forecasts of the FFR and M1 growth are revised consistent with the adaptive expectations hypothesis. Following earlier discussion, the FFR and M1 growth rate forecasts are analyzed according to the following adaptive model:

$$(16) \quad (E(X_{t+s}) - (E(X_{t+s-1})) = \lambda_0 + \lambda_1(x\text{-}E(X))_{t-i}$$

where:

$s = 0, \ldots, 3$ for forecast horizons one through four, respectively; and
$i = 1$ for the FFR and M1 growth and

= 2 for the rates of change in the CPI and real GNP.[3]

That is, forecasts of these variables are revised according to previous forecast errors.

Results for the FFR and M1 growth support the adaptive hypothesis. The one quarter ahead FFR best conforms to adaptive expectations. The value of the coefficient on the one quarter ahead forecast error is 127 basis points, meaning that the one quarter ahead forecast revision is sensitive to previous forecast errors. The forecast error coefficients (or the learning coefficient) fall as time horizons lengthen. This indicates that immediately previous errors are important for prediction adjustment for short span, one quarter ahead forecasts, but are of diminishing importance for longer span forecasts.

The results for M1 are also favorable to the adaptive expectations hypothesis. Even though the forecast error coefficients are all fairly small, they are all statistically significant. The four quarter ahead coefficient, for instance, is a small 0.067 percent, yet it is statistically different from zero. Again, the forecast error coefficient tends to fall as time horizons lengthen, indicating that forecast revisions are less sensitive to previous forecast errors for longer forecast horizons.

The results for the rate of change in CPI and for real GNP growth also are displayed in Table 5. These results are not as favorable to the adaptive expectations hypothesis. This is likely, due to the offsetting nature of the errors cancelling each other. Notice, however, the regressivity shown for the one quarter ahead rate of change in the CPI. A 1 percent positive error two quarters ago is met with a revision in the opposite direction of 0.255 percent. Notice also the negative signs (even though the coefficients are not statistically different from zero) in the table for the rate of change in the CPI and real GNP. This is evidence of the frequent directional changes of these two variables.

Summary and Conclusions

This study has analyzed a set of quarterly forecast survey data for conformity to rational expectations. The data utilized are the consensus forecasts on four macroeconomic variables (FFR, M1 growth, rate of change in CPI, real GNP growth) of multiple time horizons generated by the monthly *Blue Chip*

[3]Because of the nature of the information set (more current for the Fed Funds rate (daily) and M1 growth (weekly), less current for the rate of change in the CPI (monthly) and the rate of change of real GNP (quarterly)), adaptive expectations for Fed Funds and M1 growth are tested with a lag of only one quarter on the right side of equation (16). For the rates of change in the CPI and real GNP, the right side variable is lagged two quarters.

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Financial Forecasts newsletter. Standard statistical tests for rationality were applied to determine whether the properties of unbiasedness, efficiency, and error orthogonality were exhibited. The data also were tested for adaptive expectations.

The results indicate that forecasts from the *Blue Chip Financial Forecasts* do not conform generally to the rational expectations hypothesis, although one forecast, the one quarter ahead FFR, performed well. Data for longer-term forecast horizons on this variable did not conform to the rationality properties. Also, rationality and adherence to rational expectations properties were found to deteriorate as the time horizon is lengthened. This is not true of real GNP which, consistent with previous findings, performed better as forecast horizons increased. The three and four quarter ahead CPI forecasts were not rational, and none of the one through four quarter ahead M1 forecasts were rational. For equations that exhibited first order autocorrelation in the residuals, employing the GLS estimation technique generally did not improve the results.

Tests of efficiency indicate that only the one quarter ahead forecast of the FFR exhibited the property of efficiency. Unfortunately, the form of the data for the rates of change of the CPI and GNP precluded any test of efficiency on these variables.

Evidence is found that forecasters use the adaptive model in formulating forecast revision for both the FFR and the growth rate of M1. For each of these variables, the learning coefficient was greatest for the one quarter ahead forecast, decaying as the forecast horizon lengthened. Data for the rates of change in the CPI and real GNP were not conducive to tests of adaptive expectations. Evidence of regressivity was found in the one quarter ahead forecast of the change in the CPI.

In summary, evidence was found of unbiasedness and efficiency (the rational expectations properties) only for the one quarter ahead forecast of the FFR. Other tests for unbiasedness and efficiency were not as conclusive as for the one quarter ahead FFR. Also, some evidence of adaptive behavior on the part of the forecasters was found.

These results, particularly the fact that forecast rationality deteriorates for longer horizons, suggest that the planning frontier should be updated continually. The results also suggest that those management decisions that are crucially dependent upon the Fed Fund rate, M1, and the CPI should allow for an error margin that increases with the forecasts the further one forecasts into the future.

The converse appears to be true for managerial decisions keyed primarily to GNP forecasts (e.g., sales, production, and inventory). In this case, the current results and the error offset phenomenon support the view that attention to longer-run predictions may prove more worthwhile than strict reliance on

shorter-term forecasts. The need for iterative forecast updating still is indicated for GNP-related variables, however.

The result showing short-term, but decaying longer-term rationality for the FFR has immediate implications for the management of financial institutions. The obvious reference here is to interest rate risk and the net interest margin exposure brought by the combined influences of an institutions asset/liability mix and interest rate volatility. If forecasters, on average, can predict short-term money market rates, financial institutions might attempt a more aggressive approach to short-term gap management. That is, short-term asset/liability restructuring, where feasible, may be a partial substitute for more passive hedging strategies (e.g., interest rate futures, options, swaps). The decaying rationality of the FFR, however, also implies that the various portfolio immunization techniques (e.g., gap management, duration analysis, floating rates) intended to insulate portfolio value from the effects of interest rate movements should be allotted more weight in the longer-run planning horizon. This would be especially true for those institutions characterized by excessive asset/liability mismatch.

Another factor in forecast based management of financial institutions depends on the ability of an institution to revise its balance sheet in accordance with projected trends in GNP and interest rate movements. For example, the projection of a weak economy may lead to a desire for a heavier concentration in risk free securities with a concurrent reduction in high yielding loans. Likewise, the appropriate liability adjustment based on a forecast of increased interest rates would be to restructure toward longer-term deposits. The difficulties associated with short-term balance sheet adjustment, however are well known. Because the current results show that GNP forecasts are more reliable over the longer horizon, however, asset/liability revision keyed to forecasted swings in the business cycle may be a reasonable support strategy for portfolio management.

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Table 1
Preliminary Accuracy Measures

	One Quarter Ahead	Two Quarters Ahead	Three Quarters Ahead	Four Quarters Ahead
		Fed Funds Rate		
ME	-0.061	0.107	0.396	0.721
MAE	0.455	0.926	1.212	1.428
RMSE	0.622	1.193	1.558	1.825
RMSE/SD	0.425	0.801	1.047	1.229
		M1 Growth		
ME	-1.091	-1.214	-1.320	-1.611
MAE	3.246	3.957	4.380	4.495
RMSE	4.150	5.097	5.483	5.635
RMSE/SD	0.871	1.059	1.111	1.129
		Rate of Change in CPI		
ME	0.682	1.069	1.353	1.600
MAE	0.965	1.281	1.487	1.643
RMSE	1.657	1.934	2.195	2.502
RMSE/SD	1.002	1.156	1.267	1.409
		Real GNP Growth		
ME	-0.247	-0.244	-0.407	-0.571
MAE	1.659	1.506	1.327	1.229
RMSE	1.906	1.774	1.551	1.468
RMSE/SD	1.372	1.252	1.115	1.022

Forecasts of FFR and M1 are for 1983:2 (one quarter ahead), . . . , 1984:1 (four quarters ahead) to 1988:3. Forecasts of real GNP and the CPI are for 1984:3 (one quarter ahead), . . . , 1985:2 (four quarters ahead) to 1988:3

ME = mean error
MAE = mean absolute error
RMSE = root mean squared error
RMSE/SD = root mean squared error divided by standard deviation of actual values

Table 2
OLS Unbiasedness Test Results

$$X_t = \alpha + \beta E(X_t) + \varepsilon_t$$

Forecast Horizon	α	β	$F_{k-1,n-k}$	D.W.	$\bar{R}^2$
		Fed Funds Rate			
One Quarter Ahead	1.243 (1.889)	0.852* (10.505)	1.793	1.717	0.839
Two Quarters Ahead	2.780 (2.394)	0.644* (4.579)	3.325	0.776	0.500
Three Quarters Ahead	3.850* (2.657)	0.489* (2.863)	5.436*	0.512	0.275
Four Quarters Ahead	4.464* (2.791)	0.395 (2.151)	7.973*	0.372	0.168
		M1 Growth			
One Quarter Ahead	-5.373 (-1.296)	1.855* (3.453)	2.143	0.982	0.374
Two Quarters Ahead	9.328 (1.193)	-0.117 (-0.109)	1.184	0.620	-0.052
Three Quarters Ahead	24.627* (2.719)	-2.278 (-1.800)	4.155*	0.692	0.106
Four Quarters Ahead	32.546* (3.241)	-3.413 (-2.395)	6.042*	1.023	0.208
		Rate of Change in CPI			
One Quarter Ahead	-0.728 (-0.380)	1.011 (2.094)	1.752	2.814	0.175
Two Quarters Ahead	0.113 (0.042)	0.718 (1.139)	3.427	2.037	0.020
Three Quarters Ahead	0.816 (0.253)	0.516 (0.723)	4.652*	1.940	-0.035
Four Quarters Ahead	3.333 (0.965)	-0.059 (-0.081)	6.289*	1.883	-0.083

Table 2 (continued)
OLS Unbiasedness Test Results

$$X_t = \alpha + \beta E(X_t) + \varepsilon_t$$

Forecast Horizon	α	β	$F_{k-1,n-k}$	D.W.	$\bar{R}^2$
		Real GNP Growth			
One Quarter Ahead	6.035*	-1.004*	12.289*	2.170	0.238
	(4.944)	(-2.448)			
Two Quarters Ahead	6.629*	-1.169	7.101*	2.498	0.165
	(3.768)	(-1.990)			
Three Quarters Ahead	4.958	-0.573	1.821	2.081	-0.051
	(1.682)	(-0.567)			
Four Quarters Ahead	-0.347	1.431	1.218	2.401	0.048
	(-0.123)	(1.287)			

Forecasts of FFR and M1 growth are for 1983:2 (one quarter ahead), . . . , 1984:1 (four quarters ahead) to 1988:3. Forecasts of CPI change and real GNP growth are for 1984:3 (one quarter ahead), . . . , 1985:2 (four quarters ahead) to 1988:3

t-statistics are in parentheses

D.W. is the Durbin-Watson statistic

$\bar{R}^2$ is the adjusted R-square

The F-statistic is for the joint hypothesis ($\alpha = 0, \beta = 1$) with k - 1, n - k (k = 2, n = 14, . . . , 22) degrees of freedom

*Significant at the 5 percent level

Table 3
GLS Unbiasedness Test Results

$$X_t^* = \alpha^* + \beta^* E(X_t)^* + \varepsilon_t^*$$

Forecast Horizon	α^*	β^*	$F_{k-1,n-k}$	D.W.	$\bar{R}^2$	ρ
			Fed Funds Rate			
One Quarter Ahead	1.315 (1.911)	0.843* (9.947)	1.834	1.814	0.994	0.068
Two Quarters Ahead	4.113*	0.487* (2.951)	4.637* (2.884)	1.054	0.971	0.402
Three Quarters Ahead	5.888*	0.256 (3.511)	7.279* (1.293)	0.824	0.955	0.521
Four Quarters Ahead	6.042*	0.227 (3.286)	7.412* (1.074)	0.788	0.947	0.518
			M1 Growth			
One Quarter Ahead	-3.774	1.649 (-0.808)	1.129 (0.603)	1.441	0.766	0.266
Two Quarters Ahead	13.675	-0.730 (1.661)	1.514 (-0.651)	1.181	0.601	0.396
Three Quarters Ahead	20.306	-1.709 (2.073)	2.301 (-1.246)	1.249	0.641	0.331
Four Quarters Ahead	24.478	-2.286 (2.219)	2.861 (-1.460)	1.286	0.693	0.321

Forecasts of FFR and M1 growth are for 1983:3 (one quarter ahead), . . . , 1984:2 (four quarters ahead) to 1988:3

ρ is the estimate of first order autocorrelation

X_t^*, $E(X_t)^*$, and ε_t^* have been transformed by $(1 - \rho L)$, where L is the lag operator

*Significant at the 5 percent level

Also see notes to Table 2

Table 4
OLS Efficiency Test Results
Fed Funds Rate

$$(X-E(X))_t = \delta_0 + \delta_1(X-E(X))_{t-1} + \delta_2(X-E(X))_{t-2} + \delta_3(X-E(X))_{t-3} + \eta_t$$

	One Quarter Ahead	Two Quarters Ahead	Three Quarters Ahead	Four Quarters Ahead
δ_0	1.490	1.849	1.791	0.684
	(1.816)	(1.634)	(1.635)	(0.462)
δ_1	-0.092	1.086*	1.403*	1.161*
	(-0.431)	(3.682)	(3.953)	(2.905)
δ_2	-0.105	-1.569*	-0.812	0.031
	(-0.331)	(-3.566)	(-1.882)	(0.053)
δ_3	0.018	0.246	-0.837*	-1.327*
	(0.083)	(0.825)	(-2.841)	(-3.364)
$F_{k-1,n-k}$	1.247	7.357*	6.584*	9.340*
D.W.	2.036	1.808	1.788	1.525
$\bar{R}^2$	0.036	0.488	0.709	0.582
		M1 Growth		
δ_0	-0.389	-1.368	-2.516	-3.389
	(-0.189)	(-0.622)	(-1.116)	(-1.448)
δ_1	0.594*	0.856*	0.917*	0.889*
	(2.462)	(3.319)	(3.488)	(3.260)
δ_2	-0.234	-0.259	-0.172	-0.129
	(-0.747)	(-0.773)	(-0.499)	(-0.363)
δ_3	-0.181	-0.267	-0.270	-0.163
	(-0.742)	(-1.028)	(-1.019)	(-0.589)
$F_{k-1,n-k}$	3.047*	5.747*	6.713*	5.940*
D.W.	1.831	1.894	1.830	1.732
$\bar{R}^2$	0.235	0.415	0.474	0.451

Sample period for FFR and M1: 1983:2 (one quarter ahead), . . . , 1984:1 (four quarters ahead) to 1988:3

The F-statistic is for H_0: $\delta_1 = \delta_2 = \delta_3 = 0$ with k - 1, n - k (k = 4, n = 18, . . . , 22) degrees of freedom

*Significant at the 5 percent level

Also see notes to Table 2

Table 5
Adaptive Forecast Revision

$$(E(X_{t+s-1}) - E(X_{t-1})) = \lambda_0 + \lambda_1(X-E(X))_{t-i},\ s = 0, \ldots 3;\ i = 1, 2$$

Forecast Horizon	λ_0	λ_1	$\bar{R}^2$	D.W.
		Fed Funds Rate		
One Quarter Ahead	-0.091 (-1.311)	1.273* (11.269)	0.863	1.290
Two Quarters Ahead	-0.021 (-0.132)	0.450* (3.396)	0.369	2.878
Three Quarters Ahead	0.014 (0.076)	0.299* (2.564)	0.258	2.052
Four Quarters Ahead	0.086 (0.368)	0.242 (2.060)	0.246	1.724
		M1 Growth		
One Quarter Ahead	-0.319 (-1.696)	0.182* (4.022)	0.431	1.373
Two Quarters Ahead	-0.186 (-1.375)	0.100* (3.702)	0.414	2.248
Three Quarters Ahead	-0.220 (-2.095)	0.080* (4.359)	0.529	2.303
Four Quarters Ahead	-0.182 (-1.522)	0.067* (3.338)	0.420	2.454

Table 5 (continued)
Adaptive Forecast Revision

$$(E(X_{t+s-1}) - E(X_{t-1})) = \lambda_0 + \lambda_1(X-E(X))_{t-i},\ s = 0, \ldots 3;\ i = 1, 2$$

Forecast Horizon	λ_0	λ_1	$\bar{R}^2$	D.W.
		Rate of Change in CPI		
One Quarter Ahead	-0.169 (-0.935)	-0.255* (-2.348)	0.244	1.544
Two Quarters Ahead	-0.184 (-1.160)	-0.130 (-1.660)	0.128	1.639
Three Quarters Ahead	-0.079 (-0.666)	-0.052 (-1.089)	-.018	1.175
Four Quarters Ahead	0.046 (0.357)	0.005 (0.128)	-0.140	1.198
		Real GNP Growth		
One Quarter Ahead	-0.082 (-0.487)	0.040 (0.438)	-0.061	2.688
Two Quarters Ahead	-0.078 (-0.435)	-0.002 (-0.018)	-0.091	2.484
Three Quarters Ahead	-0.062 (-0.484)	-0.056 (-0.660)	-0.598	1.412
Four Quarters Ahead	0.083 (0.855)	0.027 (0.415)	-0.115	1.541

Sample period for Fed Funds and M1 growth:is from 1983:2 (one quarter ahead), . . . , 1984:1 (four quarters ahead) to 1988:3. Sample period for CPI change and real GNP growth is from 1984:3 (one quarter ahead, . . . ,1985:2 (four quarters ahead) to 1988:3

i = 1 for the FFR and M1 Growth; i = 2 for percentage changes in the CPI and real GNP

Also see notes to Table 2