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Forecasting Accuracy in the Sixties

For all the criticism levied upon it by skeptics, economic forecasting nevertheless plays an important role in determining both government and business policies. One measure of its importance is the millions of dollars spent annually in efforts to specify, however roughly, the economy's future course. Another is the growing amount of professional time and talent in attempts to improve forecasting techniques. The development of the computer has given sharp impetus to these latter efforts, and in recent years advanced econometric techniques, coupled with computer simulations, have been brought to bear on the problem. Today, literally hundreds of models are used to predict future economic conditions. Many of these are intricate multiple equation econometric models, while others represent less formal applications of professional judgment.

One approach to the task of improving economic forecasts is through a comprehensive evaluation of forecasting accuracy. The National Bureau of Economic Research, with financial support from some leading industrial firms, has produced extensive literature on techniques for evaluating the validity of economic forecasts. It is through careful and systematic evaluation that forecasting errors and biases can be brought to the foreground.

Although forecasting techniques have improved since the early fifties, the most casual examination of forecasting performance reveals a need for further improvement. This study focuses on the accuracy of short-term forecasts of two important economic variables, gross national product (GNP) and the consumer price index (CPI). The data for this evaluation were collected from *Business Forecasts,* published annually by the Federal Reserve Bank of Richmond, and "Predictions," prepared annually by the Federal Reserve Bank of Philadelphia. These publications summarize the annual forecasts of leading business firms, educational institutions, research organizations, and individuals. The evaluations that follow are based on the annual changes in GNP and the CPI predicted by forecasters whose efforts are summarized in these publications.

Although there is some disagreement concerning the best way to evaluate forecasts, it is preferable in most instances to convert absolute level forecasts into predicted changes before evaluation. Since predictions are made at different times before revised figures are available, the actual levels of the variables at the time of the forecasts are not known. The evaluation should therefore be based on the accuracy of predicting the changes in the variables rather than predicting the levels themselves.

Statistical Concepts One of the most widely used concepts for depicting the accuracy of forecasts is the prediction-realization diagram. This diagram shows the actual change in the variable plotted against the predicted change in the variable. Perfect forecasting would be represented by a 45 degree line through the origin. This 45 degree line is called the line of perfect forecasts (LPF). The predictions of all forecasters can be plotted on the same chart and visualized in comparison with the LPF (see charts).

Particular importance is also given to the mean point, i.e., the point in the prediction-realization diagram, the coordinates of which are the arithmetic means of the predicted and actual changes. If the mean point lies on the LPF, the average predicted change over the entire time span is equal to the average actual change over the same time span. If the means are significantly different, the mean point will not lie on the LPF and the forecasts are said to be biased; i.e., the forecasts consistently underestimate or overestimate the actual changes.

Annual Changes in GNP The prediction-realization diagram for GNP indicates that forecasters have been quite inaccurate in predicting annual GNP changes during the past decade. This diagram and the accompanying table analyzing forecasting results show that the range of predictions for all forecasters included the actual change in only four of the ten years (i.e., the range of annual forecasts represented by the horizontal scatter of points actually crosses the LPF). In two of these years, the actual change was near one of the extreme points in the range. Another method of showing the inaccuracy is by

comparing the mean of the predicted change with the actual change. In only two years, 1962 and 1967, was the mean close to the actual change. Furthermore, the variation of observations around the LPF was large in all years except 1962 and 1967.

One hazard of forecasting changes in data having upward trends is the tendency to underestimate the changes.[1] Underestimation bias is clearly seen in this analysis. Seven of the ten means of the predicted GNP changes were smaller than the actual changes, that is, the means of the annual predicted changes were to the left of the LPF. Significant overestimation of the predicted change occurred only in 1960.

ACCURACY STATISTICS FOR SELECTED FORECASTS OF ANNUAL CHANGES IN GNP 1960-1969

(Billions of Dollars)

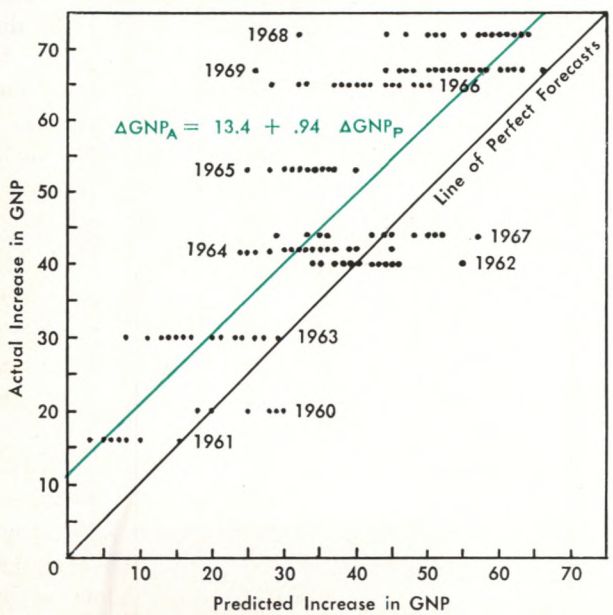
	Range of Predictions for Δ GNP	Mean Predicted Δ GNP	Mean Actual Δ GNP
1969	26.0 - 66.0	52.8	66.7*
1968	32.0 - 64.0	54.1	72.2
1967	29.0 - 57.0	45.8	43.6
1966	27.8 - 50.0	41.2	65.0
1965	25.0 - 40.0	33.2	52.5
1964	23.7 - 45.0	32.6	41.9
1963	8.0 - 28.5	17.8	30.2
1962	34.0 - 55.0	41.1	40.2
1961	3.4 - 16.0	7.9	16.3
1960	17.5 - 30.0	24.4	19.9
1960-1969	3.4 - 66.0	39.2	50.3

*Preliminary estimate.

GROSS NATIONAL PRODUCT

PREDICTION-REALIZATION DIAGRAM, 1960-1969

(Billions of Dollars)



Annual Changes in the CPI Forecasters have had almost as little success in predicting price changes as they have in predicting GNP changes. Again, an analysis of the accompanying diagram and table indicates that predictions were approximately correct in only two years, 1963 and 1964. In five years, predictions were underestimated and in three years they were overestimated. The tendency was to overestimate small changes and underestimate large changes. Dispersion around the LPF was relatively large. Since variations in price increases of one or two percentage points may have widely varying policy implications, the annual predictions of the forecasters would appear to be less accurate than is desirable for policy purposes.

Results for the Decade Forecasting accuracy for the entire decade can be measured by basically the same methods that were used to determine the accuracy in predicting the annual changes. In the case of perfection, all points in the prediction-realization diagram would lie on the LPF. In the diagrams for GNP and the CPI, the scatter of points in general does not fall on the LPF. If a line were constructed through the scatter of points connecting the midpoint of the range of values for each year, the constructed line would be nonlinear. Nonlinearity of the scatter indicates different degrees of accuracy at different levels of actual changes. The scatter of points on both the GNP and the CPI diagrams tend to lie farther from the LPF for large actual changes in the variables than for small actual changes. In each case, there is a definite tendency to underestimate large changes.

Another characteristic of the underestimation of changes is the divergence of the mean of the actual changes for the ten year period from the mean of the predicted changes for the same period. The concept of bias, as previously discussed, refers to the inequality of the two means. For the entire period, the mean actual yearly change in GNP was $50.3 billion and the mean predicted yearly change was $39.2 billion, indicating a substantial under-

[1]See Jacob Mincer and Victor Zarnowitz, "The Evaluation of Economic Forecasts," Jacob Mincer (ed.), *Economic Forecasts and Expectations*, (New York: National Bureau of Economic Research, Inc., 1969), pp. 3-46.

estimation bias in predicting annual GNP changes for the decade. The mean actual change in the CPI was 3.2% per year and the mean predicted change was 2.5% per year, again indicating a large underestimation bias in predicting annual CPI changes for the ten year period.

A least-squares straight line was fitted to the prediction-realization diagrams for GNP and the CPI. This line, which is the straight line that fits the data better than any other straight line, is shown on each diagram by a broken line. If all predictions were perfect and thus all points fell on the LPF, the least-squares line would be identical to the LPF in each diagram. The intercept would be zero and the slope of the line would be equal to one. Furthermore, since all of the points fall on a straight line, there would be perfect correlation of actual and predicted changes.

The least-squares line for the GNP and the CPI forecasts did not correspond with the LPF in either diagram, indicating bias. Since unbiased forecasts are more accurate than biased forecasts if the distances between the points in the diagram remain constant, the forecasts can be made more accurate by correcting for the bias. Graphically, removal of the bias can be accomplished by a parallel shift in the least-squares line until it intersects the mean of the actual changes on the LPF. The same results are achieved by subtracting an amount equal to the size of the bias from each point on the least-squares line. In the GNP diagram, the constant is the difference between the mean of the actual changes and the mean of the predicted changes, or $11.1 billion. The constant for the CPI diagram, found by the same method, is 0.7%. If the economy continues to expand and prices continue to rise in a pattern similar to that of the past decade, future results could probably be improved in the long run if the forecaster raises his estimates by an amount equal to the size of the bias.

Composition of Forecasts Removal of the bias in forecasting will, in most instances, improve the accuracy of predictions. However, correcting the final results does not indicate the sources of the bias. To improve the forecasting model, it is often useful to determine the source and magnitude of the forecasting error.

Errors in aggregate forecasts are usually the result of individual errors in the various components determining the aggregate variable. Some of the individual component errors are reinforcing and others are offsetting. Two different forecasts, each of which yields the same aggregate results, could have widely varying policy implications. In general, a forecasting technique that yields two small reinforcing errors in the component parts is superior to a technique that has one large positive error and one large negative error yet gives the same aggregate results. In fact, many policy makers would prefer a technique with small errors in the various elements even though the

ACCURACY STATISTICS FOR SELECTED FORECASTS OF ANNUAL CHANGES IN CPI 1960-1969

(Per Cent)

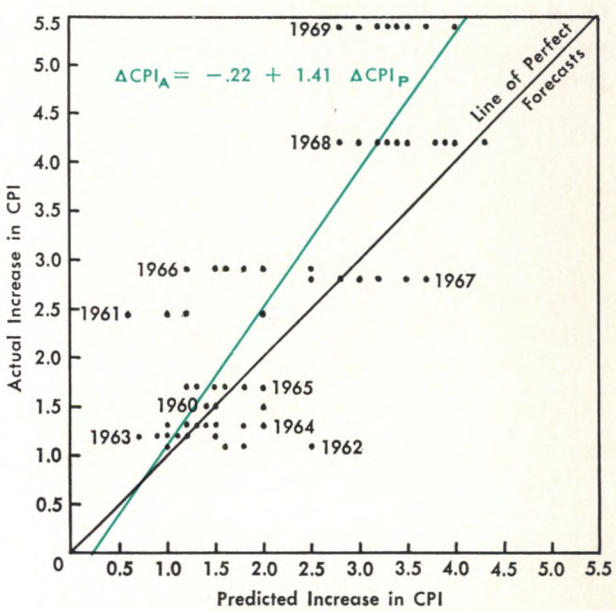
	Range of Predictions for Δ CPI	Mean Predicted Δ CPI	Mean Actual Δ CPI
1969	2.8 - 4.0	3.3	5.4*
1968	2.8 - 4.3	3.3	4.2
1967	2.5 - 3.7	3.2	2.8
1966	1.2 - 2.5	1.9	2.9
1965	1.2 - 2.0	1.5	1.7
1964	1.0 - 2.0	1.4	1.3
1963	0.7 - 1.5	1.1	1.2
1962	1.0 - 2.5	1.6	1.1
1961	0.6 - 2.0	1.4	2.4
1960	1.4 - 2.0	1.8	1.5
1960-1969	0.6 - 4.3	2.5	3.2

*Preliminary estimate.

CONSUMER PRICE INDEX

PREDICTION-REALIZATION DIAGRAM, 1960-1969

(Per Cent)



error in the aggregate measure was larger than that given by another method. For example, in 1969, the most accurate aggregate forecast in this sample predicted prices to increase by 3.6% and real GNP to increase by 4.8%. Actually, prices increased more than 5% and real GNP growth was less than 3%. Since inflation was the major problem confronting policy makers, those forecasts predicting price increases of 4.5% to 5.0% might have been more useful. Of course, the consequence of the trade-off between accuracy in predicting the aggregate and accuracy in predicting the elements is a matter determined by the use of the forecast.

Certainly, one major part of the total forecasting error in GNP predictions has been the error in predicting prices. Earlier, it was shown that GNP forecasts were relatively accurate in 1962 and 1967, and that the forecasters overestimated the GNP change only in 1960. An examination of the price statistics indicates that these were the only years in the decade when the predictions for the CPI were significantly greater than the actual changes in the CPI. Inaccurate projections for prices accounted for approximately one-third of the overestimation in the average 1960 GNP forecast. The 1962 and 1967 GNP forecasts remained reasonably accurate since the figures, adjusted for price inaccuracies, merely changed from a slight overestimation to a slight underestimation of the actual changes in the two years. In the other seven years, both the real changes in GNP and the changes in the CPI were underestimated. Corrections for inaccurate price predictions would still result in a significant underestimation of real GNP growth.

Another major part of the total forecasting error has been the cumulative error of predicting quarter to quarter changes. Most of the GNP forecasts are made in the third or fourth quarter of the preceding year before final data for that year are available. Errors from inaccurate estimates of base period data may cause cumulative errors in the quarters ahead. Other studies have shown that forecasting errors increase with the length of the predicted time span. In trend dominated series, such as GNP growth, increasing reliance on the historical trend will often eliminate some of the downward bias and result in more accurate long-term forecasts.

Summary Forecasting of economic aggregates has improved since the Korean War. Recently developed models are now able to incorporate intricate economic relationships that were "assumed away" before the era of high-speed computer technology. Data are now available with more accuracy, in greater detail, and at earlier dates than twenty years ago. However, with all these improvements in data and technology, forecasting economic aggregates beyond one or two quarters is very difficult. Economic relationships are difficult to determine for the near future and become increasingly complex over longer periods of time. Unforeseen changes in fiscal and monetary policy add to the uncertainty of future events. Nevertheless, the forecaster, as complicated as his task may be, can improve his long-run accuracy.

An analysis of annual forecasts for the decade of the sixties indicates a clear tendency to underestimate changes in GNP and the CPI. Since GNP projections were made in current dollars, underestimation of price changes accounted for part of the error in predicting GNP. However, a distinct downward bias remained. Since projections for trend dominated series generally contain substantial bias, forecasting accuracy can be improved by greater use of trend projections to reduce the downward bias.

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