

Forecasting Inflation: Does the Method Make a Difference?

By Nariman Behravesch*

The double-digit inflation of 1974 and 1975 caught many economists by surprise. After years of reliable service, their forecasting tools had started to lead them astray. As a result, businessmen and policymakers suddenly found themselves called upon to adjust to rapidly rising prices on very short notice. What happened? What went wrong?

Part of the forecasting failure can be attributed to the sheer intractability of events. The oil embargo, the wage-price freezes, and the agricultural shortages came out of the blue. No one could have known about them very far in advance, and no one could have known that they would hit almost all at once. But that doesn't get the forecasting tools off the hook. They're supposed to help even when we don't know exactly how the future will look.

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Or rather, we rely on them precisely because we don't know how the future will look.

Runaway inflation probably wouldn't have been prevented by better economic forecasting, but its impact might have been softened. Recognizing that their inflation forecasts were off the mark, economists are taking a close look at their forecasting methods. They hope to get a better grip on price changes from now on.

WHERE DO FORECASTS COME FROM?

When economists forecast inflation rates, they apply mathematical modeling techniques and their own powers of judgment to historical information.¹ A model is just a mathematical description of some state of

¹For a description of economic forecasting and of how econometric forecasts differ from judgmental ones see N. Behravesch, "Forecasting the Economy with Mathematical Models: Is It Worth the Effort?" *Business Review*, Federal Reserve Bank of Philadelphia, July/August 1975, pp. 15-25.

affairs—in this case, the national economy. The application of mathematical techniques to the economy goes by the name ‘econometrics’. Purists at the econometric end of the forecasting spectrum rely, ultimately, on the inner workings of their computer models. Purists at the judgmental end won’t use anything more complicated than a telephone and a desk calculator. Most economic forecasters feel at home somewhere between these two extremes.

Forecasting methods differ in how they mix judgment and modeling. They differ also in how many kinds of information they take into account. And different methods typically give different results.

One method—the **consensus or survey method**—usually emphasizes judgment rather than modeling. The technique here is to collect a range of different estimates from economists and others and to average them out. One of the more widely known consensus forecasts is the Business Outlook Survey of the American Statistical Association and the National Bureau of Economic Research. This survey polls about fifty economists, most of whom favor judgmental methods, to predict the rate of inflation and other measures of economic activity. About half of these economists may consult an econometric forecast to check their judgment, but only a few have their own econometric models. The ASA-NBER survey arranges the contributing forecasts numerically and picks as its representative forecast the median or midpoint of the range.² Since a large part of its input consists of noneconometric and primarily judgmental predictions, the ASA-NBER survey is a representative judgmental forecast.

A second method focuses exclusively on historical data about a **single variable** whose behavior is being forecasted, leaving all others out of account. Inflation-rate forecasts generated this way reflect past changes in

²The median of the contributing forecasts is chosen, rather than the mean, in order to minimize the influence of occasional extreme forecasts.

price levels and nothing else. They don’t show the influence that, say, wages and productivity and aggregate demand might have on future prices.

Single-variable forecasting methods are popular with institutions that don’t have the resources for large-scale efforts and don’t require the detail of econometric forecasts. One of the more widely used is the Box-Jenkins method. The advantage of Box-Jenkins forecasts is that they’re easy to understand and easy to compute. Like trend forecasts they presuppose that the future values of a variable depend on its past values and the past errors made in predicting them. A typical forecast of this sort might postulate, for example, that the level of prices in the current quarter is related to the level of prices in the last two quarters. The exact relationship of current to past prices is estimated from historical data.³

A third kind—the **econometric model** forecast—generally provides for a number of related equations that reflect the interaction of several chains of events as revealed by the data.⁴ The model is constructed and the data are selected according to a theory about how the economy fits together. The behavior of prices in such a model might be represented by an assertion that prices are set on the supply side of the economy by a markup over

³The Box-Jenkins model used in this article can be found in J. P. Cooper and C. R. Nelson, “The Ex Ante Prediction Performance of the St. Louis and FRB-MIT-PENN Econometric Models and Some Results on Composite Predictors,” *Journal of Money, Credit, and Banking* 7 (1975), p. 11. The model was estimated using data through 1966.

⁴The pure econometric model forecasts considered here aren’t really predictions. They are retrospective or historical forecasts that try to determine what the model would have predicted if it knew the actual changes in policy instruments such as government expenditures and the supply of money. Predictions differ from historical forecasts in that they require the economist to estimate future policy changes and thus to impose some judgment on the outlook. Historical econometric forecasts, or simulations, are pure model forecasts: the internal mechanisms of the model alone generate the forecast.

costs.⁵ It might be assumed, for example, that prices in the U.S. economy are set so as to cover production costs and maintain profit margins. A major component of these production costs is wages, and wages are determined by the supply and demand for labor. Most of the econometric models developed in the late 1960s and early 1970s make an assumption of this kind about the influence of wages on prices.⁶

Most econometric forecasters, however, don't rely on a pure model forecast; they

adjust the model forecast judgmentally to allow for information that isn't represented explicitly, to compensate for past misses.⁷ This kind of forecasting requires economists to help the model along with their best guesses regarding future changes in the household sector, the foreign sector, and other parts of the economy. Users also must feed in their best estimates of future changes in government expenditures and in the money stock as well as other developments that the model doesn't simulate. These are predictions based on the judgment of the forecaster, but they affect the model in ways that are consistent with its built-in assumptions about how people behave in an economic environment.

The information used by the four methods of predicting economic variables is summarized in Table 1.

⁵The model being used here is a modified version of the MPS (MIT-PENN-Social Science Research Council) model. The price and wage equations of this model are described in B. de Menil and J. J. Enzler, "Prices and Wages in the FRB-MIT-PENN Econometric Model," in *The Econometrics of Price Determination*, ed. Otto Eckstein (Washington: Board of Governors of the Federal Reserve System and Social Science Research Council, 1972). The price equation was estimated using data through 1968.

⁶W. D. Nordaus, "Recent Developments in Price Dynamics," *The Econometrics of Price Determination*.

⁷An example of this type of forecasting is the MIT-PENN-SSRC model modified by the judgment of three forecasters over different intervals at the Federal Reserve Bank of Philadelphia.

TABLE 1

Type of Information	Survey	Single-Variable†	Econometric Model Simulation‡	Judgmentally Modified Econometric Model‡
Past Values of the Variable Being Predicted	✓*	✓	✓	✓
Past Values of Other Variables	✓*		✓	✓
Actual Values of Policy and External Variables			✓	
Judgmental Information	✓			✓
Future Values of Policy and External Variables	✓*			✓

*In survey or judgmental forecasts, it may be difficult to determine exactly how past values of variables and policy variables influence the forecast.

†In single-variable forecasts, the relation of past to future values of the variable being predicted is estimated using the historical data.

‡In econometric models, the impacts of past values of variables and policy variables on the variables being predicted are estimated using the historical data.

HOW THE FORECASTS CAME OUT

It's easy to see how the forecasts came out for the period 1971-75 by plotting graphs of actual and predicted values. The graphs that are reproduced in Charts 1-4 on pages 14-15 show how well inflation-rate forecasts generated by the four different methods agreed with actual changes in the inflation rate. The vertical axis of each graph is the scale of forecasted inflation-rate values; the horizontal axis is the scale of actual values. If a forecasted value of, say, 2 percent were matched by an actual value of 2 percent, the dot for that forecast would be right on the diagonal; when the dot is not somewhere on the diagonal, as it usually isn't, actual values failed to coincide with projected ones. So, for example, in the first graph of Chart 1, the point labelled 74II shows that the actual rate of inflation in the second quarter of 1974 was around 9½ percent against a predicted rate of about 6½ percent.⁸

The charts are arranged by kind of forecast. Each of them contains four graphs that show how forecasts behave when they're used for periods, one, two, three, and four quarters beyond the base quarter. The earliest base period for all forecasts is the third quarter of 1971. The number of quarters shown diminishes from left to right across the charts as the forecast horizon extends from one to four quarters ahead.

Comparing the Forecasts. A glance at the graphs reveals that most of the points fall below the diagonal. This shows that all four kinds of forecasts generally underestimated inflation rates throughout the forecasting period. And the underestimates became

⁸The ASA-NBER and the MPS model-plus-judgment forecasts were generated using the data available at the time of the forecast. In the interim, however, the inflation data have been revised a number of times. Therefore, in order not to penalize these forecasts for the data revisions, the respective forecasting errors have been adjusted by subtracting the difference between the inflation data available at the time of the forecast and the most current data.

more severe as the forecasts looked farther ahead. The worst forecasting years were 1973 and 1974—years when international pressures tended to upset normal economic expectations.

Again, even a casual look at the graphs makes it clear that the single-variable forecasts were far and away the least accurate. The other kinds of forecasts were bunched; it's hard to tell which had the better track record simply by looking. But economists have developed several measures for ranking them more precisely. Two of these measures are mean error and mean square error; there are others as well (see Appendix).

Mean error is average error: if a forecast has a positive error of 2 in a given quarter and a negative error of 2 the next quarter, its mean error for the two-quarter period is zero. Mean error is not a very useful measure, however, because it doesn't indicate how far off the mark a forecast is. If an inflation-rate forecast, for example, were 10 percentage points too high one year and 10 too low the next, it still would average out to a zero mean error, despite its gross inaccuracy. So economists use mean square error to calculate how far off the zero line errors are, no matter how nicely they average out.

How They Stack Up. These measures show the relative strength of econometric methods. The pure simulation, the judgmentally modified model forecast, and the survey forecast consistently had smaller mean errors and mean square errors than the single-variable forecast, with the judgmentally modified simulation doing best for one, two, and three quarters ahead (see Table 2, page 15).

In short: While all inflation-rate forecasts have been too low in recent years, and while these forecasts have been less accurate over the longer haul, the outlook surveys and both kinds of econometric forecasts have performed far better than the forecasts based on a single variable.

WHY DO FORECASTS MISS?

Forecasts miss in differing degrees for dif-

ferent reasons. Single-variable forecasts are likely to miss because they use little information and don't provide for judgmental corrections. Unlike the other three kinds of forecasts, single-variable forecasts don't consider the way prices are set in the economy for clues to future price changes. Because they're based entirely on past conditions and trends, they're unusually prone to missing sudden changes. The one whose performance is reflected in Chart 2, for example, assumes that the inflation trend of any two successive quarters will tell the forecaster what the inflation rates will be in the following quarter.⁹ But it doesn't always work out that way, even in the short run.

The problem is compounded in forecasts that look more than one quarter into the future. Since single-variable forecasts depend solely on past changes, forecasts of two or more periods ahead require, as inputs, forecasts of the periods immediately preceding them. So, for example, in using the Box-Jenkins method to forecast inflation rates three quarters ahead, the economist has to feed in the predicted level of prices for one and two quarters ahead. As a result, the forecast errors for one and two quarters ahead are built into the forecast for three quarters ahead. Error accumulation is a thorn in the side of all economic forecasts of more than one period ahead. But it's especially troublesome in single-variable forecasts, since they use past inflation rates alone to calculate future rates.

Survey forecasts too set their sights on past inflation trends in estimating future trends. But the judgmental information that many contributing economists bring to bear on their forecasts reduces the weight of past trends and thus probably weakens the bias toward underestimating inflation rates. Unfortunately, the value of judgmental information appears to fall off as the forecasting

horizon moves farther ahead.

Model simulations also look backward to get a line on the future, explicitly representing the economy's behavior over a given period. Since models ordinarily allow for a range of influences on inflation rates, their forecasts usually reflect not only past changes in inflation but also past changes elsewhere in the economy.

Every retrospective forecast is subject to error when it's outrun by events. A sudden change in people's saving and spending habits, for example, can impact heavily on prices and throw the forecast off. If government unexpectedly slaps on wage and price controls, the results can baffle the forecaster. Or if another country buys heavily in the commodity markets here, even the best forecast may not provide much guidance.

Error builds up in econometric model forecasts of two or more periods ahead because past changes are used to predict future changes. Since econometric models assume that developments such as inflation are influenced not only by their own historical trends but also by wage hikes and other forces, they can accumulate error from many sources over time. Econometric models may miss also because they're approximations to the structure of the economy at a given time. They become outdated if behavioral and institutional changes that they haven't captured occur in the economy.

When an economist modifies a model forecast in line with his own expectations of the future, he in effect supplements the information it incorporates. This is no longer a retrospective exercise but a predictive one. Whether it makes for greater accuracy depends on how good the forecaster's judgment is and how apt he is at anticipating policy changes.

LEARNING FROM PAST MISTAKES

The method makes a difference in forecasting inflation. One thing economic forecasters have learned from their recent experience is that the past isn't always an accurate guide to

⁹The current econometric literature is considering the application of Box-Jenkins methods to a number of variables simultaneously.

CHART 1
SURVEY FORECAST:
BUSINESS OUTLOOK SURVEY
(ASA-NBER)

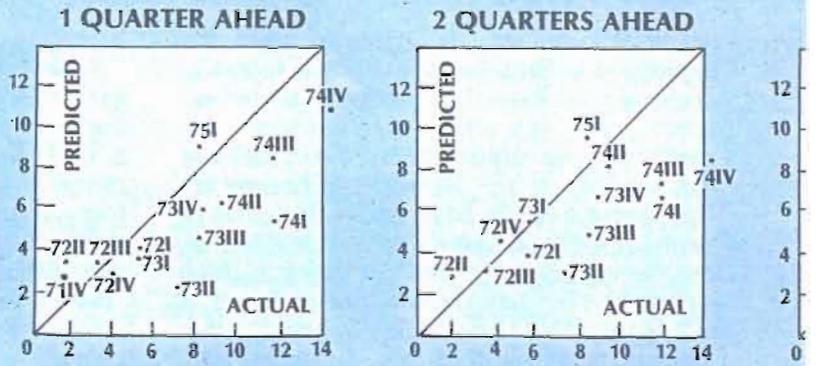


CHART 2
SINGLE-VARIABLE FORECAST:
BOX-JENKINS

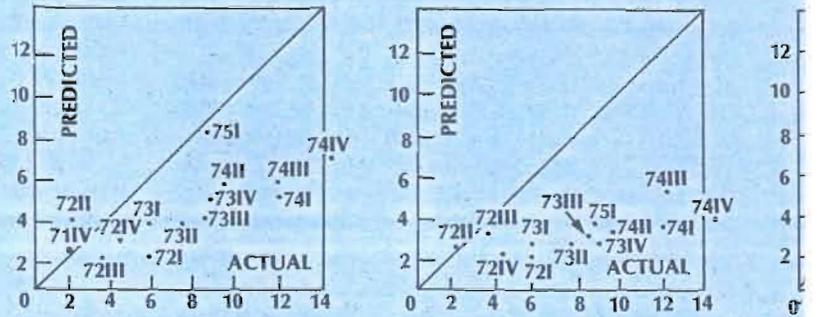


CHART 3
ECONOMETRIC FORECAST:
MPS

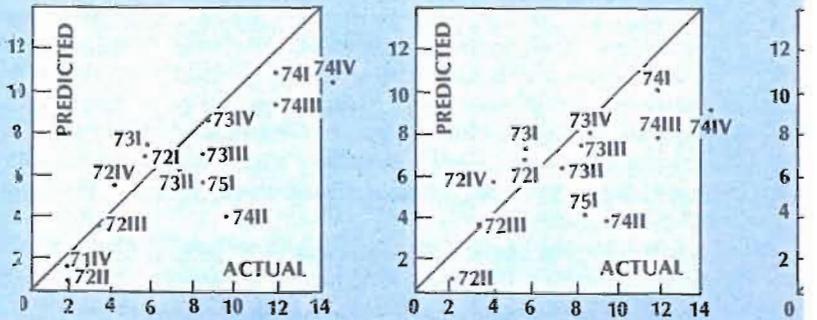
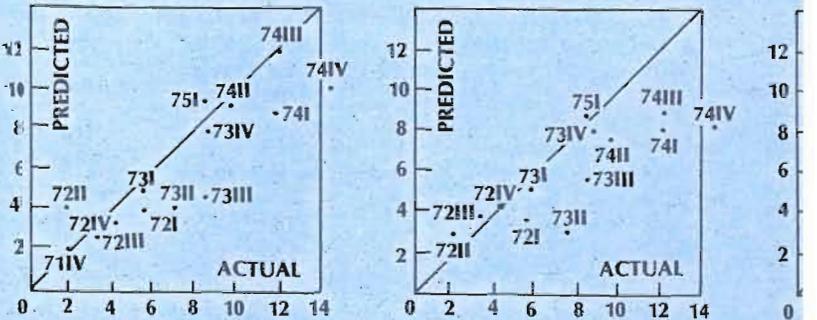
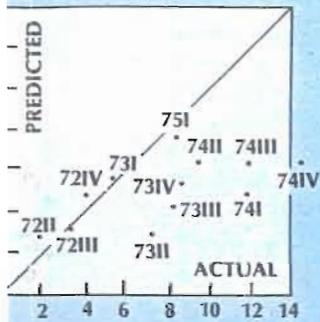


CHART 4
ECONOMETRIC FORECAST
(MODIFIED): MPS



DIFFERENT FORECASTING METHODS GIVE DIFFERENT FORECASTS

3 QUARTERS AHEAD



4 QUARTERS AHEAD

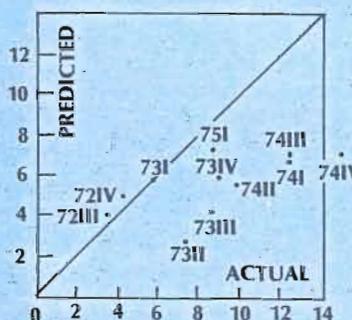
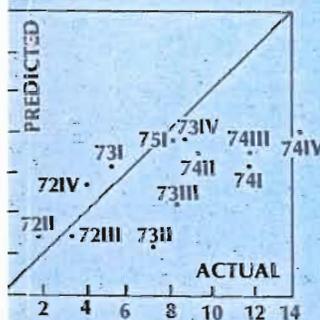
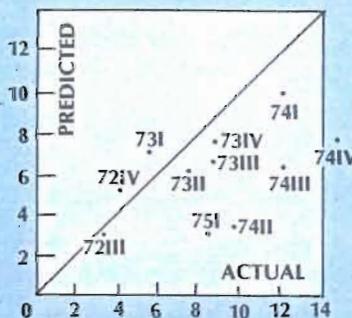
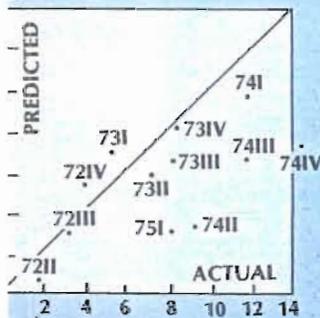
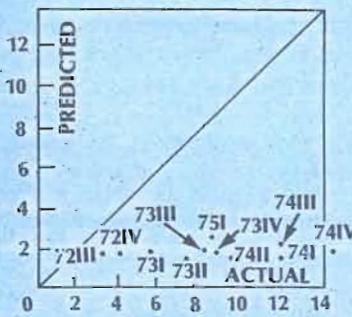
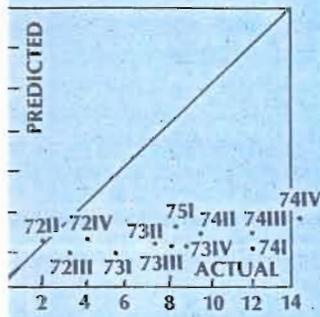
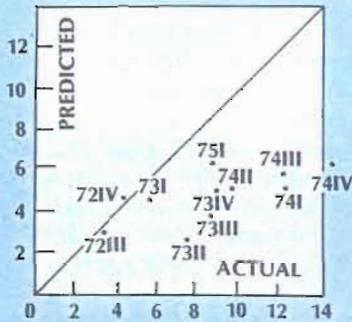


TABLE 2

MEAN ERROR OF FORECASTS

	Quarters Ahead			
	1	2	3	4
ASA-NBER	-1.82	-2.05	-2.96	-3.60
Box-Jenkins	-3.20	-4.92	-5.63	-6.56
MPS Model	-1.40	-1.87	-2.42	-2.48
MPS Model (Modified)	-1.13	-1.79	-2.14	-2.88

Mean error is average error. A positive error of any size in one quarter that's matched by a negative error of the same size in the next quarter gives a zero mean error for the two-quarter period.

MEAN SQUARE ERROR OF FORECASTS

	Quarters Ahead			
	1	2	3	4
ASA-NBER	8.58	9.73	17.24	19.79
Box-Jenkins	17.25	32.86	42.34	53.15
MPS Model	5.86	9.45	13.46	14.13
MPS Model (Modified)	4.60	7.61	11.57	14.79

Mean square error is computed by squaring each quarter's error and averaging out all the squares. A high mean square error is a sign that forecasting errors are relatively large.

future inflation rates. As a result, they've begun to keep a closer watch on current developments, such as commodity price movements and changes in world market conditions, for signals of higher prices ahead.

They've learned also that purism, whether of the judgmental or of the mathematical sort, imposes unnecessary restraints on the forecaster's work. Eclecticism, in the form of judgmentally modified econometric modeling, appears to offer the greatest promise for further development. It's relatively easy to reformulate some econometric models so that they capture the kind of information that would have pointed to high inflation rates in 1974 and 1975. An economist who uses one of the improved models can hope to chalk up a better track record in inflation forecasting

from now on.

The method makes a difference to policymakers, too. Because government policy is built into econometric models along with other institutional features, econometric forecasts allow policymakers to trace the influence of their decisions—for example, the influence of slower or faster monetary growth on inflation and unemployment. Single-variable and survey forecasts lack this advantage.

The unusual inflation experience of recent years provided economists with a tough test of their forecasting abilities. What they've learned is helping to reshape their forecasting tools—and, they hope, sharpen their view of the future.

APPENDIX OTHER MEASURES OF FORECASTING ACCURACY

Mean error and mean square error are discussed in the text of this article. Mean absolute error and the Theil statistic are two other measures of forecasting accuracy. Mean absolute error is the average of the absolute values of the errors. The Theil statistic was developed by Henri Theil of the University of Chicago and is computed using the formula

$$U_n = \frac{\sum_{t=1}^m (P_{t+n} - A_{t+n})^2}{\sum_{t=1}^m (A_{t+n} - A_t)^2},$$

where the P are predicted values, the A are actual values, n is the forecasting horizon, and m is the number of forecasts in computation.

Mean absolute error, like mean square error, measures the dispersion of forecasting errors. The Theil statistic measures dispersion of the forecasting errors against the actual changes in the variable being predicted.

Here's how these two measures rank our four kinds of forecast:

MEAN ABSOLUTE ERROR

	Quarters Ahead			
	1	2	3	4
ASA-NBER	2.43	2.39	3.19	3.71
Box-Jenkins	3.47	4.93	5.65	6.56
MPS Model	1.89	2.39	2.86	2.97
MPS Model (Modified)	1.61	2.05	2.70	3.20

THEIL STATISTIC

	Quarters Ahead			
	1	2	3	4
ASA-NBER	1.09	1.22	1.43	1.09
Box-Jenkins	1.55	2.24	2.25	1.79
MPS Model	0.90	1.20	1.27	0.92
MPS Model (Modified)	0.80	1.08	1.17	0.94

These results confirm the ranking of methods by mean error and mean square error. The Theil statistic seems to indicate, however, that errors associated with predicting the inflation rate don't necessarily increase over the forecast horizon. In the above example, the Theil statistics for predictions four quarters ahead are not much larger than those for predictions one quarter ahead. 

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