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An Evaluation of ASA/NBER Business Outlook Survey Forecasts

ABSTRACT: A well-designed and well-organized consensus forecasting system may be a valuable tool in business planning and decision making. Since it began in 1968, the ASA/NBER Business Outlook Survey, which includes a panel of 160 business economists and economic statisticians, has generated a record long enough on which to conduct an evaluation. ¶ First, the relative predictive power of the survey forecasts is examined by using ex post comparisons with econometric forecasts and benchmark forecasts generated by an autoregressive scheme. Second, the absolute predictive power is evaluated by comparisons of median and mean forecasts, by analyzing the standard error of forecasts (a procedure that can not be applied to econometric forecasts), and by decomposition of the forecasters' methodology. Third, the forecasting error in each variable is decomposed, in order to determine its origins.

NOTE: We wish to express our appreciation to Charlotte Boschan for the use of the ASA-NBER questionnaires and to George Green for providing the Wharton ex ante forecasts. We would like to thank Charlotte Boschan, Gary Fromm, and Stanley Diller of the staff reading committee, Henri Theil, Roy Moor, and David Grove of the Board reading committee, and Geoffrey Moore for their valuable comments, and Rapidata for providing the computer time for this study.

INTRODUCTION

The ASA/NBER Survey of Forecasts is a joint project of the American Statistical Association and the National Bureau of Economic Research. This project was initially suggested by Dr. Geoffrey H. Moore in his presidential address at the 1968 ASA annual meeting.[1] Subsequently, the terms of the arrangement were approved by both the ASA and the NBER. The survey includes a regular panel of roughly 160 economists and economic statisticians, volunteers from the members of the Business and Economic Statistics Section of the American Statistical Association. It provides a systematic, analytical record of past forecasts. A continuing review of the record provides an opportunity to improve forecasting procedures and results.

The official forecasts of ASA/NBER Survey were first released in December 1968 and since have been released regularly every quarter. In each quarter, a questionnaire is sent to all regular panel members, and about 60 to 80 of them actively participate in the forecasting survey by returning the questionnaire. Before each ASA annual meeting, the questionnaire is sent to all ASA members in the Business and Economic Statistics Section. Two sets of summaries are tabulated, one including only regular panel members and the other including all ASA members. However, this study is limited to the tabulations summarizing the forecasts of regular panel members. The questionnaires are sent from the American Statistical Association in the second month of each quarter after the preliminary GNP data are released by the Bureau of Economic Analysis of the Department of Commerce. A set of the latest preliminary GNP data, as well as the most recent data for other variables, is attached to the questionnaire, so that all participants have access to the same data base. The participants are asked to provide four- or five-quarter span forecasts of ten variables. The ten variables are: GNP, GNP implicit price deflator, plant and equipment expenditures, change in business inventories, industrial production index, rate of unemployment, consumer expenditures for durable goods, national defense purchases, corporate profits after taxes, and new private housing units started. They are also asked to attach subjective probabilities to the potential annual percentage changes in money GNP and price deflators, and to the decline in real GNP in the future quarters. In addition, they are requested to state their key assumptions in making the forecasts and the forecasting methods they used.

The questionnaires are collected and tabulated at the National Bureau of Economic Research under the supervision of Victor Zarnowitz and Charlotte Boschan.[2] After the tabulation, a set of summary tables with a brief analysis is distributed to all participants, and a summary of the economic outlook is released to the press and published in the ASA *Amstat News* and the NBER's new journal, *Explorations in Economic Research*.[3] In order to

avoid the effect of occasional extreme forecasts made by some panel members, the median, instead of mean, forecasts are reported.

In this study, we make comparative and absolute evaluations of the ASA/NBER Survey forecasts and offer suggestions for improving their predictive performance. The forecasting period used is from the fourth quarter of 1968 to the second quarter of 1973, 19 forecasts in total. Throughout the study only four major variables—nominal GNP, real GNP (GNP58), implicit price deflator (IPD), and unemployment rate (UR)—are analyzed. Since the real GNP is not included in the original ten variables in the questionnaire, it is inferred from the questionnaire return by dividing the nominal GNP by the implicit price deflator. Nevertheless, the individual participants may have directly forecasted any two of the three variables and derived the third by an identity.

COMPARATIVE EVALUATION

In the comparative evaluation, the ASA/NBER survey forecasts are compared directly with the forecasts generated by an econometric model and a so-called naive model. The econometric model used is the Wharton Quarterly Model because it is the only model for which regular ex ante forecasts were released over the period of the study and whose historical record was made available to us. The naive method used is an autoregressive scheme with four periods of lag, since past experience shows that the autoregressive model possesses a substantial margin of superiority over other naive models and that a relatively small number of lags is sufficient to produce a satisfactory benchmark.[4] The regression coefficients were reestimated in every quarter to generate the forecasts for the following four quarters.[5] In other words, from the fourth quarter of 1968 to the second quarter of 1973, 19 regressions were made for each variable investigated, each regression using a sample period of 40 quarters up to the jumpoff quarter (one quarter before the forecast). Selection of the length of the sample period was arbitrary. The autoregressive forecast of real GNP is generated by taking the ratio of predicted GNP to predicted IPD, the same procedure used in the forecasts survey.

Our error statistics are presented in terms of root-mean-square-error (RMSE). The RMSEs of predicted change (one quarter change), predicted level (accumulated change to the specified quarter), predicted percentage change, and predicted accumulated percentage change are calculated by the following formulas:[6]

RMSE of predicted change

$$= \{(1/T)\Sigma\,[(Y_t^f - Y_{t-1}^f) - (Y_t^a - Y_{t-1}^a)]^2\}^{1/2}$$

RMSE of predicted level

$$= \{(1/T)\Sigma\,[(Y_t^f - Y_0^f) - (Y_t^a - Y_0^a)]^2\}^{1/2}$$

RMSE of percentage change

$$= \{(1/T)\Sigma\,[(Y_t^f - Y_{t-1}^f)/Y_{t-1}^f - (Y_t^a - Y_{t-1}^a)/Y_{t-1}^a]^2\}^{1/2}$$

RMSE of accumulated percentage change

$$= \{(1/T)\Sigma\,[(Y_t^f - Y_0^f)/Y_0^f - (Y_t^a - Y_0^a)/Y_0^a]^2\}^{1/2}$$

where

Y_t^f = forecast value of Y at time t
Y_0^f = actual data in jumpoff quarter as of the time the forecast was made
Y_t^a = actual value of Y at time t
T = number of forecasts.

The extra terms $(-Y_0^f + Y_0^a)$ in the formula of predicted level adjust the forecasted values by a constant amount, thus making the jump-off data value agree with the revised actual data series. If no revisions in actual data have occurred, these extra terms are equal to zero. The comparisons of RMSEs of the three forecasting methods on four major variables are reported in Table 1. For each forecasting method, first quarter (Q1), second quarter (Q2), third quarter (Q3), and fourth quarter (Q4), forecasts are analyzed. Obviously, for the first quarter forecasts, the RMSEs of predicted change are identical to the RMSEs of predicted accumulated change; hence the latter are omitted in Tables 1, 2, and 5.

The forecasting period used, from 68.4 to 73.2, is generally considered a difficult period for forecasters. During this period there was an amalgamation of rapid inflation, a high unemployment level, a moderate recession, a serious auto strike, a large government deficit, and a foreign trade deficit. In such a period of unusual changes, although forecasting is difficult, mechanical forecasting devices which rely heavily on historical data may be even less reliable. Our findings in Table 1 support this point. In general, the autoregressive forecasts are inferior to the ASA/NBER forecasts and to the Wharton forecasts in terms of the RMSE in predicted changes. For current and real GNP the errors of the autoregressive forecast are almost twice as large as those of the ASA/NBER forecasts. For the price deflator, the errors in the autoregressive forecasts also are worse than in the ASA/NBER forecasts, but to a much smaller extent. This is because prices are, in general, more autoregressive than output.[7] In addition, the inflation between 68.4 and 73.2 follows a rapid upward trend, which can be picked up easily by an autoregressive scheme. The autoregressive predictions of changes in the unemployment rate are relatively poor but also relatively stable across the forecasting spans, whereas in both the Wharton and the ASA/NBER forecasts the errors increase as the spans increase.

The RMSE of predicted level in real GNP indicates the superiority of the

TABLE 1 The Comparison of Root-Mean-Square-Errors of Different Forecasting Methods, 1968.4 to 1973.2

Forecast Span	Predicted Change				Predicted Level			Predicted Percentage Change				Predicted Accumulated Percentage Change		
	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q2	Q3	Q4
Gross National Product (GNP)														
Wharton	4.69	6.77	8.14	7.51*	7.48*	10.51	10.02*	0.45	0.67	0.80	0.74	0.71	1.08	1.02
ASA/NBER	4.30*	5.86*	7.50*	7.90	8.47	10.83	11.04	0.40	0.55	0.72	0.76	0.81	1.05	1.04
Auto-regressive	9.11	13.48	13.83	14.33	9.41	9.88*	10.65	0.88	1.33	1.36	1.42	0.92	0.99	1.08
Gross National Product in 1958$ (GNP58)														
Wharton	2.99*	4.83	5.91*	6.59*	4.00*	5.10	5.91	0.39	0.65	0.80	0.89	0.55	0.70	0.80
ASA/NBER	3.42	4.50*	6.07	7.34	5.68	7.77	11.30	0.45	0.60	0.82	0.99	0.77	1.05	1.54
Auto-regressive	7.11	10.62	11.35	15.22	7.38	8.08	13.86	0.96	1.45	1.55	2.08	1.00	1.10	1.93
Implicit Price Deflator (IPD)														
Wharton	0.46*	0.64*	0.85	0.83*	0.93	1.46	1.95	0.33	0.45	0.61	0.59	0.67	1.09	1.47
ASA/NBER	0.53	0.74	0.74*	0.86	1.07	1.42	2.00	0.38	0.54	0.53	0.62	0.79	1.08	1.54
Auto-regressive	0.82	1.06	1.05	0.96	0.75*	0.91*	0.91*	0.57	0.74	0.73	0.67	0.54	0.65	0.65
Unemployment Rate (UR)														
Wharton	0.18	0.27	0.34	0.38	0.35	0.61	0.80	4.41	5.52	6.99	8.59	8.41	14.61	20.00
ASA/NBER	0.12*	0.21*	0.27*	0.31	0.28	0.48	0.70	2.77	4.69	5.99	7.00	6.79	11.93	18.20
Auto-regressive	0.23	0.31	0.31	0.30*	0.22*	0.23*	0.25*	5.28	7.35	7.36	6.93	5.31	6.08	6.78

*Smallest error among three methods.

ASA/NBER forecast over the naive forecast. However, the superiority declines as the forecasting period is extended. In predicting current GNP, the naive forecast has been more accurate than the consensus forecast in the third and fourth quarters. The RMSEs of predicted levels of IPD and UR show that with respect to these two variables, autoregressive forecasts have been superior to the two other methods in multiquarter predictions. The superiority of the autoregressive model for predicting IPD was further tested by extending the forecasts into the 3Q 1973–4Q 1974 period with favorable results. (See Appendix C.)

The RMSEs in predicted changes indicate that the consensus forecasts generally outperform the econometric model forecasts in all variables but the price deflator in the first two quarter forecasts. Again, the superiority of the ASA/NBER forecasts declines as the forecasting span is extended. In the four-quarter-ahead forecasts, only the unemployment rate is worse in the Wharton forecast than in the ASA/NBER forecasts.

In general, the comparison shows that the Wharton forecast has the best record in predicting both the change and the level of real GNP but the poorest record in predicting the unemployment rate. For current GNP, the Wharton forecast is less accurate in the near quarters but it is relatively better as the forecasting extends to the fourth quarters.

The RMSEs in percentage changes in both the Wharton and the ASA/NBER forecasts are less than 1 percent in all four forecasting quarters in GNP, real GNP, and price level. The forecasting errors generated by the autoregressive scheme are much larger; the percentage errors are greater than 1 percent in GNP and real GNP after the second quarter. When comparing the percentage errors, we find that all three forecasting methods have relatively smaller errors in the price level; this may be because the price level is more or less trend-dominated in this period. The percentage errors in the unemployment forecasts are far greater than in the other variables, no doubt because the fluctuation in the unemployment rate is so large.

ABSOLUTE EVALUATION

Median Forecast Versus Mean Forecast

In a symmetrical distribution, both the arithmetic mean and the median are unbiased estimates of the central tendency, but the mean is more efficient. If the distribution is skewed, the mean will be different from the median since the mean is more sensitive to extreme observations. The greater the skewness, the greater the difference will be. If the distribution is skewed to

the left, the mean is greater than the median. If the distribution is skewed to the right, the mean is less than the median. It is thus natural to take the difference between the mean and the median as measuring the skewness of the distribution. The skewness of the distribution of ASA/NBER forecasts is due largely to the occasional extreme forecasts. In order to avoid the influence of these extreme observations, the median forecasts, instead of the mean forecasts, are used in the formal release of ASA/NBER forecasts. Since the mean is commonly used in most statistical work, some examination of the difference between the mean and median forecasts is desirable.

We find that the differences between mean forecasts and median forecasts of the four variables are relatively small when the economy is in a trend-dominated period. But these two forecasts differ substantially when the economy is approaching, or reaches, a turning point. This finding leads us to conclude that more extreme forecasts are made when the economy is in the vicinity of a turning point. In addition, large differences also are found in the forecasts made in the third quarter of 1971, probably because of the uncertainty created by the announcement of President Nixon's new economic policy.

The RMSEs of mean forecasts are calculated and compared with the RMSEs of median forecasts in Table 2 and Chart 1. On examining these results we find:

1. The mean forecast has a larger average error than the median forecast in the first forecasting quarter for all major variables except price deflator. When examining all four forecasting quarters, the median forecast looks better for current dollar GNP (6 out of 7 comparisons), while the mean forecast looks better for the deflator (6 out of 7 comparisons) and for real GNP (5 out of 7 comparisons). For unemployment they are about the same.

2. As the forecasting horizon lengthens, the accuracy of both mean and median forecasts deteriorates, but the accuracy of median forecasts deteriorates more rapidly. In the four-quarter-ahead forecast, the mean forecast is better than the median forecast in all variables except GNP in current dollars.

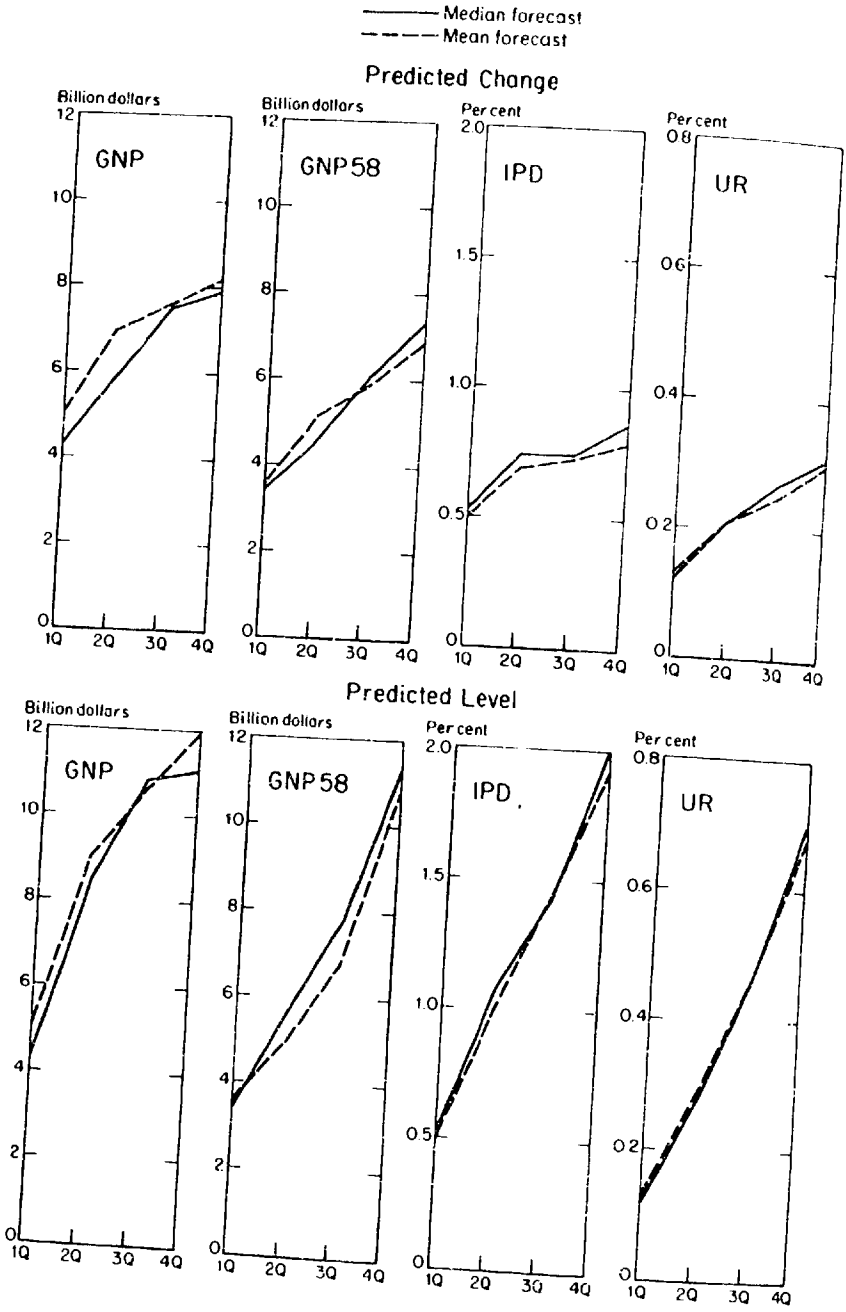
3. According to our results, the mean forecast is not less accurate than the median forecast. Over the four forecasting quarters, the mean forecast of each of the four variables studied had a smaller RMSE than the median forecast in more than half of the total forecasts. The ratios of RMSEs of mean to median forecasts indicate that mean forecasts are slightly better than median forecasts. Perhaps, it would be advisable to use mean forecasts, at least for the longer term forecasts for which they appear to be more successful.[8]

TABLE 2 The Comparison of RMSEs of the ASA/NBER Median Forecast and Mean Forecast, 1968.4 to 1973.2

Forecast Span	Predicted Change				Predicted Level			Predicted Percentage Change				Predicted Accumulated Percentage Change		
	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q2	Q3	Q4
Gross National Product (GNP)														
Median Forecast	4.30*	5.86*	7.50*	7.90*	8.47*	10.83	11.04*	0.40	0.55	0.72	0.76	0.81	1.05	1.04
Mean Forecast	5.02	6.97	7.51	8.17	8.96	10.61*	11.95	0.46	0.66	0.71	0.77	0.83	1.01	1.14
Mean/Median	1.17	1.19	1.00	1.03	1.06	0.98	1.08							
Gross National Product in 1958$ (GNP)														
Median Forecast	3.42*	4.50*	6.07	7.34	5.68	7.77	11.30	0.45	0.60	0.82	0.99	0.77	1.05	1.54
Mean Forecast	3.56	5.14	5.86*	6.80*	4.99*	6.79*	10.77*	0.46	0.69	0.78	0.92	0.67	0.91	1.46
Mean/Median	1.04	1.14	0.97	0.93	0.88	0.87	0.95							
Implicit Price Deflator (IPD)														
Median Forecast	0.53	0.74	0.74	0.86	1.07	1.42*	2.00	0.38	0.54	0.53	0.62	0.79	1.08	1.54
Mean Forecast	0.50*	0.69*	0.73*	0.79*	0.99*	1.43	1.91*	0.36	0.50	0.53	0.57	0.73	1.08	1.47
Mean/Median	0.94	0.93	0.99	0.92	0.93	1.00	0.96							
Unemployment Rate (UR)														
Median Forecast	0.12*	0.21	0.27	0.31	0.28*	0.48	0.70	2.77	4.69	5.99	7.00	6.79	11.93	18.20
Mean Forecast	0.13	0.21	0.25*	0.30*	0.29	0.48	0.68*	2.94	4.56	5.53	6.64	6.88	11.80	17.48
Mean/Median	1.08	1.00	0.93	0.97	1.04	1.00	0.97							

*Smallest error between two methods.

CHART 1 Comparison of RMSEs of the ASA/NBER Median Forecast and Mean Forecast, 1968–1973



Standard Deviation

For any consensus forecast it is important to find out how close the consensus is. Obviously such a forecast is more representative if the dispersion is small rather than large. Therefore, we have calculated the standard deviation of the distribution of forecasts in each quarter and reported them in Table 3. The standard deviation measures the dispersion of the distribution of all forecasts and, hence, provides a measure of uncertainty among forecasters about the future. When the economy is in the middle of a trend-dominated period the forecasts could be expected to be more alike. As the economy approaches or reaches a turning point, the forecasts made by different panel members might be more divergent.

We observe large standard deviations in all four major variables in 69.3, 70.4, and 71.3. The fourth quarter of 1969 is classified by the NBER as a business cycle peak and the fourth quarter of 1970 a trough. Apparently, the downturn in 1969 shows some early symptoms so that the standard deviations in the third quarter of that year are large. The large standard deviations in the third quarter of 1971 probably indicate uncertainty about Phase I of President Nixon's new economic policy.

In the fourth quarter of 1972, large standard deviations are found in the second, third, and fourth quarter forecasts of GNP and GNP58, but not in the other two variables. Uncertainty in this quarter may have been generated by the GM strike and a question as to how much real output would be affected. The standard deviation of the price variable is large in the second, third, and fourth quarter forecasts made in 73.2. The rapid increase in food prices in that quarter may have created some differences in opinion among the forecasters on prices.

In conclusion, we may state that if large variances are found in all major economic variables, it may indicate that the economy is approaching, or is at, a turning point or that there has been a drastic change in economic policy. If large variances are found in only one or two variables, it may be because of some sectoral difficulties.

Decomposition by Methodology

In a consensus forecast, different forecasting methods are used by the panel members to reach their predictions. The methods used may vary from a very naive technique to the most sophisticated econometric models. Often, the forecaster uses more than one method to obtain his forecasts. He may use one method to forecast one set of variables and another to forecast another set of variables. Or, he uses the forecasts from one method as his prime forecasts and those obtained from other methods to make adjustments.

In the questionnaire, the participants are asked to rank several forecast-

TABLE 3 The Standard Deviations of the ASA/NBER Forecasts

Quarter	GNP				GNP58				IDP				UR			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Q4/68	3.6	6.4	8.9	12.1	4.0	5.4	7.2	9.2	0.49	0.77	0.89	1.11	.12	.17	.23	.25
Q1/69	3.5	5.6	9.7	11.6	3.9	5.0	7.7	9.2	0.58	0.67	0.71	0.87	.16	.25	.24	.25
Q2/69	2.9	5.6	8.7	12.2	3.0	5.2	7.9	11.1	0.37	0.58	0.69	0.91	.10	.18	.26	.31
Q3/69	7.0	10.6	19.3	27.5	5.7	8.9	12.9	18.8	0.80	1.17	1.49	2.01	.12	.22	.35	.49
Q4/69	3.2	6.0	9.2	12.5	3.6	5.4	8.9	10.8	0.50	0.62	0.90	1.02	.14	.21	.30	.46
Q1/70	3.3	5.3	13.1	13.2	2.9	4.5	10.1	10.6	0.47	0.60	0.77	1.02	.18	.29	.35	.40
Q2/70	3.9	7.7	11.6	15.6	4.2	9.0	14.5	19.2	0.77	1.48	2.18	2.80	.27	.43	.55	.59
Q3/70	3.9	6.7	9.8	11.7	3.3	5.5	7.7	8.8	0.39	0.59	0.81	1.03	.17	.35	.42	.46
Q4/70	7.8	14.7	19.0	26.4	6.7	9.8	13.5	18.8	0.66	0.86	1.32	1.84	.25	.38	.51	.60
Q1/71	6.1	9.6	11.5	14.3	4.5	6.8	7.8	9.7	0.34	0.54	0.78	0.88	.14	.27	.35	.38
Q2/71	5.8	10.0	12.4	17.5	4.7	7.8	8.8	11.9	0.44	0.63	0.81	1.08	.15	.27	.30	.35
Q3/71	10.9	16.0	20.5	25.6	10.6	13.9	17.3	21.6	1.50	1.79	2.23	3.00	.26	.34	.36	.37
Q4/71	14.5	9.0	13.3	17.8	10.4	7.3	9.8	12.2	0.44	0.64	0.98	1.19	.10	.17	.22	.25
Q1/72	6.0	9.3	12.1	16.9	4.6	6.1	7.8	11.4	0.50	0.74	0.91	1.06	.16	.17	.22	.24
Q2/72	4.6	4.6	8.0	10.7	3.4	5.2	7.6	8.2	0.50	0.97	1.31	1.67	.10	.16	.18	.24
Q3/72	6.9	10.1	17.0	15.4	5.3	6.9	12.0	10.1	0.50	0.76	1.00	1.24	.11	.21	.25	.29
Q4/72	5.0	19.5	14.8	31.2	2.9	12.8	7.5	18.7	0.29	0.59	0.82	1.12	.10	.14	.15	.23
Q1/73	14.2	14.9	14.6	16.3	11.0	11.2	10.6	11.3	1.18	1.25	1.38	1.62	.11	.15	.19	.23
Q2/73	6.0	9.5	12.5	21.4	5.5	8.0	10.1	15.8	0.73	1.18	1.76	2.08	.10	.17	.24	.31

ing methods according to importance in making their forecasts. The six methods to be checked off in the questionnaire are: own econometric model, outside econometric model, informal GNP model, leading indicators, anticipation surveys, and others. In this study, since we are interested in a comparison among different forecasting methods, own econometric model and outside econometric models are grouped together.

The econometric model method is defined as the use of a simultaneous equations system to predict the major economic variables, so that the interrelationships among variables are brought explicitly into consideration in making predictions. The informal GNP model technique is a judgmental forecasting method which predicts each major component of GNP based on the forecaster's judgment and various information sources. The leading indicators approach refers to the use of the NBER leading, lagging, and coincident indicators to forecast the cyclical movements of aggregate economic activity. The anticipation surveys method refers to the use of survey data such as consumer attitude surveys or intentions surveys. The "others" method includes all other forecasting techniques not identified.

The total number of participants and their percentage distributions among the five methods of the first, second, and third ranks are reported in Table 4. Since there are members who checked only the most important method or the first two methods, the percentage distribution in each category is calculated based on the number of participants who have checked that particular rank. In other words, the total numbers of forecasters of these three columns are not identical. In addition, if a person did not answer this question at all, his forecast is excluded from Table 4, but included in the tabulation of median forecasts.

First, let us study the most important forecasting method used in ASA/NBER forecasts. Apparently, the most popular one in this category is the informal GNP model; roughly half of the panel members used this method. The number of participants using econometric models was only about 15 percent of the total, at the beginning of the forecasting period, but rose to about 30 percent by 1971. This phenomenon is partly due to the emergence of a number of prominent aggregate econometric models in the early 1970s which are made available to both academic and industrial economists for forecasting purposes. This increase in econometric model users is accompanied by a decrease in the number of forecasters attaching first importance to leading indicators and informal GNP models. During the five year forecasting period, the percentage of forecasters relying primarily on leading indicators has declined from more than 15 percent to less than 5 percent of the total; the informal GNP model users have also dropped from 60 percent to 50 percent. This finding indicates a tendency within the forecasting fraternity to move toward more complex forecasting techniques.

TABLE 4 **The Number of ASA/NBER Forecasters and the Percentage Distribution According to Forecasting Methodology in the Most, Second Most, and Third Most Important Method Used**

Quarters	Number of Forecasters	Econometric Model (percentage)	Informal GNP Model (percentage)	Lead Indicators (percentage)	Anticipations Surveys (percentage)	Other Methods (percentage)
			Most Important Method Used			
68.4	87	18	55	16	2	8
69.1	63	13	65	8	0	14
69.2	56	13	61	16	0	11
69.3	72	11	60	17	4	8
69.4	57	7	54	16	0	23
70.1	58	10	59	13	2	17
70.2	49	16	57	13	2	12
70.3	55	13	60	15	2	11
70.4	96	19	45	17	0	20
71.1	54	22	57	7	0	13
71.2	57	26	53	9	0	12
71.3	78	28	47	8	3	14
71.4	76	29	51	9	1	9
72.1	66	32	56	3	3	6
72.2	68	27	52	3	3	16
72.3	67	33	49	9	2	8
72.4	63	30	60	2	0	8
73.1	61	28	48	5	0	20
73.2	62	31	50	2	0	18
Average percentage		22	54	11	1	13

		Second Most Important Method Used				
68.4	74	14	18	30	34	5
69.1	52	25	8	39	25	4
69.2	52	14	12	42	27	6
69.3	70	27	13	30	24	6
69.4	61	18	16	36	28	2
70.1	60	13	15	42	25	5
70.2	42	19	12	33	29	7
70.3	48	27	10	38	19	6
70.4	46	15	20	35	28	2
71.1	49	31	18	29	20	2
71.2	55	27	16	29	24	4
71.3	38	32	16	34	11	8
71.4	64	31	17	34	14	3
72.1	57	25	14	42	16	4
72.2	78	27	21	33	19	0
72.3	48	33	21	33	13	0
72.4	56	21	18	39	20	2
73.1	74	24	19	28	23	5
73.2	51	24	16	45	14	2
Average percentage		23	16	35	22	4

TABLE 4 (concluded)

Quarters	Number of Forecasters	Econometric Model (percentage)	Informal GNP Model (percentage)	Lead Indicators (percentage)	Anticipations Surveys (percentage)	Other Methods (percentage)
			Third Most Important Method Used			
68.4	54	15	9	39	33	4
69.1	44	16	5	32	48	0
69.2	39	23	5	28	44	0
69.3	54	19	11	30	37	4
69.4	31	23	6	10	58	3
70.1	41	24	10	22	39	5
70.2	31	23	7	39	32	0
70.3	36	22	6	31	36	6
70.4	31	16	10	29	36	10
71.1	40	18	3	43	28	10
71.2	39	13	5	44	33	5
71.3	31	19	3	26	36	16
71.4	53	13	8	28	45	6
72.1	47	19	9	30	38	4
72.2	41	24	2	29	39	5
72.3	40	15	3	40	35	8
72.4	45	13	2	36	47	2
73.1	40	20	5	33	38	5
73.2	21	33	0	24	38	5
Average percentage		19	6	32	39	5

The second column in Table 4 indicates that the leading indicators are most frequently used as the second most important method to make forecasts. The percentage of members using this method is quite steady over the sample period; about 35 percent of total participants are using the leading indicators to help make their forecasts. In addition, on average, 31.5 percent of the participants reported that the indicators are used as the third important method to reach their forecasts.

The anticipations survey, which is seldom used as the primary method, is very commonly used as an auxiliary forecasting method. This is shown in the second and third columns in Table 4. On the other hand, the informal GNP method is very rarely used as the second and third important method to produce forecasts. The second and third columns of Table 4 also show that the use of econometric model forecasts to adjust predictions has also increased since 1970.

In order to make a comparison of forecasting among different methods, the forecasters have been divided according to the most important forecasting method only. For lack of observations, the anticipations survey forecast is not included. Therefore, the forcasting techniques compared here are: econometric model, informal GNP model, leading indicators, and others. The median forecasts of each subgroup are calculated. The RMSEs of each type of forecast is calculated for the forecasting period from 68.4 to 73.2 and are reported in Table 5. However, the RMSEs of leading indicator forecasts are calculated for the same period excluding 72.4 and 73.2, because only single observations are found in these two quarters.

The results in Table 5 are not conclusive. No method predicts consistently better or worse than other methods, and no method predicts consistently better in levels or in changes. All four subforecasts generate larger errors than the consensus forecasts. This is because the subsamples have a larger variance. On comparing the two more popular methods, we find that forecasters using the informal GNP model achieved smaller errors than econometric model users in the first quarter in GNP and GNP58. But the superiority of the informal GNP model declines rapidly as the forecasting span extends. Nevertheless, the informal GNP model forecasts are consistently better than the econometric model forecasts for both the price deflator and the unemployment rate.

Forecasters using the leading indicators as the primary method had the least successful forecasts of current GNP, but predicted the real GNP relatively well, especially in the shorter forecast spans. in the prediction of the price deflator, the leading indicator users experienced a larger error in one-quarter-ahead forecasts. In the multiquarter forecasts, the errors made by the leading indicator users are in line with those made by other methods.

It is also interesting to compare the RMSEs of the econometric model

TABLE 5 The Comparison of RMSEs of Different Methods Used in ASA/NBER Forecasts

Method	Predicted Change				Predicted Level			Predicted Percentage Change				Predicted Accumulated Percentage Change		
	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q2	Q3	Q4
Gross National Product (GNP)														
Econometric	5.17	6.04*	6.70*	7.31*	8.86	11.14*	10.99*	0.50	0.57	0.64	0.71	0.85	1.09	1.04
Informal GNP	4.51*	7.29	7.50	8.12	9.77	11.94	11.81	0.43	0.71	0.72	0.78	0.95	1.17	1.13
Leading Indicator	5.72	7.30	8.60	10.75	10.67	13.98	19.10	0.54	0.71	0.82	0.99	1.04	1.35	1.79
Others	5.09	6.76	9.01	9.01	8.56*	12.20	13.52	0.49	0.55	0.83	0.85	0.82	1.18	1.30
Gross National Product in 1958$ (GNP58)														
Econometric	4.44	5.30	5.77	6.97	6.71	9.62	12.38	0.60	0.71	0.78	0.97	0.91	1.31	1.69
Informal GNP	3.73*	5.35	6.08	7.29	6.51	8.32*	11.03*	0.50	0.72	0.82	0.99	0.89	1.13	1.50
Leading Indicator	3.86	3.84*	5.24*	7.52	6.06	9.32	13.52	0.52	0.67	0.86	1.00	0.82	1.25	1.81
Others	4.03	4.46	6.71	6.91*	5.90*	8.12	11.52	0.54	0.59	0.91	0.93	0.80	1.10	1.57
Implicit Price Deflator (IPD)														
Econometric	0.54*	0.83	0.83	0.86	1.14	1.64	2.21	0.39	0.60	0.60	0.62	0.85	1.24	1.70
Informal GNP	0.54*	0.75	0.72*	0.84	0.87*	1.14*	1.58*	0.39	0.54	0.52	0.61	0.75	1.00	1.41
Leading Indicator	0.75	0.63*	0.75	0.80*	1.06	1.41	1.88	0.54	0.46	0.55	0.57	0.83	1.31	1.43
Others	0.60	0.77	0.82	0.94	1.17	1.66	2.27	0.44	0.57	0.60	0.68	0.88	1.28	1.76
Unemployment Rate (UR)														
Econometric	0.13*	0.24	0.28	0.30*	0.33	0.53	0.71	3.03	5.22	6.26	6.56	7.49	12.40	17.12
Informal GNP	0.13*	0.21	0.26*	0.32	0.29	0.49*	0.69*	3.09	4.63	5.75	7.40	6.91	11.97	17.76
Leading Indicator	0.14	0.20*	0.30	0.34	0.16*	0.55	0.78	3.24	4.71	6.44	7.29	7.12	13.34	19.81
Others	0.13*	0.20*	0.28	0.33	0.28	0.49*	0.72	2.94	4.85	6.22	7.55	6.57	12.07	18.61

*Smallest error among four methods.

forecasts in Table 5 and that of the Wharton forecasts in Table 1. Apparently, the Wharton forecasts are significantly better than the average econometric model forecasts for GNP, real GNP, and price level. However, the Wharton forecasts of the unemployment rate are consistently worse than the consensus of econometric model forecasts. This finding agrees with a previous study.[9]

DECOMPOSITION OF MEAN SQUARE ERROR (MSE)

In the past, regression analysis has often been used in the evaluation of predictive performance.[10] Since the forecast (F) is always available before the actual value (A), we may consider the actual value to have a probability distribution with mean equal to F and variance equal to σ_u^2. Therefore, A can be written as:

$$A = F + u.$$

In other words, the forecast error (u) is treated as a random error with mean equal to zero and variance equal to σ_u^2. If we regress A on F, we obtain:

$$A = \alpha + \beta F + v$$

where v is the stochastic term in regression. If the forecast error (u) is uncorrelated with the forecast value (F), the regression slope, β, is equal to unity. In this case, the residual variance in regression (σ_v^2) is equal to the variance of forecast error (σ_u^2). Therefore, the forecast is efficient when $\sigma_u^2 = \sigma_v^2$. On the other hand, the forecast is unbiased if α is equal to zero. Therefore, the forecast is the best unbiased estimate of the actual value when $\alpha = 0$, $\beta = 1$, and $\sigma_u^2 = \sigma_v^2 = MSE$. As a result of this logic, the mean squared error can be broken down as

$$MSE = (\bar{F} - \bar{A})^2 + (1 - \beta)^2 \sigma_F^2 + (1 - R_{AF}^2)\sigma_A^2$$

where $\bar{F}$ and $\bar{A}$ are mean values of forecasts and realizations, R_{AF}^2 denotes the coefficient of determination in the regression and σ_F^2 and σ_A^2 are the variances of forecasts and actual values respectively. The first item on the right hand side is called the mean component (MC), the second the slope component (SC), and the third the residual component (RC) of the mean squared error. In the unbiased case, MC vanishes; in the efficient case SC vanishes. If the forecasts are unbiased and efficient, the mean squared error equals the residual component.

The accuracy statistics for the four quarter forecasts of the change and the level of major variables are presented in Table 6 and Table 7. In these two tables, the first part shows means and variances of forecasts and actual values as well as the root-mean-square-error and its components expressed

TABLE 6 The Accuracy Statistics of ASA/NBER Forecasts of the Predicted Changes of Major Variables

Quarter	Mean $\bar{A}$	Mean $\bar{F}$	Standard Deviation S_A	Standard Deviation S_F	RMSE	Percentage of RMSE Accounted by *MC*	*SC*	*RC*	Regression Statistics α	β	R^2	s.e.	Test Statistics F $\alpha=0$, $\beta=1$	t $\beta=1$	t $E(A)=E(F)$
Gross National Product (GNP)															
Q1	20.88	19.95	9.87	8.33	4.30	4.75	2.17	93.08	−0.5784	1.0760	0.8235	4.38	0.63	0.63	−0.32
Q2	21.21	18.67	10.04	6.98	5.86	18.87	8.85	72.28	−2.1194	1.2498	0.7540	5.28	3.07	1.40	−0.88
Q3	21.47	19.18	10.27	6.32	7.50	9.35	2.37	88.28	−1.2140	1.1829	0.5292	7.50	1.00	0.63	−0.78
Q4	21.78	19.31	10.51	5.12	7.90	9.77	11.99	78.23	−7.8477	1.5342	0.5584	7.47	1.95	1.47	−0.84
Gross National Product in 1958$ (GNP58)															
Q1	6.42	7.00	7.08	5.45	3.42	2.86	5.84	91.30	−1.6428	1.1519	0.7862	3.46	0.81	1.04	0.28
Q2	6.54	7.11	7.25	4.00	4.50	1.56	21.43	77.01	−4.2623	1.5207	0.7036	4.19	2.39	2.11	0.28
Q3	6.58	7.19	7.46	3.68	6.07	1.01	1.55	97.44	−2.0876	1.2056	0.3537	6.38	0.20	0.49	0.30
Q4	6.78	7.72	7.64	2.70	7.34	1.64	0.22	98.13	0.0532	0.8713	0.0945	7.78	0.13	−0.18	0.46
Implicit Price Deflator (IPD)															
Q1	1.557	1.337	0.545	0.298	0.53	17.60	0.37	82.03	0.3645	0.8923	0.2375	0.50	1.86	−0.28	−1.55
Q2	1.567	1.139	0.559	0.192	0.74	33.02	11.28	55.70	1.9115	−0.3028	0.0108	0.59	6.36	−1.80	−3.07
Q3	1.583	1.188	0.571	0.141	0.74	28.80	14.63	56.56	2.7668	−0.9963	0.0605	0.59	5.76	−1.97	−2.77
Q4	1.576	1.113	0.588	0.296	0.86	29.40	26.14	44.46	2.1098	−0.4796	0.0582	0.61	8.75	−2.87	−2.82
Unemployment Rate (UR)															
Q1	0.072	0.053	0.276	0.221	0.12	2.83	8.54	88.63	0.0113	1.1517	0.8474	0.11	1.09	1.28	−0.24
Q2	0.083	0.022	0.280	0.184	0.20	9.02	0.76	90.22	0.0590	1.0964	0.5220	0.21	0.87	0.37	−0.77
Q3	0.088	−0.024	0.287	0.148	0.27	17.14	0.00	82.86	0.1119	1.0037	0.2667	0.26	1.55	0.01	−1.43
Q4	0.092	−0.069	0.295	0.085	0.31	26.95	3.95	69.10	0.2104	1.7268	0.2442	0.27	3.13	0.96	−2.09

TABLE 7 The Accuracy Statistics of ASA/NBER Forecasts of the Predicted Levels of Major Variables

Quarter	Mean $\bar{A}$	Mean $\bar{F}$	Standard Deviation S_A	Standard Deviation S_F	RSME	Percentage of RMSE Accounted by MC	SC	RC	Regression Statistics α	β	R^2	s.e.	Test Statistics F $\alpha=0$, $\beta=1$	t $\beta=1$	t $E(A)=E(F)$
Gross National Product (GNP)															
Q1	1043.5	1042.6	111.5	110.8	4.30	4.75	2.43	92.82	−5.3647	1.0060	0.9986	4.37	0.65	0.67	−0.03
Q2	1052.5	1048.9	108.7	106.4	8.47	17.66	5.72	76.62	−16.4116	1.0190	0.9953	7.87	2.44	1.09	−0.10
Q3	1061.3	1056.0	105.9	102.6	10.83	24.07	7.52	68.41	−25.2503	1.0289	0.9929	9.53	3.46	1.28	−0.15
Q4	1070.1	1063.3	102.9	98.0	11.04	38.28	17.66	44.05	−43.4905	1.0473	0.9949	7.83	8.89	2.37	−0.19
Gross National Product in 1958$ (GNP58)															
Q1	753.0	753.6	37.1	36.1	3.42	2.86	6.64	90.50	−18.9990	1.0244	0.9923	3.44	0.89	1.12	0.05
Q2	755.2	756.1	37.1	33.8	5.68	2.48	27.32	70.19	−67.2488	1.0878	0.9836	5.05	3.39	2.50	0.08
Q3	757.2	758.6	37.0	31.6	7.77	3.50	40.57	55.93	−120.289	1.1566	0.9753	6.19	5.91	3.30	0.12
Q4	759.1	761.7	36.9	28.2	11.30	5.39	50.05	44.56	−218.911	1.2840	0.9583	8.06	8.71	3.97	0.23
Implicit Price Deflator (IPD)															
Q1	138.2	138.0	8.40	8.52	0.526	17.60	6.77	75.62	2.4357	0.9839	0.9970	0.48	2.74	−1.23	−0.08
Q2	139.0	138.4	7.92	8.28	1.07	32.76	13.61	53.64	7.2211	0.9523	0.9902	0.83	6.91	−2.01	−0.23
Q3	139.8	138.9	7.42	8.09	1.42	43.30	24.93	31.77	13.1420	0.9121	0.9883	0.85	16.11	−3.43	−0.35
Q4	140.7	139.3	6.91	8.03	2.00	44.51	35.16	20.33	21.8607	0.8527	0.9830	0.96	27.44	−4.92	−0.50
Unemployment Rate (UR)															
Q1	4.940	4.921	0.970	0.932	0.115	2.83	7.67	89.50	−0.1485	1.0341	0.9875	0.11	1.00	1.21	−0.06
Q2	5.028	4.944	0.935	0.803	0.283	8.69	11.79	79.52	−0.5146	1.1209	0.9272	0.27	2.06	1.54	−0.29
Q3	5.124	4.924	0.885	0.708	0.490	16.64	1.38	81.98	−0.2011	1.0815	0.7482	0.47	1.65	0.50	−0.73
Q4	5.233	4.844	0.805	0.658	0.707	30.38	2.02	67.61	1.1288	0.8474	0.4790	0.62	3.35	−0.65	−1.50

in percentages (*MC*, *SC*, and *RC*) The second part shows the regression results and tests statistics for the hypotheses of unbiasedness and efficiency. In calculating the predicted level, the jump-off period data of realizations is adjusted as if there were no data revision.

Tables 6 and 7 indicate that there is systematic underestimation for GNP, IPD and UR in both predicted change and predicted level during the sample period. The extent of underestimation increases as the forecasting spans are lengthened. However, real GNP is repeatedly overestimated, as the underestimation of price deflator exceeds the underestimation of current GNP.

The results of error decomposition suggest that the most important error component is the residual variance. In most cases, it accounts for roughly 50 percent or more of the total error. The real GNP is the only variable for which the forecasting error accounted for by inefficiency is consistantly greater than that accounted for by biasedness. In other variables, the error due to bias is greater than the error due to inefficiency.

Near-term forecasts usually are more efficient and less biased than the far-term forecasts. Table 7 shows that both *MC* and *SC* grow and *RC* declines as the forecasting spans are lengthened, except for *SC* in far-term forecasts of unemployment rate. However, this phenomenon is not shown clearly in Table 6. Generally speaking, the ASA/NBER forecast performs better in predicting changes than levels in terms of unbiasedness and efficiency, with some exceptions in the forecasts of unemployment rate. Among the four variables investigated the ASA/NBER forecast survey predicts GNP58 best and IPD worst.

In regression analyses, the correlation between forecasts and realizations is much lower in predicted changes than in predicted levels. The value of R^2 drops rapidly as the forecasting span extends. In predicted price changes, forecasts and realizations are not correlated after the first quarter. On the other hand, the predicted levels and actual levels are very closely correlated in all cases except the third and fourth quarter forecasts of unemployment rate.

In predicted changes, examination of t ratios shows that the regression slopes all differ significantly from zero, but differ insignificantly from unity at 95 percent confidence level except the fourth quarter forecast of price change. This indicates that inefficiency is relatively small. The t test for unbiasedness, i.e., the t ratio of $E(A) = E(F)$, suggests that the second, third, and fourth quarter forecasts of price change are significantly biased at 95 percent confidence level. The F test also rejects the joint hypothesis of unbiasedness and efficiency in these three price forecasts. In general, all other forecasts can be considered unbiased and efficient at 95 percent level of confidence.

In predicted level, the results of t tests for unbiasedness indicate that

none of the forecasts are significantly biased at 95 percent level. However, the t test rejects the hypothesis of unit slope in the second, third, and fourth quarter forecasts of GNP58, the third and fourth quarter forecasts of IPD, and the fourth quarter forecast of GNP. The F test rejects the joint hypothesis of unbiasedness and efficiency after the first quarter forecasts.

Alternative Decomposition of Mean Square Error for Real GNP[11]

As discussed before, the real GNP is not included in the original ten variables in the questionnaire; it is inferred from the questionnaire by dividing the nominal GNP by the implicit price deflator. Therefore, the forecasting error in real GNP can be traced to forecasting errors in the nominal GNP and in the implicit deflator. The forecasting error in real GNP can be measured logarithmically as

$$ln\ (\widehat{GNP}/\widehat{IPD}) - ln\ (GNP/IPD)$$

By simple transformation it can be written as

$$ln\ (\widehat{GNP}/GNP) - ln\ (\widehat{IPD}/IPD)$$

Obviously the first item is the forecast error of the nominal GNP and the second item is the forecast error of the implicit deflator, both measured in logarithmic form. The mean-square-logarithmic-error of the forecast of real GNP can therefore be written as

$$MSLE \text{ of } GNP58 = \frac{1}{T}\Sigma[ln\ (\widehat{GNP}/GNP) - ln\ (\widehat{IPD}/IPD)]^2$$

$$= \frac{1}{T}\Sigma[ln\ (\widehat{GNP}/GNP)]^2 + \frac{1}{T}\Sigma[ln\ (\widehat{IPD}/IPD)]^2$$

$$- \frac{2}{T}\Sigma[ln\ (\widehat{GNP}/GNP) \times ln\ (\widehat{IPD}/IPD)]$$

This equation states that the mean-square-logarithmic-error for real GNP equals the sum of the mean-square-logarithmic-errors for nominal GNP and implicit price deflator, minus twice the mean product of the prediction errors of the latter two variables.

The interpretation of the results is rather difficult because there is no simple way to inverse the MSLE, or its square root, into a natural number. In order to do so, it is necessary to apply Taylor's expansion for approximation.

In general, the formula of MSLE can be written as

$$MSLE = \frac{1}{T}\Sigma[ln\ (F/A)]^2$$

where F denotes forecast value, A denotes actual value, and T is the sample size. A perfect forecast means $(F/A) = 1$ and $MSLE = 0$. Let $f(x) = ln\ x = ln\ (F/A)$. The function $f(x)$ can be expanded around one by applying Taylor's expansion theorem such as

$$f(x) = f(1) + (x - 1)f'(1) + \frac{(x-1)^2}{2!}f''(1) + \ldots + \frac{(x-1)^{n-1}}{(n-1)!}f^{n-1}(1) + \ldots$$

because

$$f(1) = 0,\ f'(1) = 1,\ f''(1) = -1,\ \ldots,$$

so that

$$f(x) = 0 + (x - 1) - \frac{(x-1)^2}{2!} + 2\frac{(x-1)^3}{3!} + \ldots$$

if $x \to 1$ and $(x - 1) \to 0$, we can approximate $f(x)$ by truncating the tail of the expansion series. For real GNP, the ratio of (F/A) is so close to unity that $(x - 1)^2$ and $(x - 1)^3$ are insignificantly different from zero. Therefore, we can write

$$f(x) = ln\ x = x - 1$$

and

$$MSLE = \frac{1}{T}\Sigma[ln\ (F/A)]^2 = \frac{1}{T}\Sigma[(F/A) - 1]^2 = \frac{1}{T}\Sigma[(F - A)/A]^2$$

This equation states that MSLE is approximately equal to the mean-square-percentage-error when F/A is in the neighborhood of one, and the percentage error is defined as the ratio of forecast error to actual value. The square root of MSLE is, therefore, in the same percentage unit.

Checking the ASA/NBER forecast record, we found the forecast/actual ratios of GNP58, GNP, and IPD in different quarters are all within the range of .969 and 1.033, and most are even within ±1 percent range. The above approximation can therefore be applied to all three series. In other words, their log errors can be considered as percentage errors in all three series.

For a cyclical variable, such as a first difference or a ratio, whose forecast/actual ratio is far from unity, the tail in its expansion equation cannot be truncated. Then we should write the general form,

$$MSLE = \frac{1}{T}\Sigma\{[(F - A)/A] - [(F - A)/A]^2/2! + 2[(F - A)/A]^3/3! + \ldots\}^2$$

In this case, it is still difficult to tell what the MSLE measures. However, we at least know the MSLE is a nonlinear function of percentage errors.

In Table 8, the MSLE's are reported in scientific expression and their square roots, which indicate average percentage errors, are in parentheses. The average percentage errors of the four quarter forecasts of GNP58

TABLE 8 The Decomposition of Mean-Square-Logarithmic-Error of GNP58

	MSLE of GNP58	MSLE of GNP	MSLE of IPD	2 × Mean-Cross Product of GNP and IPD
Q1	4.3188 E–5 (.00657)	7.5627 E–5 (.00870)	5.0628 E–5 (.00712)	8.3068 E–5
Q2	9.3146 E–5 (.00965)	13.6517 E–5 (.01168)	11.2609 E–5 (.01061)	15.5980 E–5
Q3	17.8992 E–5 (.01338)	17.8913 E–5 (.01338)	17.2886 E–5 (.01315)	17.2806 E–5
Q4	31.6414 E–5 (.01779)	20.9473 E–5 (.01447)	30.0495 E–5 (.01733)	19.3554 E–5

in the sample period are .66 percent, .96 percent, 1.34 percent, and 1.78 percent respectively. Since all forecast errors are measured in the percentage of actual values; direct comparison of forecast errors of the three variables can be made. It seems that all three error series follow the same path of error accumulation over the forecast horizon. The average percentage errors of GNP58 and IPD increase roughly .3 or .4 percent a quarter as the forecast span extends. The percentage error of GNP starts at a higher level, but accumulates at a slower rate.

The mean-square-percentage-error of GNP58 can be broken into three components: the MSLE of GNP, the MSLE of IPD, and twice the mean product of GNP and IPD. The cross-product item has a negative entry. In the first and second quarter forecasts, the largest component is the mean cross-product and the smallest component is the MSLE of IPD. In the third and fourth quarter forecasts, they are reversed in order. The third quarter forecasts of GNP58 are almost equally affected by the three components. In the fourth quarter forecast, the error of IPD is substantially larger than those from the other two sources. It inidcates that the forecast of real GNP absorbs more errors from implicit price deflator as the forecast span ex'ends.

In fact, the MSLE is the second moment of percentage errors about the origin, and the mean-cross-product is the product moment of percentage errors about the origin. Therefore, the mean-cross-product measures the relative variations in GNP and IPD. In Table 8, the mean-cross-products are all positive. It indicates that the percentage error in GNP and the percentage error in IPD have a tendency to move together about the origin. In other words, if one series overestimates, the other one is also more likely to overestimate. Since GNP58 is the ratio of GNP and IPD, the simultaneous underestimation, or overestimation, of GNP and IPD provides the opportunity of error offsetting between numerator and denominator. The

percentage error in GNP58 is therefore less than the sum of the percentage errors in GNP and IPD. In fact, it is only about half as large. The positive correlation between the errors in GNP and IPD serves the important function of substantially reducing the errors in forecasts of real GNP from what they would otherwise be.

CONCLUSION

In this paper we have attempted to determine the relative and absolute accuracies of the ASA/NBER survey forecasts. The relative accuracy analysis finds that the ASA/NBER forecasts are significantly better than autoregressive extrapolations.

The comparison of mean forecasts and median forecasts shows that the mean forecasts tend to create smaller errors as the forecast span extends. The size of the difference between mean and median forecasts may be related to developments in the business cycle. In addition, the standard deviation, which measures the dispersion of the distribution of forecasts, can also be used as a barometric indicator of general business cycles and other sectoral instabilities.

The decomposition of mean-squared-errors shows that the most important error component is the random residual variance. The real GNP is the only variable in which the forecasting error accounted for by inefficiency is consistently greater than that by biasedness. In terms of unbiasedness and efficiency, the ASA/NBER forecasts perform better in predicting changes than in predicting levels.

The results of decomposition of the sample according to the most important forecasting method used are not conclusive. No method predicts consistently better or worse than other methods and no method predicts consistently better in levels or in changes. However, the error in econometric model forecasts accumulates at a slower rate in the four quarter span. This is more significant in predicted changes than in predicted levels. There is no clear evidence that the ASA/NBER forecasts are better or worse than the Wharton econometric model forecasts.

APPENDIX A The Regression Results of Naive Model: 1968.4 and 1973.2

Year and Quarter	Constant	$X_{(t-1)}$	$X_{(t-2)}$	$X_{(t-3)}$	$X_{(t-4)}$	R^2
			GNP			
68.4	−3.7305	1.2992	−0.2996	−0.0040	0.0284	0.9986
	(−1.3619)	(7.7786)	(−1.0848)	(−0.0148)	(0.1678)	
73.2	−5.1861	1.1721	−0.0418	0.0951	−0.2082	0.9988
	(−0.9844)	(7.0324)	(−0.1531)	(0.3449)	(−1.0898)	
			IPD			
68.4	−2.6025	1.5363	−0.7997	0.5533	−0.2631	0.9990
	(−2.7501)	(9.5402)	(−2.7619)	(1.9717)	(−1.7292)	
73.2	−1.2577	1.4447	−0.3309	−0.1036	0.0046	0.9991
	(−1.5799)	(8.2469)	(−1.1052)	(−0.3297)	(0.0242)	
			UR			
68.4	0.1571	1.4468	−0.6044	−0.0772	0.1925	0.9272
	(0.6306)	(8.8071)	(−2.0991)	(−0.2834)	(1.4000)	
73.2	0.4421	1.3881	−0.4405	0.3175	−0.3628	0.9686
	(3.0152)	(8.7796)	(−1.6109)	(1.1924)	(−2.3596)	

NOTE: The values in parentheses are *t* values.

APPENDIX B ASA/NBER Business Outlook Survey Forecast Record (median)

Quarter Fore-casted	Gross National Product (GNP) Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span	Gross National Product in 1958$ (GNP58) Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span
Q4–68	885					720.0				
Q1–69	901	896				721.0	723.0			
Q2–69	916	913	907			727.0	725.0	726.0		
Q3–69	938	930	926	924		727.0	732.0	729.0	733.0	
Q4–69	955	950	943	943	940	729.0	731.0	738.0	743.0	740.0
Q1–70	963	964	962	956	N/A	730.0	730.0	734.0	741.0	N/A
Q2–70	972	973	974	974	N/A	725.0	732.0	732.0	738.0	N/A
Q3–70	985	985	985	989	N/A	730.0	730.0	735.0	738.0	N/A
Q4–70	993	998	1003	1003	1005	727.0	734.0	738.0	743.0	744.0
Q1–71	1017	1017	1015	1019	N/A	734.0	735.0	741.0	744.0	N/A
Q2–71	1040	1039	1037	1032	1036	740.0	743.0	744.0	742.0	767.0
Q3–71	1058	1055	1054	1054	1049	742.0	745.0	746.0	750.0	749.0
Q4–71	1083	1081	1078	1074	1074	755.7	749.0	754.0	754.0	759.0
Q1–72	1101	1105	1104	1103	1099	764.1	764.7	758.0	765.0	765.0
Q2–72	1132	1127	1133	1132	1128	774.0	775.6	777.6	771.0	776.0
Q3–72	1167	1159	1153	1157	1154	796.0	786.0	787.0	787.6	778.0
Q4–72	1192	1195	1184	1179	1184	809.0	808.0	796.0	797.7	799.4
Q1–73	1226	1221	1222	1211	1205	823.0	821.0	818.0	807.0	807.1
Q2–73	1265	1254	1249	1248	1237	837.2	834.0	833.0	829.0	818.0
Q3–73	1298	1290	1278	1274	1273	841.2	844.8	843.0	842.0	837.0
Q4–73	1329	1323	1314	1302	1298	843.8	847.0	852.7	851.0	851.0
Q1–74	1351	1347	1345	1336	1326	839.0	842.9	852.3	859.2	859.0
Q2–74	1378	1373	1366	1366	1357	831.0	838.0	844.3	857.0	865.4
Q3–74	1414	1406	1398	1388	1387	828.0	835.0	843.0	846.9	861.0
Q4–74		1447	1440	1430	1412		831.0	843.0	851.0	852.1
Q1–75			1481	1473	1459			836.0	850.0	860.0
Q2–75				1515	1508				842.0	858.0

APPENDIX B (continued)

Quarter Fore-casted	Implicit Price Deflator (IPD)					Unemployment Rate (UR)				
	Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span	Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span
Q4–68	123.0					3.6				
Q1–69	125.0	124.0				3.5	3.8			
Q2–69	126.0	126.0	125.0			3.5	3.8	4.0		
Q3–69	129.0	127.0	127.0	126.0		3.6	3.6	3.8	4.0	
Q4–69	131.0	130.0	128.0	127.0	127.0	3.8	3.8	3.8	3.9	3.9
Q1–70	132.0	132.0	131.0	129.0	N/A	4.0	4.1	4.0	3.9	N/A
Q2–70	134.0	133.0	133.0	132.0	N/A	4.7	4.3	4.4	3.9	N/A
Q3–70	135.0	135.0	134.0	134.0	N/A	5.1	4.8	4.4	4.4	N/A
Q4–70	136.6	136.0	136.0	135.0	135.0	5.7	5.2	4.7	4.3	4.3
Q1–71	138.6	138.3	137.0	137.0	N/A	6.0	5.7	5.1	4.6	N/A
Q2–71	140.5	139.8	139.4	139.0	135.0	5.9	5.8	5.6	4.9	4.5
Q3–71	142.6	141.6	141.3	140.5	140.0	6.0	5.8	5.7	5.5	4.8
Q4–71	143.3	144.3	142.9	142.4	141.5	5.9	5.9	5.7	5.6	5.4
Q1–72	144.1	144.5	145.6	144.2	143.6	5.8	5.8	5.8	5.6	5.4
Q2–72	146.2	145.3	145.7	146.9	145.3	5.7	5.7	5.6	5.6	5.4
Q3–72	146.7	147.4	146.5	146.9	148.4	5.6	5.5	5.5	5.4	5.5
Q4–72	147.3	147.9	148.7	147.8	148.1	5.4	5.4	5.4	5.4	5.3
Q1–73	148.9	148.8	149.4	150.0	149.3	5.0	5.2	5.2	5.3	5.2
Q2–73	151.1	150.2	150.0	150.6	151.2	4.9	4.9	5.1	5.2	5.2
Q3–73	154.3	152.7	151.6	151.3	152.1	4.8	4.8	4.9	5.0	5.1
Q4–73	157.5	156.2	154.1	152.9	152.6	4.8	4.8	4.8	4.8	5.0
Q1–74	160.8	159.8	157.8	155.5	154.5	5.3	5.1	4.9	4.8	4.8
Q2–74	165.8	163.6	161.8	159.4	156.8	5.4	5.6	5.5	5.1	4.9
Q3–74	170.6	168.5	165.9	163.9	161.1	5.4	5.6	5.9	5.7	5.2

APPENDIX B (concluded)

Quarter Fore-casted	Implicit Price Deflator (IPD)					Unemployment Rate (UR)				
	Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span	Q1 Span	Q2 Span	Q3 Span	Q4 Span	Q5 Span
Q4–74		173.9	170.9	168.3	165.7					
Q1–75			176.8	173.3	170.0		5.7	5.8	6.0	5.8
Q2–75				179.8	175.3			5.8	5.7	5.8
									5.9	5.5

NOTE: By reading the table diagonally within each variable, one will find five consecutive quarterly forecasts from the same survey, starting with the quarter in which the survey was taken (1Q span). Reading the table horizontally, one will find all five forecasts made for a single quarter by five consecutive surveys with the latest forecast in the first column of that variable. Since some surveys only requested four quarter forecasts, the five quarter span forecast column contains "N/A" or "not available" items. See Table 4 for the approximate number of forecasters for each survey.

APPENDIX C The Comparison of IPD Forecasts, 1973.3 to 1974.3

Model	1973.3	1973.4	1974.1	1974.2	1974.3
Jump-off Point	152.5	155.1	158.4	162.7	167.4
			1Q Span		
Autoregressive	155.1	158.6	162.5	167.8	171.7
Wharton	155.1	157.9	161.8	166.3	171.8
ASA/NBER	154.3	157.5	160.8	165.8	170.6
			2Q Span		
Autoregressive		158.5	162.0	168.2	171.5
Wharton		157.8	160.6	165.3	169.6
ASA/NBER		156.2	159.8	163.6	168.5
			3Q Span		
Autoregressive			161.9	167.6	171.7
Wharton			159.8	163.4	168.6
ASA/NBER			157.8	161.8	165.9
			4Q Span		
Autoregressive				167.4	171.0
Wharton				161.7	166.3
ASA/NBER				159.4	163.9

NOTES

1. See (6), pp. 20–21.
2. For detailed description, see (8).
3. The current forecasts of the ten variables are also included in the NBER data bank which can be accessed through several time sharing systems. They also appear regularly in the Conference Board's *Statistical Bulletin*, and *Economic Outlook USA* published by the Survey Research Center, The University of Michigan.
4. It is customary to use four periods of lag in an autoregressive scheme when quarterly data is used (See [2], [3] and [7]). Our empirical results show, in most cases, only the coefficients of the first one or two lagged dependent variables are statistically significant. However, the inclusion of the third and fourth lagged variables does increase the goodness of fit ($\bar{R}^2$). The autoregressive equations used in the first and last sample quarter forecasts (68.4 and 73.2) are included in Appendix A. Also see [5], p. 38.
5. The reestimation of regression coefficients in every quarter biases the result in favor of the naive model.
6. In [1], Green and Klein used on the first two formulas to evaluate the forecasting record of the Wharton model. However, it is more meaningful to calculate root-mean-square-errors of percentage change, because the variables, whose root-mean-square-errors are calculated, take values of a different order of magnitude in different periods. For example, there was inflation, which implied that the GNP price deflator was at a much higher level in 1973 than in 1968. When the level of a variable is higher at the end of a

sample period than at the beginning, we should simply expect larger prediction errors at the end of the period.

7. This is shown in Appendix A.
8. If means improve forecasts, some modified means, such as a weighted mean, would probably improve them still more.
9. See [4].
10. See [5], pp. 9–20.
11. This section is based on a suggestion made by H. Theil.

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