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Sample Period Simulations and Mechanical Ex Post Forecasts

3.1 INTRODUCTION

In investigating sample period simulations and mechanical ex post forecasts, we examine the predictive ability of econometric models in the unrealistic situation where all of the exact values of the lagged variables and the future values of the exogenous variables are known. This procedure is designed to help accomplish four ends. First, it enables us to isolate the magnitude of forecasting error that results from the model alone. We see how well the model would forecast in the absence of any interaction between forecaster and model and of any uncertainty about the values of exogenous variables. Second, the procedure helps to reveal the effect of various mechanical constant adjustments on the predictive accuracy of the model. Two adjustment rules, in particular, a simple one similar to that used by Wharton forecasters and a more sophisticated type, are applied to the sample period simulations and ex post forecasts. Under the Wharton rule, all of the equations in which the dependent variable is *not* expressed as a first difference[1] are adjusted by the average

[1] In the Wharton model the equation for the change in unfilled orders was not treated as a first difference equation.

of their corresponding structural equation residuals in the jump-off period and one period prior to it, with the adjustment remaining the same for all prediction spans. The more sophisticated constant adjustment allows for a geometrically declining weight as the prediction span increases (see Chapter 1, p. 9). These two methods will be referred to hereafter as "*AR* (average residual) constant adjustment" and "*GG* (Goldberger-Green) constant adjustment," respectively. Third, our procedure of performing mechanical sample period simulations and ex post forecasts enables us to make certain interesting comparisons between forecasts—the sum of components versus aggregated variables, one quarter versus one year, sample period versus postsample period. Finally, it provides us with the data needed to explain the effects on Wharton's simulation and forecast record of both a forecast-oriented estimation procedure (*ROS*) and the anticipations version of the Wharton model.

In order to accomplish these four objectives each model was simulated over both its sample period (with minor exceptions to be noted later) and a postsample period. Simulations were calculated six quarters ahead from each starting date, but only the first four are tabulated here.

Each six-quarter prediction uses observed values of lagged endogenous variables before the starting date, but internally generates the values of the endogenous variables after that date. The actual values of the exogenous variables are used, since it is desirable to isolate the effect of incorrect exogenous values on forecasting error at a later point. Next, the one-year-ahead prediction is computed as the average of the predictions for one to four quarters ahead from each jump-off quarter. Then prediction errors are computed as the difference between the predicted and realized values and are summarized as the mean square error of prediction (*MSE*) and the root mean squared error (*RMS*). Similarly, the *RMS* per cent error expresses the prediction error as a percentage of the realized value in the jump-off quarter. Further, for each variable under investigation, we tabulate the *MSE* value and its partitioning into *UM*, *US*, and *UC*; the *RMS* per cent error; the ratio of the root mean square error to that obtained by the naive 1 (no change) model prediction; and the *RMS* error obtained by prediction with naive 1 and 2 (same change) models (see Chapter 1, pp. 14–15).

Tables 3.1–3.10 and 3.12–3.21 record the values of the OBE and Wharton models—one to four quarters ahead and a year ahead—for current and constant dollar GNP (*GNP*, *GNP58*), consumption (*C*), investment (*I*), and unemployment (*UNRATE*). Tables for other variables are in the appendix, on pp. A51–A74 and pp. A90–A111 for OBE and Wharton, respectively.

Tables 3.11 and 3.22 are presented in order to facilitate comparing the performance of the different constant adjustment procedures within the same sample and forecast periods, as well as the performance of the same forecasting procedure in the sample period as differentiated from the forecast period. For this purpose the *RMS* per cent error values for each variable, model, period, prediction span, and adjustment method are divided by the corresponding value of the "no constant adjustment" prediction.[2] The ratios of the forecast period errors to the corresponding sample period errors are also calculated for each prediction method. Since these ratios involve the averages of sums of squares of random variables, they would have followed an *F* distribution if the values in the numerators had been independent of those in the denominators, and if the random variates had been independent and normally distributed. Since in our opinion these assumptions are too strong for the data under investigation—especially the assumption about the independence of the *RMS* of the different prediction methods—the values that would be statistically significant for the *F* distribution serve only as benchmarks for the descriptive statistic we calculate, and may not be given the usual interpretation.[3] Indeed, in order to avoid any possible misinterpretation we call them *signal* values rather than significant values.

Table 3.23 compares the anticipations and *ROS* results with the standard two-stage least squares (*TSLS*) Wharton *MSE*s. Tables 3.24–3.27 illustrate the origin of GNP *MSE* in terms of its structural and stochastic sources, and show where the gains and losses occur when we use *ROS* coefficients, or equations with anticipations variables, instead of the standard model with the *TSLS* coefficients. These tables are explained in section 3.4 below.

[2] The only year-ahead calculation using the *RMS* per cent error was for the one-year-ahead prediction made with the OBE model. All other year-ahead values and ratios were calculated on the basis of *RMS* (instead of *RMS* per cent error). The same was done in the case of the variables which appear in the model in a first-difference form.

[3] It would be incorrect in any case to use this statistic as a measure of structural change from the sample to the forecast period since the *RMS* will generally have a smaller expected value in the period of fit than any other period, even in the absence of structural change.

In addition to our tables we present several diagrams for key variables in the appendix on pp. A75–A89 and pp. A112–A119. These diagrams are called "complete forecasting accuracy diagrams" because they show all of the dynamic simulation results from one to six quarters, superimposed on the actual path of the variable. More than any summary statistic these diagrams reveal how well a model is performing. All graphs are based on both sample period simulations and ex post forecasts with the OBE and Wharton-EFU models.

3.2 THE OBE MODEL

Introduction

The version of the OBE model used for our sample period simulations and ex post forecasts is similar to the model presented in Chapter 2.[4] The sample period for this OBE model extends from the first quarter, 1953 to the fourth quarter, 1965. The sample period simulations begin in the second quarter of 1953 and are restarted each quarter through the third quarter of 1964 in order to obtain six-quarter predictions. The fourth quarter, 1964 simulation was calculated for five quarters so that it would still end within the sample period. Similarly, the simulations for the first, second, third, and fourth quarters of 1965 were generated for four, three, two, and one, respectively.

As stated earlier, the sample period simulations presented here use revised values for all of the predetermined variables. In addition, the parameters of the tax functions are changed whenever there is a corresponding change in the tax laws. The parameters of each tax function are usually estimated by least squares for the duration of any tax law. In some cases where there were only a few observations, simple inspection sufficed for determining the parameters.

Sample Period

Tables 3.1–3.5 and 3.11 at the end of this chapter and Tables

[4] The equations for this model are listed in George R. Green, in association with Maurice Liebenberg and Albert Hirsch, "Short- and Long-Term Simulations with the OBE Econometric Model," in Bert G. Hickman, ed., *Econometric Models of Cyclical Behavior.* New York, NBER, 1972, pp. 92–123.

A51–A74 in the appendix show sample period simulation errors.

First we evaluate the size of the errors as recorded in these tables. The *RMS* error for the one-quarter simulations of GNP with *NO* adjustment is 4.62. This looks uncomfortably large when compared with the *RMS* for naive 2 (same change) of 5.29. However, the *RMS* per cent error is only 0.84, which gives a better impression. The first-quarter *RMS* per cent error for GNP in constant dollars (*GNP58*) is 0.56 for OBE and 2.83 for naive 2. The OBE *RMS* for unemployment is 0.42, which is identical with the naive 2 result. The year-ahead statistics show the OBE model in a much more favorable light. Here the comparable *RMS*s for the OBE simulations with *NO* adjustment and for naive 2 are 5.86 versus 13.67 for *GNP*, 4.52 versus 19.99 for *GNP58*, and 0.51 versus 1.31 for *UNRATE*. The finding that naive model predictions deteriorate rapidly relative to econometric model predictions with the increase in the prediction span is consistent with the expectation that, while historical regularity will dominate in short prediction spans, a model reflecting exogenous events will be necessary for reasonable prediction in longer spans.

Next we examine the effect of constant adjustments on the simulations. In Table 3.11 we see that the effect of the *GG* constant adjustments was to improve simulation performance. The simulations with the *GG* adjustments are superior to those with no constant adjustments for all variables in all quarters, except for the consumption of automobiles and parts in the last two quarters. However, it should be stressed that these differences are "signal" (i.e., significant if the *F* statistic were applicable) in predictions beyond two quarters only in a few cases (purchase of services, nonresidential fixed investment, net foreign balance, and imports).

There is a very persistent pattern to the decomposition of error; both *UM* and *US* are small relative to *UC*. This is especially true for the shorter time periods. Thus, most of the inaccuracy in the predictions stems from the failure of the realized and simulated values to move together, rather than from the fact that the average values and variances of the two differ. This is related to the argument of Suits[5] that a quarterly model need not be judged according to its ability to account for quarter-to-quarter

[5] D. B. Suits and G. R. Sparks, "Consumption Regressions with Quarterly Data," in J. S. Duesenberry *et al.*, eds., *The Brookings Quarterly Econometric Model of the United States*, Chicago, Rand McNally and Co., 1965.

variations. A model estimated with quarterly data which can generate quarterly forecasts may be the preferred model for predicting half-year or year-ahead values, whereas a model based on monthly data might be preferred for predicting quarterly values. The decomposition of error does show that the major weakness of the models lies in tracking quarterly fluctuations.

It is somewhat surprising that the *AR* adjustments, which did not perform well relative to the other methods, were most successful in getting the predictions on the right track. The component of bias (*UM*) is consistently smaller for the *AR* adjustments than for any other method. This was true for all of the simulations from one to four quarters. The *US* component remains small in almost all cases and only occasionally exceeds 10 per cent of the total mean square error.

For the largest component of error, *UC*, the *GG* adjustments usually produce the lowest values, but with very few exceptions the *NO* constant adjustment simulations improve their relative position for the *UC* component as the prediction span lengthens. The *AR* adjustments are inferior to the other two methods for the *UC* component.

Third, the effects of aggregation can be seen in Tables 3.1–3.5. Specifically, the aggregate consumption *MSE* is typically twice as large as the sum of *MSE*s of all consumption components, for all time spans and constant adjustments. The error buildup for investment is much smaller, while the foreign sector comprises only one endogenous variable, so that, by definition, there is no error buildup in the sample period simulations. The buildup of error in the aggregation of consumption, investment, and the foreign sector to GNP can be seen by comparing the sum of the *MSE*s for the main components ($\sum$ *MSE*) with GNP *MSE* and by comparing the sum of the *MSE*s for the disaggregate functions ($\sum\sum$ *MSE*) with the GNP *MSE*. Here we find that the sum of the major *MSE*s is not noticeably different from the GNP *MSE* in the first quarter. This indicates that component errors tend to be independent of each other. The sum of the *MSE*s for the individual equation components in the first quarter carry over the gain for the consumption sector that we note above. In the year-ahead forecast even the sum of the major components is less than the *MSE* for GNP. This is consistent with interdependence of forecast error. In fact, many equations are dependent on the same endogenous variables or lagged endogenous variable. Thus, we should expect dependence through the estimated structural system.

On the other hand, some of the *SER*s may have a negative correlation with other *SER*s. This would tend to make the sum of the component *MSE*s higher than the GNP *MSE*. We will explore this breakdown of aggregation error in more depth in section 3.4.

Another type of aggregation error is over time. This occurs in the one-year-ahead prediction, which is the average of the first through the fourth quarters of prediction. Therefore, the one-year-ahead prediction is, on the average, a forecast for two and one-half quarters. If the quarterly errors are independent of each other, one should expect the one-year-ahead *MSE* to lie between the values for the second and third quarters of prediction. Here we find that the *RMS* for the five variables in Tables 3.1–3.5 for the year-ahead forecast falls between the first and second quarter *RMS* for the *NO* and *GG* forecasts, and between the third and fourth quarter forecast for four out of five of the *AR* forecast variables. The *NO* and *GG* results are consistent with the hypothesis that the OBE model can track periods of more than one quarter better than quarterly fluctuations.

Forecast Period

Tables 3.6–3.11 allow us to make a number of significant observations. First, the *RMS* error for GNP is larger with the OBE than the naive 2 model for all methods of forecasting and for all forecast spans. The GNP *RMS* per cent error shows that for the best OBE forecast (*GG*) the *RMS* per cent error was 0.76 for the one-quarter forecast and 2.53 for the year-ahead forecast. The first-quarter *RMS* per cent error values for the OBE forecasts of *GNP58* are slightly inferior to naive 2, but the year-ahead *RMS* per cent error for the OBE *GNP58* predictions with *GG* adjustments is only 0.61, compared with 2.55 for naive 2. The OBE results for *UNRATE* by all measures are inferior to both naive 1 and 2, for almost all forecast spans and all forecast methods.

Second, the effect of the constant adjustments on the forecast can be seen in Table 3.11. Both the *GG* and *AR* adjustments improve forecast performance in the first quarter of forecast. The improvement is at *signal* levels in many cases. The *AR* forecast for GNP is similar to the *GG* forecast for all quarters of forecast, but after the first quarter the *AR* forecast for *GNP58* is even inferior to the *NO* results. The deterioration of the *AR* forecasts is especially apparent for the purchases of nondurables and for corporate profits. In both cases the *AR* adjustment improves the first-quarter forecast. However, the *GG* results appear to approach the *NO* adjustment results in the later quarters without becoming inferior to them. This is partly due to the decaying nature of the *GG* adjustments, but since later forecast periods depend on earlier periods, the specific comparisons of the *GG* and *NO* results cannot be determined a priori.

A comparative analysis of the breakdown of *MSE* into its *UM*, *US*, and *UC* components for the three methods of forecasting shows how the adjustments affect forecast error. In general, the constant adjustments reduce the *UM* component dramatically for all spans of forecast, but increase the *UC* component. Typically, the *AR* adjustment shows this tendency most strongly, while the *GG* adjustment falls between the *AR* and *NO* shift from *UM* to *UC* error. Thus, the gain that might have been obtained by reducing *UM* is lost by increases in the *UC* component. Another method of adjustment (such as adjusting the entire model forecast on the basis of the total model forecast error that would have occurred had *NO* adjustment simulations been made for quarters preceding the forecast) might reduce *UM* without increasing *UC* as much as it was increased by the individual equation adjustments on the basis of the jump-off period *SER*s.

Third, the aggregation of error and the results of the sample period versus those of the forecast period are illustrated in Tables 3.1–3.11.

The GNP *MSE* for the sum of the major components ($\sum$ *MSE*) is about equal to the GNP *MSE* in the first quarter of forecast for all methods of forecasting, but this result changes markedly as the span of the forecast increases, and even more noticeably in the year-ahead forecasts. Here the GNP *MSE* is typically three times the sum of the *MSE* of the minor components ($\sum\sum$ *MSE*) and twenty-five to forty per cent greater than the sum of the major components ($\sum$ *MSE*). This is undoubtably due to what may be called the structural interdependencies in the model. As noted above, when the same endogenous variable or lagged endogenous variable appears in many equations, any error in that variable will be transmitted to all of the components. Thus, the error in the components will not be independent, and, as the span of the forecast increases, the presence of the same lagged variables with the same error in many different equations will become more pronounced.

H. O. Steckler[6] reports results for the MIT-FRB model according to which the sum of component *MSE* errors are lower than aggregate errors in the first two quarters but larger in later quarters. He also shows that the gain in the component sum over the aggregate is not present when we look at prediction of change, even when it concerns change five or six quarters hence. Since errors in lagged endogenous variables may not noticeably effect the prediction of change, this finding is consistent with our explanation here and in section 3.4.

In examining the accumulation of error over time, we find that the one-year-ahead error falls about half of the time between the first- and second-quarter-ahead error, and between the third and fourth for the remainder. This is weak evidence that there is no systematic positive relationship between errors in all quarters of every forecast.

A comparison of the forecast period results with those of the sample period is made on the right side of Table 3.11. The ratios of per cent *MSE* errors in the forecast period to those of the sample period for *NO* adjustment projection show a preponderance of ratios over 1.0 at the *signal* level. This is especially true in later periods of forecast. The important exception to this is *GNP58*, which shows a ratio near 1.0. The corporation profits forecasts show a ratio of less than 1.0 consistently. In general, we expect ratios greater than 1.0 when we move out of the period of fit. Nevertheless, the very large ratios, above the signal levels in many cases, are distressing. The *AR* forecast period-sample period ratio (except for the year ahead in Table 3.11) appears on average to be around 1.0 when we look at per cent *MSE*. This, in combination with the generally favorable *AR-NO* comparisons in the forecast period, might be taken as a sign that the *AR* sample period simulations are more indicative of the most favorable forecast period results that can be expected than are the *NO* adjustment simulations.

3.3 THE WHARTON STANDARD *TSLS* MODEL

Introduction

The model used for sample period simulations and ex post forecasts

[6] H. O. Steckler, "Forecasting with the FRB-MIT Model," Working Paper No. 44, Economic Research Bureau, SUNY, Stony Brook, N. Y., November 1971, pp. 19–21.

(described on pp. 32 through 35 above) was estimated on the basis of data published after the July 1965 revision in the national income accounts. It is estimated using two-stage least squares (*TSLS*), with principle components in the first stage, over a sample period spanning the first quarter, 1948 through the fourth quarter, 1964. Tax equations were estimated using ordinary least squares (*OLS*) over the periods for which particular tax laws were in effect. Sample period simulations were carried out for six-quarter intervals beginning with the first quarter of 1953, and the model was then restarted for each quarter through the third quarter of 1963 in order to obtain the six-quarter predictions. The fourth quarter, 1963 simulation was calculated for only five quarters so that it would end within the sample period; similarly, the simulations for the succeeding quarters of 1964 were generated for four, three, two, and one, respectively. The starting date—first quarter, 1953—was chosen even though the sample period extends from 1948 through 1964. The Korean War years are excluded from these simulations because they include economic fluctuations not adequately captured by an econometric model designed primarily to forecast the post-1964 period. As currently written, the solution program for the Wharton-EFU model will not converge to a reasonable answer (for example, unemployment greater than zero) for more than one quarter ahead for some of the Korean War period forecasts.

In this section we make some comparisons between OBE and Wharton results. These results may be biased by several differences between OBE and Wharton. For OBE we run sample period simulations over the entire sample period, first quarter, 1953–fourth quarter, 1965 (excluding the very first observation which was used for the calculation of the constant adjustment), since it begins after the Korean War years. The OBE sample period was carried one year beyond Wharton's. One can expect to reduce the errors of a subsample by fitting the regressions to this subsample. This is especially true in the present case, since the national economy fluctuated more in the 1948–1952 period than in the 1953–1965 period. Furthermore, the addition of the year 1965 for OBE also improved its performance because that year exhibits a smooth and trend-dominated pattern. The effect of this addition is clearly seen in a comparison of the *RMS* errors of GNP for naive models 1 and 2: OBE's naive 2 is smaller than the corresponding values for Wharton, while the converse is true with respect to naive 1. This indicates that the series were more trend-dominated in the period covered by OBE than in the Wharton period.

Sample Period—Standard Version with *TSLS* Coefficients

Examining the sample period simulations in Tables 3.11–3.15 and Table 3.21, one can observe several consistent findings. First, the errors are uncomfortably large. In particular, the $6.75 billion *RMS* error in predicting GNP without adjustments one quarter ahead is only slightly lower than the $8.15 billion *RMS* of actual change in naive 1, and higher than the $5.90 billion *RMS* error in naive 2. It is only a small consolation that the 6.75 *RMS* is a small percentage of the average sample period value of GNP, which is about $480 billion. Similarly unimpressive results are reported for the other variables. For instance, the *RMS* error in predicting aggregate consumption without adjustment one quarter ahead is $3.94 billion, as compared with $4.54 billion for naive 1 and $3.00 billion for naive 2. For gross private domestic investment, the $3.72 billion *RMS* is to be compared with $4.05 billion for naive 1 and $5.08 billion for naive 2. Of the sixteen variables reported at the end of this chapter and in the appendix, all first-quarter Wharton predictions—except for consumption of nondurables and services (*CNS*), gross private domestic investment (*I*), nonfarm investment in plant and equipment (*IP*), change in stock of nonfarm inventories (*DII*), and exports (*FE*)—were worse, as measured by *RMS*, than at least one of the naive models considered here. However, this picture changes quite markedly with an increase in the prediction span beyond one quarter, when the naive model predictions are only rarely better than those of the Wharton model. The exceptions are prediction of the unemployment rate (*UNRATE*) for all six quarters and a year ahead, and of corporate profits before taxes (*PROFIT*) for two quarters ahead. When the prediction span increases to four quarters ahead, the *RMS* associated with the naive model prediction for all variables except *UNRATE* and *PROFIT* is typically two to four times that of the Wharton model prediction. The finding that the naive model prediction deteriorates rapidly relative to the Wharton model, as well as to the OBE model, strengthens our view that for longer-span forecasts exogenous events must be reflected in the forecast.

In general, the sample period simulation results are slightly worse for the Wharton model than for the OBE model. This is particularly noticeable for the *GG* and *AR* constant adjustments and for the shorter spans. If we consider the simulation results for nominal GNP with no constant adjustments, the first quarter Wharton *RMS* error of $6.8 billion is substantially worse than the OBE error of $4.6 billion. However, the difference narrows as the prediction span increases, and, beginning with the third quarter of prediction, the figures are essentially the same.

Similarly, for consumption and investment, OBE shows smaller errors in the shorter prediction spans (one and two quarters ahead), but the *MSE*s become larger than with Wharton for longer prediction spans. The gap between the two model simulations is considerably larger, in favor of OBE, for constant-dollar GNP, and steadily widens in favor of OBE for unemployment.

A second observation that applies throughout indicates that the constant adjustments do not seem to improve the year-ahead results consistently, except for *PROFIT*. However, for the shorter prediction span quite a few of the constant-adjusted predictions seems to be *signally* (i.e., significantly, were the *F* statistic applicable) better than the unadjusted predictions. This is particularly noticeable in investment and its components in the foreign trade variables. For the rest of the variables (see Table 3.22) there are no *signal* differences between the predictive performance of *GG* constant adjustment and that of no constant adjustment, while that of the *AR* constant adjustment deteriorates very rapidly and becomes *signally* worse than the other two methods as the prediction span increases. It is not surprising that the performance of the *AR* constant adjustment deteriorates relative to the other methods with an increase in the prediction span, there being no theoretical reason for maintaining the same level of adjustment for the different time spans. Neither is it surprising that the predictions without constant adjustment and those with the *GG* constant adjustment converge to similar values with the increase in the prediction span because of the geometrically declining weights attached to the *GG* predictions.[7] On the other hand, it is somewhat surprising that for prediction spans beyond one or two quarters the *GG* constant adjustment has not performed *signally* better

[7] It should be emphasized that in the single predictions the *GG* and *NO* constant adjustments cannot be expected to converge to the same predicted values with the increase of prediction span. This is so because later period forecasts depend on the earlier predictions, and in the earlier period the forecasts made with the two methods diverge. Our contention refers only to summary measures, such as *RMS*.

than *NO* constant adjustment. As a matter of fact, for almost all prediction spans beyond two quarters it is the latter method that has made better (albeit not necessarily signally better) predictions of the values for GNP (nominal and real), consumption and most of its components, and investment than any other prediction method considered here.

A comparison of Wharton versus OBE as to the relative effect of the *AR* and *GG* adjustments on their respective sample period results reveals that the *GG* adjustments produced a slightly more noticeable improvement for OBE than for Wharton. The net effect of the *AR* adjustments made both the OBE and Wharton *MSE*s for *GNP* and *GNP58* slightly inferior to the *NO* results. For OBE this involved improved first-quarter results but much inferior ones in the later quarters of forecast, while for Wharton all quarters of forecast were slightly inferior to the *NO* simulations. The main component of the sample period simulation error is the *UC* component. The *UM* component is small in the *NO* simulation and is not noticeably improved by the *AR* adjustments for OBE, while it is increased by the adjustment for Wharton.

Thirdly, the effects of aggregation can be seen in Tables 3.12–3.16. For GNP we find that the sum of the *MSE* for the major components ($\sum$ *MSE*) in the first quarter of forecast is about two-thirds of the GNP *MSE* for all methods of simulation. In the year-ahead results the $\sum$ *MSE* are much smaller than GNP *MSE* in the adjusted simulations, but only slightly smaller for the *NO* adjustment forecast. The results in the consumption sector show the sum of the *MSE* for the consumption components to be less than half of the *MSE* of total consumption in the year-ahead forecasts for all three methods of forecasting. This result and a similar one for investment carry over into the sum of minor components ($\sum\sum$ *MSE*) for GNP and make the $\sum\sum$ *MSE* for GNP about one-third of GNP *MSE* for *NO*, *AR*, and *GG*. This error buildup in aggregation is more pronounced than it was for OBE. As we see in section 3.4 below, a major reason for this is that the OBE model multiplier (exogenous expenditure multiplier) is smaller than the Wharton multiplier (about 1.12 versus 1.75).

All of the Wharton year-ahead *RMS* errors are smaller than the second-quarter *RMS* error. This is evidence of error cancellation over time. It is in the same direction as our finding for OBE, but is quantitatively more significant for Wharton than for OBE.

Forecast Period—Standard Version with *TSLS* Coefficients

The forecast period (first quarter, 1965–fourth quarter, 1968) results are quite disappointing. The predictions without constant adjustments are clearly the worst of those shown. For all variables the error increases from the first to the second quarter and then declines for the rest of the six-quarter period. The *RMS* errors of GNP for the first two quarters are \$21.7 and \$24.4 billion. These compare unfavorably with the *RMS* of actual changes of \$16.1 and \$31.7 billion, and even more unfavorably with *RMS* errors of naive model 2, which are \$5.5 and \$11.2 billion, respectively. The *RMS* error for aggregate consumption and investment relative to the naive models is not much better. It is clear that the Wharton model cannot be used to make short-term forecasts outside the sample period without some kind of adjustment. However, after four periods the *RMS* error for GNP is only \$15.4 billion. By this time naive models 1 and 2 have *RMS* errors of \$61.8 and \$24.1 billion, respectively. This makes the *NO* constant adjustment forecasts appear in a relatively more favorable light. Similar declines of *RMS* error are found for most GNP components, and are particularly noticeable for the consumption and investment aggregates.

The relationships between the prediction performance of the OBE and Wharton models in the forecast period are similar to those found in the sample period—the OBE performance is slightly superior to that of Wharton in the shorter prediction spans, while the reverse is true for the longer spans. For instance, for nominal GNP, smaller errors are yielded by the OBE model than by the Wharton model for one-quarter predictions and a few two-quarter predictions, while the reverse is true of predictions for three and four quarters and a year ahead. The situation is the same for aggregate consumption and investment. Noticeable exceptions are real GNP, purchases of durables excluding autos and parts, investment in nonfarm housing, changes in the stock of nonfarm inventories, profits before taxes, and the unemployment rate, where OBE performs better for all of the prediction spans, and purchases of automobiles and nonfarm investment in plant and equipment, where the Wharton performance is superior.

It should be emphasized, however, that in comparing the forecast periods of the OBE and the Wharton models, two factors should be taken into account: export is exogenous in OBE and endogenous in Wharton, biasing the comparison in favor of OBE in the present analysis, since by definition there are no errors in exogenous variables in ex post analysis; also, the OBE and Wharton forecast periods are not identical. This difficulty can be partly overcome by using the *RMS/RMS* of naive 1 value, which provides in some sense a measure of the difficulties in predicting different periods.[8] The statements about the OBE forecast period performance relative to Wharton are based on *RMS/RMS* of naive 1 values.

Turning, next, to the effect of constant adjustments on the Wharton forecast, we note that constant adjustments do make quite a difference in the forecast period. The *AR* adjustments lead to predictions that are relatively much better than the *NO* adjustment forecasts for the first two quarters. Their relative advantage begins to decline thereafter, so that by the fourth quarter these predictions are not much better, and sometimes even worse, than those without the constant adjustments. This is the case for GNP in current and constant prices, for several of the consumption components, and for investment and several of its components. The predictions of *CNA*, *IP*, the foreign trade sector, *PROFIT*, disposable income, and unemployment with *AR* adjustments continue to have significantly smaller errors for the full four-quarter period than forecasts without adjustment to the model. This is also the case for the *GG* adjustment made in predicting unemployment and disposable income (see Table 3.22).

Since the *AR* adjustments give relatively good performance in the first two quarters and the *NO* constant adjustment forecasts do better for the remaining periods, the *GG* adjustments should perform best throughout. With a few exceptions, this is exactly what happens. For GNP in current dollars, the *GG* adjustments are substantially better than no constant adjustments but slightly worse than *AR* adjustments for the first three quarters. For the remaining three quarters the *GG* adjustments are the best. The pattern of the consumption components (except *CNA*) is very similar to GNP. However, for aggregate consumption all constant adjustment methods maintain a smaller level of *RMS* than that of no constant adjustment. A pattern similar to the GNP case is observed for

[8] For an economic interpretation of *relative* accuracy measures, see Jacob Mincer and Victor Zarnowitz, "The Evaluation of Economic Forecasts," in J. Mincer, ed., *Economic Forecasts and Expectations*, New York, NBER, 1969 (especially Section II).

investment and the investment components, with the changeover coming at the fourth quarter. After this quarter the *NO* constant adjustment forecasts are slightly better than the *GG* adjustment predictions. For constant dollar GNP, the changeover comes in the third period. The pattern is reversed for unemployment, where the *GG* adjustments are best for three quarters, while the *AR* adjustments are best thereafter.

The decomposition of error for *NO* this time shows an interesting pattern. The large errors in the first two quarters are due primarily to large components in *UM*, but by the four-quarter forecast almost the entire error is due to imperfect covariation. Thus, the early forecasts are "biased," but the model tends to return to the right track as the prediction span increases.

The size of the error is considerably diminished by introducing constant adjustments. However, the level of error is still too high to be satisfactory. It is particularly hard to accept a *RMS* error in predicting unemployment one quarter ahead of 0.89 per cent (using the method of *GG* constant adjustment which gives the smallest error) when compared with *RMS* errors of 0.18 per cent and 0.19 per cent for naive models 1 and 2, respectively.

In comparing the effect of constant adjustments on the Wharton and OBE forecasts, we see a dramatic improvement in the adjusted over the unadjusted first-quarter forecast for Wharton (*RMS* for GNP averages more than 100 per cent higher in the *NO* forecast than in the adjusted forecasts [Table 3.17]), but only moderate improvement of OBE (*RMS* for GNP is about 40 per cent greater in the *NO* forecast than in the adjusted forecasts [Table 3.67]). All of this difference appears to be attributable to the *UM* component, which is much larger for Wharton than for OBE for the unadjusted first-quarter forecasts. As the span of the forecast increases, the *UM* component in the *NO* forecast increases for OBE but declines for Wharton. In both forecasts for all forecast spans, the adjustments improve the *UM* component, but almost always hurt the *UC* component. For OBE the reduction of the *UM* component in the later periods of forecast aids the forecast noticeably, while it has smaller significance for Wharton. As to *GNP* and *GNP58*, the increase in the *AR* *UC* component more than offsets the gain for the *UM* component in the fourth quarter of forecasts for Wharton. The same is true for the OBE *AR*

GNP58 forecast, but the cut in the *UM* component is greater than the increase in the OBE *GNP* forecast. We find that our previous observation in connection with OBE—that a procedure reducing the *UM* component but leaving *UC* the same would markedly improve forecast performance —holds true for Wharton as well.

Finally, we look at aggregation and the forecast versus the sample period. Table 3.17 shows that the sum of the *MSE* for the major GNP components one year ahead is slightly larger than GNP *MSE* for the *NO* and *GG* forecasts and slightly smaller for the *AR* forecasts. The sum of the minor components ($\sum\sum$ *MSE*) is about one half of the GNP *MSE* for all methods of forecasting and all spans, except for the first-quarter *AR* and *GG* forecasts, which show less loss in the process of aggregation. On the whole, the sample period and forecast periods appear to show the same order of aggregation loss, except for the first-quarter *AR* and *GG*, where the loss in aggregation in the sample period was great. The loss from aggregation is greater for Wharton than OBE in the early quarters of forecast but smaller in the later quarters, probably due to Wharton's higher impact multiplier but lower dependence on lagged endogenous variables.

The year-ahead errors are between the second and third quarters or the first and second quarters of *MSE*s. Thus, just as in the case of OBE, we find that there is some offsetting of error in longer forecasts.

A comparison of the forecasts with the sample period results in Table 3.22 shows, surprisingly, that the ratios of *AR* forecast to sample period *RMS* per cent error for *GNP* and *GNP58* are signally below 1.0 in the first quarter. The *GG* values are about 1.0, and the *NO* values are about 1.8 (signally larger than 1.0). For longer spans all of the ratios appear to approach 1.0 in a gradual way from their initial ratios. A look at all of the variables on Table 3.22 leads to the very rough observation that the *AR RMS* per cent error sample period results are better predictors of best forecast period results than the *NO* adjustment sample period simulations—just as in the case of OBE. In contrast to OBE, the adjustments for Wharton improve the forecast relative to the sample period, but more so in the first quarter than in the fourth quarter of the forecast, when they helped OBE forecasts most noticeably.

We speculate here that some structural shifts occurring after the sample period are responsible for making the adjustments more helpful in the forecast period than in the sample period. The adjustments capture this change as far as it affects the intercept of the equation and not the slope coefficients. Even when a slope coefficient is altered (say, the *MPC*), the constant adjustment will capture its effect on the level of consumption after a two-quarter lapse, even though it does not change the model multiplier appropriately. When shifts in structure, as portrayed by an equation, take place in the sample period the model builder replaces the equation with an alternative specification or adds a variable (perhaps a dummy variable) to compensate for this shift. Thus, the equation adjustments show less impact on sample period simulations than they do on forecast period results. It should be emphasized here that our forecast period results are not simply results after the period of fit, but results with models specified before the forecast period.

3.4 THE WHARTON ANTICIPATIONS VERSION AND THE STANDARD VERSION WITH *ROS* COEFFICIENTS

How is model performance influenced by changing the specification or the coefficient estimation procedure for a model? Any change in either the specification or the coefficients will alter both the stochastic and structural interdependencies in a model. Interdependencies are irrelevant in the context of single equation forecasting, but they may be very important in a systems forecast. The importance of aggregation error in early quarters for Wharton and in later quarters for OBE supports this contention. We find here that, if stochastic negative covariance offsets structural interdependencies, the error aggregation shown above may understate the cost of structural interdependence for forecast performance.

The alternative specification that we try for the Wharton model is called the "anticipations version." It can be thought of as representing a class of alternative specifications where predetermined variables are introduced in such a way that they share some of the explanatory role formerly assumed by endogenous variables. In the anticipations version of the Wharton model, anticipation variables (housing starts are included in this group) are added to five of the structural equations in the standard model. An eight-point index of consumer anticipations is added to the equation for consumer durables except automobiles and parts (*COD*), and to that of purchase of automobiles and parts (*CA*). First, investment anticipations for manufacturing firms, and later, for nonmanufacturing firms, are added to the equations for manufacturing investment in plant and equipment (*IPM*) and for regulated and mining investment in plant and equipment (*IPR*). Finally, private nonfarm housing starts are added to the explanatory variables for investment in nonfarm residential construction (*IH*).[9]

Our alternative estimation procedure, which we call "regression on simulated" (*ROS*), can be thought of as representing a class of alternative estimations for the structural equation coefficients that are oriented towards improving systems forecast performance. These coefficients are estimated by finding the least squares coefficients over the Wharton sample period, when the first-quarter *AR* simulated values from the standard *TSLS* Wharton model are used for the contemporaneous explanatory endogenous variables in the aggregate demand equations. The results reported here for *ROS*[10] are generated with the new coefficients.

From Table 3.23 we see that, with *AR* adjustments, the anticipations and *ROS* sample period simulations and ex post forecasts of *GNP* and *GNP58* are all superior to the *AR* standard model results. This superiority is often at signal levels. Furthermore, this advantage holds for most of the other variables. We find that this occurs even though the *SERs* for the individual equation for the three procedures show hardly any differences.

Seeking to explain these findings, we develop the following decomposition procedure for comparing standard and anticipation results (the generalization to include the *ROS* coefficients is trivial since the procedure can be used whenever the results of using different coefficient values are compared) for *GNP58 MSE*, first for the illustrative model below, and then for comparing our three procedures.

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[9] The estimated equations are listed in M. K. Evans and L. R. Klein, *The Wharton Econometric Forecasting Model*, Studies in Quantitative Economics No. 2, Philadelphia Economic Research Unit, University of Pennsylvania, 1967, pp. 8–9. Note that lagged housing starts are used in the computation of *IH* by the Commerce Department.

[10] For an account of the origin of these procedures, see L. R. Klein, *The Theory of Economic Prediction*, Chicago, Markham Publishing Co., 1971, pp. 66–74. For a fuller account of our method and the values of the *ROS* coefficients, see M. K. Evans, Y. Haitovsky, and G. I. Treyz, "An Analysis of the Forecasting Properties of U.S. Econometric Models," in *Models of Cyclical Behavior*, Studies in Income and Wealth, No. 36, New York, NBER, 1972, pp. 1128–1136.

Aggregate consumption equation:	$C_t = \alpha + \beta DI_t + U_t$	(3.1)
Aggregate investment equation:	$I_t = \gamma Y_t + W_t$	(3.2)
Transfer payment equation:	$P_t = \kappa Y_t + Z_t$	(3.3)
Retained earnings equation:	$RE_t = \mu Y_t + S_t$	(3.4)
National income identity:	$Y_t = C_t + I_t + G_t$	(3.5)
Disposable income identity:	$DI_t = Y_t + D_t - T_t$	(3.6)
Government expenditures:	G_t is exogenous	(3.7)
Tax revenues:	T_t is exogenous	(3.8)

In this system of equations, $D_t = P_t - RE_t = (\kappa - \mu)Y_t + Z_t - S_t = \xi Y_t + V_t$. From this we can derive the so-called "reduced form" by expressing each of the endogenous variables in terms of the exogenous variable and the disturbances U_t, W_t, and Y_t. The forecasting errors for the endogenous demand components of national income can be easily derived, in turn, from the reduced form and we obtain:

$$\delta C = \frac{1}{1 - \beta(1 + \xi) - \gamma} \cdot [-\beta(1 - \gamma)(\delta T - \delta V) + (1 + \xi)(\delta G + \delta W) + (1 - \gamma)\delta U], \tag{3.9}$$

$$\delta I = \frac{1}{1 - \beta(1 + \xi) - \gamma} \{-\beta\gamma(\delta T - \delta V) + \gamma\delta G + [1 - \beta(1 + \xi)]\delta W + \gamma\delta U\}, \tag{3.10}$$

and

$$\delta Y = \frac{1}{1 - \beta(1 + \xi) - \gamma}[-\beta(\delta T - \delta V) + \delta G + \delta W + \delta U], \tag{3.11}$$

where δT and δG are the errors the forecaster makes in projecting the values for the exogenous variables, and δU, δW, and $\delta V(\equiv \delta Z - \delta S)$ are the forecasting errors of the structural equations. δU, δW, and δV are equal to the structural equation residuals (*SER*s, i.e., U, W, and V) unless the equations are adjusted. In the latter case they are equal to the *SER* minus any adjustment to the constant term of the equation in question. Since we have considered only ex post forecasts, we need to suppress the δT and δG terms; the squared error for national product (Y) is then given by

$$\frac{1}{n}\sum(\delta Y)^2 = M^2\left[\beta^2\frac{1}{n}\sum\delta V^2 + \frac{1}{n}\sum\delta W^2 + \frac{1}{n}\sum\delta U^2\right. \tag{3.12}$$
$$\left. + 2\beta\left(\frac{1}{n}\sum\delta V\delta U + \frac{1}{n}\sum\delta V\delta V\right) + \frac{2}{n}\sum\delta U\delta W\right]$$

and

$$M = [1 - \beta(1 + \xi) - \gamma]^{-1}.$$

Notice that

$$\frac{1}{n}\sum\delta V^2 = \frac{1}{n}\sum\delta S^2 + \frac{1}{n}\sum\delta Z^2 - \frac{2}{n}\sum\delta S\delta Z,$$
$$\frac{1}{n}\sum\delta V\delta U = \frac{1}{n}\sum\delta Z\delta U - \frac{1}{n}\sum\delta S\delta U,$$

and

$$\frac{1}{n}\sum\delta V\delta W = \frac{1}{n}\sum\delta Z\delta W - \frac{1}{n}\sum\delta S\delta W.$$

That is, included in the *MSE* for national income are not only the *SER*s associated with the structural equations for all of the endogenous components that make up both Y and DI, but also the cross products between all pairs of these errors as well as the model multipliers.

Now let us add an anticipation variable (x) to the consumption equation:

$$C_t = \alpha^* + \beta^* DI_t + \eta x_t + U_t^*. \tag{3.13}$$

If the addition of this exogenous variable changes the identifying restrictions and if this variable is not orthogonal to all other exogenous variables, the coefficients in the other equations of the system will also be changed in principle. However, in practice moderate-sized macroeconometric models are overidentified to such an extent and the samples are so small that principal component methods are used to obtain the values for the first stage of two-stage least squares. Under these conditions, the introduction of a new exogenous variable will not perceptibly change the coefficients in the other equations. If this is the case, only the coefficients in the structural equation to which the anticipation variable is added will be changed when an estimation technique using limited information with the principal component is applied.

Since we assume that we know x without error, the coefficients of equations 3.9–3.11 will be the same as before, except that β^* will replace β and δU^* will replace δU. Thus, the mean loss from squared forecast errors is

$$\frac{1}{n}\sum \delta Y^2 = M^{*^2}\left[\beta^{*^2}\ \frac{1}{n}\sum \delta V^2 + \frac{1}{n}\sum \delta W^2 + \frac{1}{n}\sum \delta U^{*^2}\right.$$
$$\left. + 2\beta^*\left(\frac{1}{n}\sum \delta U^*\delta V + \frac{1}{n}\sum \delta V\delta W\right) + \frac{2}{n}\sum \delta U^*\delta W\right] \tag{3.14}$$

where $M^* = [1 - \beta^*(1 + \xi) - \gamma]^{-1}$.

The gain from adding the anticipations variable can be obtained by subtracting (3.12) from (3.14). This yields

$$\begin{aligned}
Gy = \frac{1}{n}\sum \delta Y^2 - \frac{1}{n}\sum \delta Y^{*2} = {} & \overbrace{\frac{M^2 - M^{*2}}{M^2}\ \frac{1}{n}\sum \delta Y^2}^{\text{1 structural}} \\
& + \overbrace{\left[\frac{1}{n}\sum \delta U^2 - \frac{1}{n}\sum \delta U^{*2}\right] M^{*2}}^{\text{2 stochastic}} \\
& + \overbrace{\left[\frac{1}{n}\sum \delta U\delta W - \frac{1}{n}\sum \delta U^*\delta W\right] M^{*2}2}^{\text{3 stochastic}} \\
& + \overbrace{2M^{*2}\beta\left[\frac{1}{n}\left(\sum \delta U\delta V - \sum \delta U^*\delta V\right)\right]}^{\text{4 stochastic}} \\
& + \overbrace{(\beta^2 - \beta^{*2})M^{*2}\ \frac{1}{n}\sum \delta V^2}^{\text{5 structural}} \\
& + \overbrace{2(\beta - \beta^*)\left(\frac{1}{n}\sum \delta U^*\delta V + \frac{1}{n}\sum \delta V\delta W\right)}^{\text{6 structural}}.
\end{aligned} \tag{3.15}$$

It is useful to divide the terms in the gain from adding anticipation variables to the equation above into (a) gains (or losses) from changing the stochastic properties of the structural equation residuals and (b) gains (or losses) from changing the structural parameters of the model. Terms 2, 3, and 4 are in the first category, while terms 1, 5, and 6 are in the second.

The direction of the gains (or losses) resulting from changes in the model's estimated structural parameters that occur when anticipations variables are added can be predicted for terms 1 and 5, but is ambiguous for term 6. In our simple model, β is the coefficient in the consumption equation before, and β^* is the value after, the anticipatory variable has been introduced. On a superficial level, we know that *DI* and x will be collinear, and that this will mean that $\beta^* < \beta$, since x will pick up some of the explanation of changes in consumption. On a more philosophical level, it is clear that consumption is determined by a complex set of basic economic and psychological phenomena, and that the explanatory variables we use are proxies for these true structural variables. Thus, when we use an anticipation variable we are using an estimate of the basic determining variables that runs parallel to the disposable income estimate of these variables, and the weight put on the disposable income variable is reduced. Both terms 1 and 5 will be positive when $\beta^* < \beta$. In the case of the first term, where $M^* < M$, we can say that this gain from using anticipations data is due to the reduction of total interdependency in the system. In the case of term 5, we can call this a gain due to the reduction of the weight given the particular endogenous variable entering the equation to which the anticipations variable is added. The weight given term 6 is reduced, but we don't know a priori whether the sign of $(1/n\sum\delta U^*\delta W + 1/n\sum\delta V\delta W)$ will be positive or negative. Thus, we do not know whether term 6 will be positive or negative.

The expected gains (or losses) from changing the stochastic properties of the model depend on our interpretation of the change we introduce by adding anticipations variables to the model. If we think that adding anticipations variables reduces the reliability of the system's estimated parameters, the expected structural equation residuals in the forecast period may increase. If, on the other hand, we consider the estimated parameters and relationships of the anticipations model as reliable as those of the standard model, we would expect the properties of its sample period structural equation residuals to be as good an estimate of forecast period results as those of the standard version. In the second case, we have no expectations until we see the sample period results.

This analysis can be easily generalized to explain the effects of the *ROS* coefficients. Equation 3.15 is valid for comparing the results with and without the *ROS* coefficients. If the *ROS* coefficients reduce the coefficients of the endogenous explanatory variables, the effects due to the changed structural dependencies are parallel to those due to the addition of anticipation variables. Changes in stochastic dependency are shown in terms 2 through 4 in equation 3.15.

Accounting for the forecast error in each component of an aggregative variable, even if the feedback of that *SER* error and the cross products of the *SER*s are included, is not sufficient to explain the *MSE* of the aggregate. If $\delta Y = \delta C + \delta I$, then $(\delta Y)^2$ will include the term $2\delta C\delta I$ as well as the *MSE* of the model forecast for each component. The value of this cross product will be

$$\begin{aligned}\sum \delta C \delta I = (M^2/n)\{&\gamma(1-\gamma)\sum \delta U^2 + \beta(1-\xi) \\ &[1-\beta(1+\xi)]\sum \delta W^2 + \beta^2\gamma(1-\gamma)\sum \delta V^2 \\ &+ [\beta(1-\gamma) - \beta^2(1-2\gamma)(1+\xi)]\sum \delta W \delta V \\ &+ 2\beta\gamma(1-\gamma)\sum \delta U \delta V \\ &+ [1-\beta(1+\xi) - \gamma(1-2\beta(1+\xi))]\sum \delta W \delta U\}.\end{aligned} \tag{3.16}$$

Since this equation involves sums of squares as well as sums of cross products, we can expect it to be positive. This is true even if the cross products of the *SER*s are negative as long as the weighted values of the squared sums have a greater absolute value. It is negative covariance that masks the cost of structural interdependency on aggregation loss. As mentioned before, the Wharton and OBE aggregation loss reported above is the total aggregation loss and thus may be the net of stochastic interdependency gain and structural interdependency loss.

When we consider multiperiod forecasts with a model that includes lagged endogenous variables, the forecasts for later periods are affected by errors made in the endogenous variables in earlier periods as well as by contemporaneous errors. We illustrate this with a model that is identical with the model above except for the substitution of equation 3.17 for equation 3.1.

$$C_t = \alpha + \beta DI_t + \beta_1 DI_{t-1} + U_t. \tag{3.17}$$

The error in the first period of forecast for this new model is identical with that shown in equations 3.9–3.11 because DI_{t-1} will in principle be known exactly at the time the first-period forecast is made. The second-period error for Y in an ex post forecast ($\delta G_1 = \delta T_1 = \delta G_2 = \delta T_2 = 0$), its square, and its mean squared error are shown in the following equations:

$$\delta Y_2 = M[\beta \delta V_2 + \delta W_2 + \delta U_2 + \beta_1 \delta DI_1] \tag{3.18}$$

where

$$\delta DI_1 = (1 + \xi)\, M[\beta \delta V_1 + \delta W_1 + \delta U_1] + \delta V_1;$$

$$\begin{aligned} \delta Y_2{}^2 = {} & M^2[\beta^2 \delta V_2{}^2 + \delta W_2{}^2 + \delta U_2{}^2 + \beta_1{}^2\, \delta DI_1{}^2 \\ & + 2\beta\delta V_2 \delta W_2 + 2\beta \delta V_2 \delta U_2 + 2\beta_1 \beta \delta V_2 \delta DI_1 \\ & + 2\delta W_2 \delta U_2 + 2\beta_1 \delta W_2 \delta DI_1 + 2\beta_1 \delta U_2 \delta DI_1] \end{aligned} \tag{3.19}$$

where

$$\delta DI_1 = (1 + \xi)\, M[\beta \delta V_1 + \delta W_1 + \delta U_1] + \delta V_1;$$

and

$$\begin{aligned} (1/n) \sum \delta Y_2{}^2 = {} & (1/n)\{M^2[\beta^2 \sum \delta V_2{}^2 + \sum \delta W_2{}^2 + \sum \delta U_2{}^2 \\ & + 2\beta \sum \delta V_2 \delta W_2 + 2\beta \sum \delta V_2 \delta U_2 \\ & + 2 \sum \delta W_2 \delta U_2] \\ & + M^2 \beta_1{}^2 (1 + \xi)^2\, [M^2(\beta^2 \sum \delta V_1{}^2 \\ & + \sum \delta W_1{}^2 + \sum \delta U_1{}^2 + 2\beta \sum \delta V_1 \delta W_1 \\ & + 2\beta \sum \delta V_1 \delta U_1 + 2 \sum \delta W_1 \delta U_1)] \\ & + M^2 \beta_1{}^2 \sum \delta V_1{}^2 + 2M^3 \beta_1{}^2 (1 + \xi)(\beta \sum \delta V_1{}^2 \end{aligned}$$

(continued)

$$
\begin{aligned}
&+ \sum \delta W_1 \delta V_1 + \sum \delta U_1 \delta V_1) \qquad (3.20)\\
&+ 2M^2\beta_1[(1 + \xi) M(\beta \sum \delta V_2 \delta V_1\\
&+ \sum \delta V_2 \delta W_1 + \sum \delta V_2 \delta U_1) \delta V_2 \delta V_1\\
&+ (1 + \xi) M(\beta \sum \delta V_1 \delta W_2 + \sum \delta W_1 \delta W_2\\
&+ \sum \delta U_1 \delta W_2) + \sum \delta W_2 \delta V_1\\
&+ (1 + \xi) M(\beta \sum \delta V_1 \delta U_2 + \sum \delta W_1 \delta U_2\\
&+ \sum \delta U_1 \delta U_2) + \sum \delta U_2 \delta V_1]\}.
\end{aligned}
$$

The corresponding values for the anticipations version error are obtained by replacing β_1, β, and U by β_1^*, β^*, and U^* in equations 3.18–3.20. It is important to note that the two-quarters-ahead error includes not only contemporaneous products and cross products of *SER*s but also products and cross products between two forecast periods (all of the terms following the $2M^3\beta_1^2(1 + \xi)\sum \delta U_1 \delta V_1$ term in equation 3.20). From this we can see that, if the first-quarter stochastic errors were the same in the anticipations and standard version, the stochastic gain (or loss) in the second period for the anticipations version would come from products and cross products between *SER*s from period one to period two. The gain from the change in the values of structural parameters for the anticipations version would come both from the $M^{*2} < M^2$ and from the lower weight for the lagged values. In general, $\beta_1^2 > \beta_1^{*2}$ because the anticipation variable will usually be collinear with the lagged explanatory variables and thus absorb some of their explanatory power. This reduction in β_1 will lower the absolute value of the weighted cross product terms. If the weighted sum of products from period t to period $t + 1$ is positive, this will represent a gain from using anticipations data.

The *ROS* coefficients can be expected to lead to larger weights for the lagged endogenous values if the system-generated values of the endogenous variables have a smaller correspondence with their actual values than did their counterparts in the first stage of the two-stage least squares. Since lagged variables appear with error in the second-quarter forecast, this would lead to an increased structural error for *ROS* in the second quarter relative to the first quarter when *ROS* forecasts are compared to other forecasts.

We start our investigation of the three procedures by examining the mean squared error (*MSE*) of the structural equation residuals (*SER*s) shown in Table 3.24. Here we see that the anticipations specification and the *ROS* coefficients apparently have very little effect on the sum of the *MSE* of the components of *GNP58*. In the portion of the sample period with *AR* adjustments spanning the first quarter of 1953 through the fourth quarter of 1964, the sum of *MSE*s for *GNP58* is 9.3 for the standard version, 8.6 for the anticipations version, and 9.8 for the *ROS* coefficients. When these *SER MSE*s are compared with the corresponding *MSE*s in the simultaneous solution of the entire model (on Table 3.15)—49.8, 30.4, and 28.5—two striking facts emerge: first, they are much smaller, and second, the relative size of the *SER MSE*s bears no correspondence to the systems forecast result. The lack of correspondence between the *AR MSE*s for the *SER*s of *GNP58* and the corresponding model *MSE*s is also seen in the forecast period, where the comparison is 29.0 versus 46.7 for the standard version, 26.9 versus 30.4 for the anticipations version, and 28.8 versus 30.8 for *ROS*. We also note that there is an increase in the *MSE* of the *SER*s from the unadjusted standard to the anticipations versions from 82.2 to 86.0, but this is negligible when compared with the increase from 285.3 to 397.6 in model forecast *GNP58 MSE*s. Thus, we must seek an explanation for the forecast error differences in other sources of systems error.

Since the Wharton model is much more complicated than the illustrative model presented above, we have devised means whereby macroeconometric models may approximate the values for the sources of gain from the standard to the anticipations version shown in equations 3.15 and 3.20. While the Wharton model is nonlinear and many of the demand components have different multipliers, we can determine an approximate value for M and M^* by shocking each demand equation and then taking a weighted average of the effect of this shock on constant dollar GNP. This procedure yields a value of approximately 2 for M (4 for M^2), and 1.7 for M^* ($\simeq 3$ for M^{*2}), where M^* is the anticipations version multiplier. Its effect on improving the sample period simulations and ex post forecasts can be seen as the first term at the bottom of Table 3.25. The top part of this table corresponds to equations 3.12 and 3.14, while the values in the bottom part correspond to equation 3.15. The next term in the lower portion of Table 3.25 (term 2) is estimated directly by (a) finding the mean of the sum of the squares of the *SERs* for all the demand components of *GNP58*, (b) adding them together (as in Table 3.24), (c) finding the difference between these totals for the standard and anticipations version, and (d) multiplying by M^{*2}. The third term at the bottom of Table 3.25 was calculated as follows: First the difference was found between the mean of the square of the sums of errors and the mean of the sum of the squares of errors of the *GNP58* components. This difference is the value of the cross product terms. Next, the difference of these values from the standard to the anticipation version was found and multiplied by $3(M^{*2})$.

It is not feasible to estimate the remaining terms in equation 3.15 (4, 5, and 6) directly for the Wharton model because the appropriate *SERs* are difficult to find. Thus, the total of terms 4, 5, and 6 is calculated as a residual (since the difference between the *MSE* for *GNP58* from the standard to the anticipations version is known). Some of this reduction is due to $\beta^* < \beta$. In almost every case the coefficients for endogenous explanatory variables were smaller in the anticipations version than in the standard version.

The values found on the bottom of Table 3.25 explain the difference between the anticipations and standard *MSEs*. From first quarter, 1953 to fourth quarter, 1964, with no constant adjustment, we find that the anticipations *MSE* for sample period simulations was better than the standard version. Out of the total of 18.6 improvement in *MSE* for *GNP58*, 10.7 was due to the lower multiplier in the anticipations version, while 3.6 and 5.4, respectively, were due to smaller products and larger negative cross products of *SERs*. There was almost no difference from the other sources of error. In the forecast period, the *NO* adjustment *MSE* for *GNP58* in the anticipations version was 112.3 higher than for the standard version. From Table 3.25 we can see that more than the entire relative deterioration of the anticipations version was due to the sum of terms 4, 5, and 6 in equation 3.15. The answer to this unexpected result can be found in Part II of this book. An examination of the individual sums of squares and of the approximations of the δV term (error in disposable income equations) values reveals that if forecasts made by Wharton with this model had been made without constant adjustment, the Wharton model disposable income equations would have had large and persistent negative errors during the entire period from the first quarter of 1965 to the last quarter of 1968. We find that, while the *MSE* of the anticipations and the standard version *NO* adjustment results are about the same, the average (*not* average absolute values) of the sum of the *SER*s for *GNP58* over the sixteen forecasts was 0.41 for the standard version and 3.75 for the anticipations version. This occurred because only two out of sixteen values had a different sign than the majority in the anticipations version, compared with six out of sixteen in the standard version. Thus, the coincidence of persistent bias in the *U, V,* and *W* terms lead to a very large error from the sum of terms 4, 5, and 6 in equation 3.15. A confirmation that this persistent bias is the cause of the problem comes from the error breakdown in Table 3.20, where we see that the inferior performance of the anticipations version is due almost entirely to the *UM* component. In fact, the anticipations version is significantly superior for the *UC* component, and the *US* component is negligible for both versions.

The *AR* adjustment sample period simulations afforded much the same comparisons between anticipations and standard versions as the *NO* adjustment figures (see the bottom of Table 3.25). However, here the sample period proved to be a good predictor of the forecast period. By eliminating the extra bias, the *AR* forecast did not have the large contribution from terms 4, 5, and 6 for the anticipations version that we saw in the *NO* adjustment results. Therefore, the same factors that made the anticipations *MSE* for *GNP58* smaller than the standard *MSE* in the sample period also contributed to the superior performance in the forecast period.

The GNP results in current dollars are very similar to the GNP results in constant dollars. The ratio of standard to anticipations is also very similar for these two variables. Since there are no anticipations variables for prices, any change in these ratios stems from indirect rather than direct causes.

Comparing the *ROS* and *TSLS* results when both are used with *AR* constant adjustments, we see from Table 3.24 that the *MSE*s for individual equations are hardly changed, either in the sample or in the forecast period, by the use of *ROS* coefficients with *AR* adjustments instead of *TSLS* coefficients with *AR* adjustments. The total *MSE*s for the *GNP58* components of 9.3 versus 9.8 for *TSLS* and *ROS*, respectively, in the sample period and of 29.1 versus 28.8 in the forecast period give no indication of the difference in first-period forecast performance of the two sets of coefficients. When we look at the parenthetical values in Table 3.25, we note that even the covariance of errors among *GNP58* components gives no indication of the difference. In fact, the positive covariance of +3.4 for *ROS* in the sample period compared with 0.1 for *TSLS* estimates, and the lower negative covariance of −12.4 for *ROS* versus −15.3 for *TSLS*, would appear to give the *TSLS* estimates a slight advantage as far as stochastic interdependency is concerned. Even terms 4–6 of equation 3.15, which involve both stochastic and structural interdependency, show little difference. More than the entire *ROS* superiority in *GNP58 MSE* of 21.3 in the sample period and 15.9 in the forecast period can be explained by the difference in the *TSLS* M^2 value and the *ROS* M^{*2} value. The value of M is about 2 for *TSLS* and about 1.4 for *ROS*, which makes M^2 about 4 and M^{*2} about 2. Thus, the impact of the error coming from stochastic sources on *MSE* in the *TSLS* results is twice as large as that on *MSE* in the *ROS* results.

We can now turn to the major components of *GNP58*. The stochastic sources of error shown on top of Table 3.25 in brackets are broken down by components in Table 3.26. The sum of the products shown for C and I is found by adding the *MSE* values for the components of C and I in Table 3.24. The errors in Tables 3.12–3.23 can now be interpreted. Thus, for consumption a small part of the gain from the anticipations version as compared with the standard version can be attributed to the 2.1 gain in *MSE* from the *SER*s of the consumption equations themselves and from its reverberation. The rest of the gain must be accounted for by $M^* < M$, the gains in the investment equations, and the slight gain from cross products from the rest of the system. The increase from the sum of the components to total *MSE* for C shows that the weights on the squared error terms, similar to those in equation 3.16 above, must have been important since the absolute values of cross products are small. The effect of $M > M^*$ increases the value of these terms and accounts for the higher ratio of standard to anticipations for total consumption than for the sum of the components (Table 3.23). The failure of the consumption forecast made with with *NO* anticipations forecast period method relative to the standard version is consistent with the result for *GNP58*. The ratio of the standard to the anticipations version is smaller for consumption than for GNP. This reflects the loss in the anticipations *SER*s of the consumption equations themselves, as well as the strong covariance between the disposable income and consumption error that existed in the *NO* forecast. Of the components of consumption, purchase of automobiles and parts (*CA*) showed the lowest standard-to-anticipations ratio. Here the increase in the *MSE* of the *SER* from 4.98 to 9.38 in the *CA* equation (due almost entirely to consistent underestimation—the *AR MSE SER* for anticipations *CA* is the same as for the standard one) contributed to the *UM* component, which was the main cause of the poor anticipations performance.

The *NO* adjustment anticipations investment equations, as evident from Table 3.26, show a substantial reduction in *SER MSE*s from the equivalent standard equations. For one quarter ahead, this *NO* result keeps the total investment anticipations forecast in the 1965–1968 period equivalent to the standard, despite superior standard version forecasts of some of the explanatory endogenous variables. The anticipations gain for nonfarm residential housing (see Table 3.23) reflects the structural equation results because there are no endogenous explanatory variables in the housing equation. The large *UM* error in the inventory anticipations prediction (p. A95) reflects the dependence of the inventory equations on the endogenous variables. The *AR* first-quarter investment results show a very slight relative improvement for the anticipations version, despite a dramatic improvement in the absolute *MSE* for both the anticipations and standard versions.

The net foreign balance as well as exports and imports are about the same *for anticipations and standard in all of the NO and AR results.* We know that the individual equation results and the cross products of *SER*s within the sector are identical in the regular and anticipations versions. Thus, any change in the standard-to-anticipations ratio is due to the indirect effect of changes in the forecasts of other variables. The personal disposable income and unemployment variables are also only indirectly affected by the change in versions. Therefore, the extent of the improvement in the first-quarter unemployment predictions for both *NO* and *AR* from the standard to the anticipations version, while not signal, is remarkably large. Here again the *UM* component was responsible for making the anticipations *NO* forecast for disposable income inferior to the standard forecasts. This is consistent with our previous finding that a coincident reinforcement of anticipation and disposable income errors made the total *NO* adjustment anticipations forecast relatively poor compared to the *NO* adjustment standard version.

The breakdown of the *ROS* component results in Table 3.26 shows that the stochastic interdependencies in the model were not changed in any noticeable way by the move from the *TSLS* to the *ROS* coefficients. We explain above that the superiority of *ROS* over the *TSLS MSE* for *GNP58* stems from lower structural interdependency for *ROS* than for *TSLS*. This is substantiated by the observation that the *ROS* gain is generally more noticeable for aggregates than for sums of components.

The ratio of the standard forecast to the anticipations forecast of *GNP58* for the second quarter ahead may be pushed up via two avenues. First, the stochastic gain (or loss) will come from smaller weighted sums of products and cross products from period t to period $t + 1$ for the anticipations version than for the standard version (see the cross product terms in equation 3.20). In Table 3.27, we see that the anticipations version has a slightly smaller value for unweighted *SER* products from period t to $t + 1$ than the standard in every case except that for the forecast period *NO* adjustment. The other sources of increase for the standard-anticipations ratio will come from lower weights in the anticipations than in the standard version for errors in the lagged endogenous variables. Our estimate of the average weight given to errors in the previous quarter is based on weighting the results from simulations with first-quarter shocks. If we shock one of the equations by one in the first quarter and measure the change from the control to the disturbed result in the second quarter, we see from equation 3.18 that our result will be $M\beta_1 (1 + \xi)M$ (e.g., set $\delta W_1 = 1$ and all other δ terms $= 0$). A rough weighting of the values obtained over the thirteen structural equations yielded a value of 0.7 for the standard version and 0.4 for the anticipations version. We can find the value we want, $M^2\beta_1^2(1 + \xi)^2$ (see equation 3.20), by dividing the value we found by M (and M^*) and squaring these values. This yields 0.12 for the Wharton equivalent of $M^2\beta_1^2 (1 + \xi)^2$, or 0.06 for $M^{*2} \beta_1^{*2} (1 + \xi^*)^2$, in equation 3.20. Thus, the weight for past errors in the standard version is about twice that in the anticipations versions, and *MSE* would grow from the first to the second period by this amount due to this change in weight.

Looking at Table 3.23, we see that in the second quarter there was a relative gain for the anticipations over the standard *GNP58* forecast for every case except the forecast period *NO* adjustment result. In the latter case, the loss in the anticipations stochastic component shown in Table

3.27 offsets the gain obtained by giving lagged variables a lower weight. This general finding is true for every component with one exception. The unemployment result shows an increase in the standard-anticipations ratio in the *NO* adjustment forecast period result. In this case, there may have been cross-period weighted products of *SER*s for the stochastic component on the employment equations that offset the relatively large value for this component in the anticipations *GNP58* components.

The *ROS* results compared to the *TSLS MSE* show a relative decline in the second quarter of forecast accuracy for *GNP* and *GNP58* in both the sample and forecast periods. Table 3.27 shows that the unweighted sum of products and cross products from period one to period two is larger for the *ROS* coefficients than for the *TSLS* coefficients. We found that the value of $M^*\beta_1^*(1 + \xi)M^*$ for the *ROS* coefficients was about 1.0 compared with the 0.7 value for *TSLS*. Dividing this value by M^* (for *ROS* 1.4) and then squaring, we find the value of $M^{*2}\beta_1^{*2}(1 + \xi^*)^2$ is 0.25 for *ROS* compared with 0.12 for the *TSLS* estimates. This means, as seen from equation 3.20, that first-quarter errors have twice the effect on second quarter *GNP58 MSE* for *ROS* that they do for Wharton. The combination of both the increased weight put on lagged values in the *ROS* coefficients and the increased stochastic dependence between quarters accounts for the relative decline of *ROS* compared to *TSLS* as the span of the forecast is increased.

In this section we have decomposed the effect of the anticipations and *ROS* coefficients into their particular effects on stochastic and structural interdependencies. As to stochastic interdependencies, the sample period appears to be a poor predictor of the forecast period. In any case, no general pattern of changed stochastic interdependency for *AR* adjustments appears to come from comparing the anticipations version and *ROS* coefficients with the standard version *TSLS* coefficients. As to structural interdependency, switching from the standard *TSLS* to either the anticipations or *ROS* version does produce changes. These changed structural interdependencies appear to explain most of the variation in the *AR* forecast performance among the three procedures.

GLOSSARY FOR TABLES 3.1–3.21

RMS	Root mean squared error
UM	Unequal central tendency
US	Unequal variation
UC	Imperfect covariation
RMS per cent error	Root mean squared of the error expressed as a percentage of the value of the variable in question
RMS/RMS of Naive 1	The ratio of RMS to the RMS obtained by the Naive 1 (no change) model prediction
MSE	Mean squared error
$\sum$ MSE	The sum of the MSE of the components added up to obtain the variable in question
$\sum\sum$ MSE	The sum of the MSE of the components of the variables added up to obtain GNP (i.e., the sum of the MSE of the components of consumption, etcetera)
RMS of Naive 2	The RMS of the Naive 2 (same change) model prediction
NO Constant Adjustments	No adjustments whatever to the structural equations (The Wharton forecast period results differ from those reported in Evans, Haitovsky, and Treyz because in the latter a mechanical adjustment was made to the labor force equation.)
GG Constant Adjustments	Goldberger-Green adjustments to the structural equations
AR Constant Adjustments	Average residual adjustments to the structural equations
AR Constant Adjustments and ROS Coefficients	Average residual adjustments to the structural equations of a model that uses regression on simulated coefficients

TABLE 3.1

Sample Period Simulations for GNP in Current Dollars, OBE Model (2nd quarter 1953–4th quarter 1965)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	4.62	6.48	7.69	8.24	5.86
UM	0.25	1.23	2.50	5.21	1.23
US	0.01	0.14	0.39	0.38	1.06
UC	21.05	40.67	56.24	62.27	32.10
RMS per cent error	0.84	1.53	2.17	2.47	
RMS/RMS of Naive 1	0.49	0.36	0.29	0.24	0.26
MSE	21.31	42.04	59.12	67.86	34.39
$\sum$ MSE of components	20.55	35.54	47.06	52.80	27.51
$\sum\sum$ MSE of components	14.47	20.02	25.14	28.85	14.24
	GG Constant Adjustments				
RMS	3.63	5.43	6.94	7.77	5.17
UM	0.15	0.94	2.00	4.14	1.14
US	0.17	0.22	0.32	0.50	0.06
UC	12.88	28.32	45.81	55.78	25.49
RMS per cent error	0.58	1.18	1.87	2.23	
RMS/RMS of Naive 1	0.38	0.30	0.26	0.22	0.23
MSE	13.19	29.48	48.13	60.43	26.69
$\sum$ MSE of components	12.88	24.37	36.61	45.00	19.66
$\sum\sum$ MSE of components	8.96	14.85	20.38	24.81	10.14
	AR Constant Adjustments				
RMS	3.72	5.84	7.86	9.86	6.20
UM	0.05	0.68	1.59	2.83	1.00
US	0.02	0.23	1.00	1.65	0.55
UC	13.75	33.16	59.14	92.80	36.93
RMS per cent error	0.61	2.88	4.90	7.43	
RMS/RMS of Naive 1	0.39	0.32	0.30	0.28	0.28
MSE	13.82	34.06	61.73	97.28	38.48
$\sum$ MSE of components	14.47	30.29	49.20	71.12	31.53
$\sum\sum$ MSE of components	11.12	20.47	29.02	39.36	17.08

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.1 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	9.48	18.18	26.57	34.75	21.75
UM	55.91	227.49	517.61	931.23	350.81
US	10.83	39.31	82.64	138.90	55.85
UC	23.17	63.72	105.61	137.53	66.20
RMS per cent error	3.18	11.29	23.38	38.88	
MSE	89.91	330.52	705.86	1207.66	472.86
$\sum$ MSE of components	27.44	73.21	143.13	232.43	
			Naive 2		
RMS	5.29	10.86	16.94	23.50	13.67
UM	0.08	0.78	2.78	10.52	2.84
US	0.08	1.15	5.60	8.19	1.73
UC	27.77	116.11	278.51	533.64	182.32
RMS per cent error	1.22	5.29	12.91	24.72	
MSE	27.94	118.04	286.89	552.36	186.89
$\sum$ MSE of components	34.48	92.91	191.25	352.30	

TABLE 3.2

Sample Period Simulations for Consumption in Current Dollars, OBE Model (2nd quarter 1953–4th quarter 1965)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	2.93	3.74	4.39	4.77	3.48
UM	0.26	0.84	1.46	2.37	0.92
US	0.23	0.10	0.02	0.01	0.01
UC	8.12	13.03	17.83	20.38	11.20
RMS per cent error	0.84	1.23	1.74	2.08	
RMS/RMS of Naive 1	0.55	0.36	0.29	0.23	0.27
MSE	8.61	13.98	19.31	22.75	12.13
$\sum$ MSE of components	4.47	6.37	8.14	9.51	4.84
	GG Constant Adjustments				
RMS	2.54	3.30	4.08	4.57	3.15
UM	0.11	0.61	1.22	2.06	0.79
US	0.14	0.20	0.21	0.19	0.18
UC	6.18	10.05	15.18	18.63	8.94
RMS per cent error	0.65	0.97	1.51	1.89	
RMS/RMS of Naive 1	0.47	0.32	0.27	0.22	0.24
MSE	6.43	10.87	16.61	20.88	9.91
$\sum$ MSE of components	3.53	5.31	7.25	8.76	4.10
	AR Constant Adjustments				
RMS	2.68	3.74	4.98	6.20	3.97
UM	0.00	0.21	0.59	1.07	0.44
US	0.00	0.00	0.08	0.15	0.14
UC	7.19	13.75	24.15	37.25	15.15
RMS per cent error	0.68	2.46	4.51	7.03	
RMS/RMS of Naive 1	0.50	0.36	0.32	0.30	0.31
MSE	7.20	13.96	24.82	38.47	15.73
$\sum$ MSE of components	4.22	7.64	12.33	17.57	7.66

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.2 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	5.38	10.37	15.37	20.38	12.73
UM	20.98	86.07	194.84	350.11	134.29
US	2.49	10.08	21.82	39.53	16.28
UC	5.52	11.30	19.46	25.78	11.58
RMS per cent error	2.40	8.79	19.04	32.95	
MSE	28.99	107.45	236.12	415.42	162.15
$\sum$ MSE of components	12.91	42.98	92.04	157.58	
			Naive 2		
RMS	3.17	5.18	7.80	10.24	6.28
UM	0.00	0.14	0.29	1.47	0.43
US	0.06	0.18	1.56	1.72	0.35
UC	9.96	26.46	58.91	101.75	38.67
RMS per cent error	0.78	2.29	5.26	9.37	
MSE	10.03	26.78	60.76	104.94	39.45
$\sum$ MSE of components	9.21	23.73	50.53	84.91	

TABLE 3.3

Sample Period Simulations for Investment in Current Dollars, OBE Model (2nd quarter 1953–4th quarter 1965)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	3.34	4.51	5.12	5.33	3.79
UM	0.04	0.00	0.06	0.38	0.00
US	0.01	0.13	0.22	0.17	1.05
UC	11.10	20.24	25.97	27.84	13.32
RMS per cent error	17.62	31.41	39.75	42.12	
RMS/RMS of Naive 1	0.81	0.70	0.60	0.51	0.55
MSE	11.15	20.36	26.24	28.39	14.37
$\sum$ MSE of components	9.21	12.45	15.49	17.68	8.36
	GG Constant Adjustments				
RMS	2.48	3.59	4.37	4.79	3.04
UM	0.02	0.09	0.20	0.54	0.06
US	0.30	0.53	0.82	1.22	0.13
UC	5.82	12.27	18.07	21.20	9.02
RMS per cent error	11.23	23.79	33.14	35.85	
RMS/RMS of Naive 1	0.60	0.56	0.51	0.46	0.44
MSE	6.14	12.89	19.09	22.96	9.21
$\sum$ MSE of components	5.12	8.93	12.22	14.90	5.54
	AR Constant Adjustments				
RMS	2.65	3.97	4.83	5.59	3.66
UM	0.07	0.29	0.51	0.79	0.25
US	0.27	0.77	1.88	3.13	0.55
UC	6.65	14.70	20.99	27.31	12.59
RMS per cent error	13.51	64.46	86.49	106.22	
RMS/RMS of Naive 1	0.64	0.62	0.57	0.54	0.53
MSE	7.00	15.76	23.37	31.23	13.39
$\sum$ MSE of components	6.62	12.25	15.68	20.37	8.84

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.3 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	4.10	6.43	8.51	10.35	6.85
UM	1.69	7.04	16.59	29.88	11.20
US	0.49	1.08	2.51	4.33	1.15
UC	14.66	33.24	53.37	72.96	34.55
RMS per cent error	33.47	84.38	140.81	194.96	
MSE	16.84	41.36	72.47	107.16	46.90
$\sum$ MSE of components	13.67	28.14	47.08	68.43	
			Naive 2		
RMS	8.86	16.49	24.40	32.73	20.59
UM	0.63	2.87	5.69	9.50	3.99
US	0.29	19.32	94.12	262.42	58.42
UC	77.52	249.80	495.56	799.44	361.59
RMS per cent error	235.12	1020.43	2134.83	3654.38	
MSE	78.44	271.99	595.37	1071.36	424.00
$\sum$ MSE of components	23.89	66.09	134.08	255.56	

TABLE 3.4

Sample Period Simulations for GNP in Constant Dollars, OBE Model (2nd quarter 1953–4th quarter 1965)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	3.67	5.00	5.89	6.36	4.52
UM	0.00	0.11	0.42	1.35	0.22
US	0.04	0.37	0.63	0.41	0.71
UC	13.42	24.54	33.63	38.75	19.51
RMS per cent error	0.56	1.01	1.39	1.60	
RMS/RMS of Naive 1	0.50	0.37	0.30	0.26	0.28
MSE	13.46	25.03	34.68	40.50	20.44
$\sum$ MSE of components	12.63	16.05	19.58	21.98	
	GG Constant Adjustments				
RMS	3.07	4.43	5.48	6.11	4.08
UM	0.00	0.06	0.24	0.85	0.19
US	0.02	0.02	0.06	0.35	0.06
UC	9.38	19.53	29.68	36.17	16.41
RMS per cent error	0.42	0.86	1.28	1.51	
RMS/RMS of Naive 1	0.42	0.33	0.28	0.25	0.25
MSE	9.40	19.60	29.98	37.37	16.66
$\sum$ MSE of components	7.90	12.34	16.23	19.19	
	AR Constant Adjustments				
RMS	3.33	5.05	6.44	7.89	5.05
UM	0.01	0.14	0.41	1.06	0.43
US	0.00	0.00	0.02	0.31	0.13
UC	11.10	25.35	41.01	60.88	24.89
RMS per cent error	0.50	2.28	3.60	5.34	
RMS/RMS of Naive 1	0.46	0.37	0.33	0.32	0.31
MSE	11.11	25.49	41.44	62.25	25.45
$\sum$ MSE of components	9.90	17.53	23.49	29.65	

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.4 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	7.30	13.59	19.39	24.86	15.88
UM	21.79	90.03	210.42	386.59	145.34
US	5.23	19.86	42.14	74.02	31.37
UC	26.22	74.89	123.29	157.56	75.47
RMS per cent error	2.14	7.19	14.07	22.26	
MSE	53.24	184.78	375.85	618.17	252.18
$\sum$ MSE of components	21.56	50.87	94.08	145.18	
			Naive 2		
RMS	7.50	15.33	24.18	34.03	19.99
UM	0.85	4.28	11.48	29.40	9.96
US	2.83	20.54	76.25	164.70	43.72
UC	52.55	210.09	497.05	964.25	346.08
RMS per cent error	2.87	12.22	30.84	61.22	
MSE	56.24	234.92	584.77	1158.35	399.76
$\sum$ MSE of components	269.24	1043.66	2388.21	4307.41	

TABLE 3.5

Sample Period Simulations for the Unemployment Rate, OBE Model (2nd quarter 1953–4th quarter 1965)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	0.42	0.57	0.64	0.67	0.51
UM	0.00	0.00	0.00	0.01	0.00
US	0.01	0.01	0.02	0.02	0.00
UC	0.17	0.31	0.40	0.42	0.25
RMS per cent error	66.48	120.59	146.17	163.64	
RMS/RMS of Naive 1	0.87	0.65	0.58	0.53	0.57
MSE	0.18	0.32	0.41	0.44	0.25
	GG Constant Adjustments				
RMS	0.35	0.54	0.64	0.67	0.49
UM	0.00	0.00	0.00	0.01	0.00
US	0.00	0.01	0.02	0.03	0.00
UC	0.12	0.28	0.39	0.42	0.24
RMS per cent error	49.06	106.48	136.07	156.53	
RMS/RMS of Naive 1	0.72	0.62	0.57	0.54	0.55
MSE	0.12	0.29	0.41	0.45	0.24
	AR Constant Adjustments				
RMS	0.40	0.67	0.90	1.08	0.71
UM	0.00	0.00	0.01	0.02	0.01
US	0.00	0.00	0.00	0.00	0.02
UC	0.15	0.45	0.80	1.15	0.49
RMS per cent error	56.67	286.59	513.70	827.83	
RMS/RMS of Naive 1	0.82	0.77	0.81	0.87	0.79
MSE	0.16	0.45	0.81	1.17	0.52

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.5 *(Concluded)*

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	0.48	0.87	1.12	1.25	0.89
UM	0.00	0.00	0.00	0.00	0.00
US	0.00	0.00	0.00	0.00	0.02
UC	0.23	0.75	1.24	1.56	0.77
RMS per cent error	114.28	293.74	400.81	498.27	
MSE	0.24	0.75	1.24	1.56	0.79
			Naive 2		
RMS	0.42	1.00	1.65	2.30	1.31
UM	0.00	0.00	0.01	0.03	0.01
US	0.04	0.30	0.89	1.86	0.71
UC	0.13	0.70	1.82	3.42	1.00
RMS per cent error	74.03	336.24	824.31	1720.49	
RMS/RMS of Naive 1	0.87	1.15	1.48	1.84	1.47
MSE	0.18	0.99	2.72	5.31	1.72

TABLE 3.6

Ex Post Forecasts for GNP in Current Dollars, OBE Model
(1st quarter 1966–3rd quarter 1969)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	10.29	18.67	24.93	28.46	17.75
UM	49.11	220.05	417.18	545.62	220.01
US	11.39	57.61	127.94	199.83	57.60
UC	45.31	70.88	76.52	64.65	37.49
RMS per cent error	1.49	4.64	8.11	10.43	3.91
RMS/RMS of Naive 1	0.63	0.58	0.53	0.46	0.45
MSE	105.81	348.54	621.64	810.10	315.10
$\sum$ MSE of components	125.70	319.10	492.41	603.03	249.96
$\sum\sum$ MSE of components	117.55	160.45	209.02	239.60	109.97
	GG Constant Adjustments				
RMS	7.17	14.12	20.85	24.84	14.43
UM	6.55	84.03	233.83	351.97	109.63
US	1.77	29.53	108.51	191.19	50.38
UC	43.13	85.76	92.55	73.97	48.26
RMS per cent error	0.76	2.67	5.63	7.85	2.53
RMS/RMS of Naive 1	0.44	0.44	0.44	0.40	0.37
MSE	51.46	199.32	434.90	617.12	208.26
$\sum$ MSE of components	51.17	172.33	339.41	466.04	158.37
$\sum\sum$ MSE of components	56.10	96.69	148.45	186.85	69.90
	AR Constant Adjustments				
RMS	7.60	13.66	17.83	20.66	14.05
UM	2.19	18.89	77.92	147.57	50.43
US	0.04	0.12	24.42	90.83	27.50
UC	55.56	167.62	215.62	188.30	119.51
RMS per cent error	0.89	2.71	4.47	5.61	2.55
RMS/RMS of Naive 1	0.47	0.43	0.38	0.33	0.36
MSE	57.80	186.63	317.96	426.70	197.44
$\sum$ MSE of components	49.70	127.45	222.72	310.87	131.25
$\sum\sum$ MSE of components	43.29	76.62	114.26	153.89	64.19

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.6 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	16.34	32.03	47.24	62.45	39.23
UM	247.47	967.21	2127.19	3738.85	1467.18
US	1.07	5.98	21.73	51.94	14.59
UC	18.38	53.00	82.95	109.67	57.49
RMS per cent error	4.17	15.56	32.85	56.08	21.40
MSE	266.93	1026.19	2231.86	3900.46	1539.26
			Naive 2		
RMS	4.61	9.82	14.89	22.35	12.91
UM	0.03	0.00	0.11	0.37	0.08
US	0.00	0.02	0.00	0.22	0.12
UC	21.25	96.43	221.73	499.14	166.45
RMS per cent error	0.35	1.55	3.41	7.46	2.38
MSE	21.28	96.45	221.84	499.73	166.65

TABLE 3.7

Ex Post Forecasts for Consumption in Current Dollars, OBE Model
(1st quarter 1966–3rd quarter 1969)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	5.27	8.38	12.10	14.70	8.42
UM	3.85	24.91	72.10	119.89	33.37
US	4.00	14.86	46.10	80.75	21.87
UC	19.96	30.48	28.17	15.51	15.65
RMS per cent error	1.02	2.40	4.84	7.09	2.22
RMS/RMS of Naive 1	0.54	0.45	0.44	0.40	0.37
MSE	27.81	70.25	146.37	216.15	70.90
$\sum$ MSE of components	32.58	30.19	39.33	53.06	29.02
	GG Constant Adjustments				
RMS	4.44	7.40	11.01	13.63	7.74
UM	0.69	10.67	45.85	90.53	20.51
US	1.42	9.65	40.07	75.51	20.09
UC	17.64	34.47	35.36	19.83	19.33
RMS per cent error	0.75	1.92	4.03	6.07	1.88
RMS/RMS of Naive 1	0.46	0.40	0.40	0.37	0.34
MSE	19.75	54.79	121.28	185.87	59.93
$\sum$ MSE of components	25.26	33.63	46.15	58.47	26.57
	AR Constant Adjustments				
RMS	4.67	8.44	10.89	12.75	8.79
UM	0.78	6.05	27.20	56.61	19.35
US	0.00	0.26	14.64	46.11	17.19
UC	21.04	64.91	76.67	59.79	40.66
RMS per cent error	0.84	2.63	4.23	5.45	2.57
RMS/RMS of Naive 1	0.48	0.45	0.40	0.35	0.38
MSE	21.82	71.22	118.50	162.51	77.20
$\sum$ MSE of components	12.52	32.82	50.74	67.23	33.56

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.7 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	9.70	18.66	27.54	36.58	22.85
UM	80.47	322.15	712.05	1265.83	490.09
US	0.61	5.18	16.59	30.24	10.67
UC	12.92	20.97	30.09	41.76	21.28
RMS per cent error	3.76	13.45	28.54	49.54	18.62
MSE	94.01	348.31	758.73	1337.83	522.05
			Naive 2		
RMS	5.39	8.59	12.67	17.41	10.84
UM	0.01	0.01	0.11	0.13	0.10
US	0.39	0.58	0.65	15.32	4.54
UC	28.64	73.16	159.78	287.83	112.80
RMS per cent error	1.14	2.85	5.90	11.06	4.10
RMS/RMS of Naive 1	0.56	0.46	0.46	0.48	0.47
MSE	29.04	73.75	160.54	303.28	117.44

TABLE 3.8

Ex Post Forecasts for Investment in Current Dollars, OBE Model
(1st quarter 1966–3rd quarter 1969)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	9.16	15.15	17.95	18.98	12.95
UM	52.86	162.61	235.16	258.89	132.37
US	24.38	46.81	47.79	47.11	22.07
UC	6.59	19.96	39.11	54.14	13.14
RMS per cent error	51.08	138.75	193.56	215.07	94.55
RMS/RMS of Naive 1	1.53	1.87	1.83	1.68	1.63
MSE	83.83	229.39	322.06	360.13	167.57
MSE of components	64.29	114.80	95.61	109.94	60.22
	GG Constant Adjustments				
RMS	4.98	10.31	14.20	16.04	9.57
UM	9.01	65.73	131.36	163.25	64.73
US	5.16	24.56	44.51	51.11	16.80
UC	10.67	16.11	25.68	43.05	9.99
RMS per cent error	16.24	65.39	120.75	152.70	50.67
RMS/RMS of Naive 1	0.83	1.28	1.45	1.42	1.21
MSE	24.84	106.40	201.56	257.40	91.53
MSE of components	24.26	51.92	85.73	105.61	36.42
	AR Constant Adjustments				
RMS	4.75	7.07	9.78	11.55	7.06
UM	2.16	11.37	31.93	54.37	18.61
US	1.10	1.58	7.66	19.47	2.90
UC	19.26	37.09	56.01	59.56	28.40
RMS per cent error	15.72	33.58	60.71	80.58	28.88
RMS/RMS of Naive 1	0.79	0.87	1.00	1.02	0.89
MSE	22.52	50.05	95.60	133.41	49.91
MSE of components	25.41	37.62	54.90	71.71	26.49

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.8 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	6.00	8.09	9.80	11.29	7.93
UM	4.62	15.18	29.64	45.56	19.04
US	0.55	1.90	5.24	13.17	0.53
UC	30.77	48.29	61.13	68.67	43.25
RMS per cent error	24.68	45.73	63.73	80.52	38.12
MSE	35.94	65.37	96.01	127.40	62.82
			Naive 2		
RMS	8.71	14.73	20.88	26.94	17.60
UM	0.02	0.01	0.46	0.39	0.29
US	5.84	49.55	161.57	277.77	123.34
UC	69.95	167.33	273.76	447.63	186.17
RMS per cent error	51.33	159.01	299.67	477.75	201.88
RMS/RMS of Naive 1	1.45	1.82	2.13	2.39	2.22
MSE	75.81	216.89	435.79	725.79	309.79

TABLE 3.9

Ex Post Forecasts for GNP in Constant Dollars, OBE Model
(1st quarter 1966–3rd quarter 1969)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	4.79	7.52	8.98	8.86	5.86
UM	0.41	16.35	25.29	18.57	8.39
US	0.06	3.69	9.55	17.80	2.31
UC	22.48	36.53	45.80	42.13	23.64
RMS per cent error	0.51	1.17	1.64	1.58	0.69
RMS/RMS of Naive 1	0.62	0.52	0.43	0.33	0.33
MSE	22.94	56.57	80.65	78.50	34.34
	GG Constant Adjustments				
RMS	4.40	6.23	7.96	8.37	5.44
UM	1.23	0.97	3.86	1.58	0.21
US	0.35	1.80	10.37	22.17	3.68
UC	17.81	36.04	49.19	46.37	25.65
RMS per cent error	0.43	0.82	1.32	1.45	0.61
RMS/RMS of Naive 1	0.57	0.43	0.38	0.31	0.30
MSE	19.38	38.81	63.43	70.12	29.54
	AR Constant Adjustments				
RMS	4.43	7.62	10.54	12.50	8.08
UM	0.04	1.02	2.83	3.12	1.77
US	0.06	1.56	10.02	37.31	13.93
UC	19.54	55.51	98.31	115.92	49.53
RMS per cent error	0.43	1.23	2.33	3.25	1.33
RMS/RMS of Naive 1	0.57	0.52	0.51	0.46	0.45
MSE	19.63	58.09	111.16	156.35	65.23

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.9 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	7.78	14.58	20.74	27.11	17.84
UM	45.65	174.59	378.02	666.83	282.69
US	1.97	3.49	1.70	0.12	0.60
UC	12.85	34.59	50.61	67.86	35.01
RMS per cent error	1.38	4.70	9.24	15.50	6.62
MSE	60.47	212.68	430.34	734.82	318.31
			Naive 2		
RMS	4.00	8.33	12.67	19.30	11.05
UM	0.26	3.29	13.85	32.31	8.29
US	0.03	0.27	1.06	5.67	0.62
UC	15.69	65.78	145.69	334.35	113.20
RMS per cent error	0.36	1.53	3.46	7.93	2.55
RMS/RMS of Naive 1	0.51	0.57	0.61	0.71	0.62
MSE	15.99	69.34	160.59	372.33	122.11

TABLE 3.10

Ex Post Forecasts for the Unemployment Rate, OBE Model
(1st quarter 1966–3rd quarter 1969)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
	NO Constant Adjustments				
RMS	0.23	0.34	0.51	0.60	0.34
UM	0.01	0.02	0.09	0.15	0.03
US	0.00	0.00	0.01	0.02	0.00
UC	0.05	0.09	0.16	0.18	0.08
RMS per cent error	42.97	97.01	218.31	294.69	89.70
RMS/RMS of Naive 1	1.51	1.38	1.88	1.95	1.49
MSE	0.06	0.12	0.26	0.36	0.11
	GG Constant Adjustments				
RMS	0.21	0.34	0.49	0.57	0.36
UM	0.00	0.02	0.06	0.09	0.02
US	0.00	0.00	0.01	0.03	0.00
UC	0.04	0.10	0.16	0.20	0.10
RMS per cent error	35.23	96.52	199.11	267.23	100.00
RMS/RMS of Naive 1	1.36	1.39	1.80	1.86	1.58
MSE	0.04	0.12	0.24	0.32	0.13
	AR Constant Adjustments				
RMS	0.29	0.44	0.40	0.48	0.32
UM	0.00	0.00	0.03	0.06	0.02
US	0.02	0.06	0.01	0.03	0.01
UC	0.06	0.14	0.13	0.14	0.07
RMS per cent error	68.79	157.54	130.48	186.12	78.40
RMS/RMS of Naive 1	1.84	1.79	1.48	1.56	1.40
MSE	0.08	0.20	0.16	0.23	0.10

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.10 (*Concluded*)

	Quarter Ahead				One Year Ahead
	First	Second	Third	Fourth	
			Naive 1		
RMS	0.16	0.25	0.27	0.31	0.23
UM	0.00	0.01	0.02	0.03	0.02
US	0.00	0.01	0.00	0.00	0.00
UC	0.02	0.05	0.05	0.06	0.03
RMS per cent error	16.41	42.88	53.87	68.83	38.50
MSE	0.02	0.06	0.07	0.09	0.05
			Naive 2		
RMS	0.16	0.34	0.47	0.58	0.35
UM	0.00	0.01	0.02	0.02	0.00
US	0.00	0.03	0.08	0.14	0.05
UC	0.02	0.08	0.13	0.18	0.07
RMS per cent error	19.17	85.74	162.77	252.09	93.92
RMS/RMS of Naive 1	1.04	1.36	1.74	1.91	1.55
MSE	0.03	0.11	0.23	0.34	0.12

TABLE 3.11

Ratio of RMS Per Cent Prediction Errors, OBE Model

	Ratio of RMS % Error by Prediction Method to NO Constant Adjustment										Ratio of Forecast Period RMS % Error to Sample Period RMS % Errror				
	Sample Period: 1st Q '53–4th Q '64					Forecasting Period: 1st Q '66–3rd Q '69									
	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]
GNP in current dollars															
GG	0.690**	0.771*	0.862	0.903	0.882	0.510**	0.575*	0.694	0.753	0.647	1.310	2.263**	3.011**	3.520**	2.791**
AR	0.726*	1.882**	2.258**	3.008**	1.058	0.597*	0.584*	0.551*	0.538*	0.652	1.459*	0.941	0.912	0.755	2.266**
NO											1.774**	3.033**	3.737**	4.223**	3.029**
GNP in constant dollars															
GG	0.750*	0.851	0.921	0.944	0.903	0.843	0.701	0.805	0.918	0.884	1.024	0.953	1.031	0.960	1.333
AR	0.893	2.257**	2.590**	3.337**	1.117	0.843	1.051	1.421	2.057**	1.928*	0.860	0.539**	0.647*	0.609**	1.600*
NO											0.911	1.158	1.180	0.988	1.296
Consumption															
GG	0.774*	0.789	0.868	0.909	0.905	0.735	0.800	0.833	0.856	0.847	1.154	1.979**	2.669**	3.212**	2.457**
AR	0.809	2.000**	2.592**	3.380**	1.141	0.824	1.096	0.874	0.769	1.158	1.235	1.069	0.938	0.775	2.214**
NO											1.214	1.951**	2.782**	3.409**	2.420**
Purchases of autos and parts															
GG	0.848	0.958	1.034	1.018	0.978	0.626*	0.816	0.906	0.933	0.909	2.263**	2.645**	2.859**	3.070**	3.708**
AR	1.060	2.891**	3.592**	3.571**	1.341*	0.284**	0.544*	0.766	0.918	0.897	0.821	0.584**	0.695*	0.861	2.607**
NO											3.067**	3.107**	3.261**	3.350**	3.835*
Purchases of durables excl. autos and parts															
GG	0.737*	0.886	0.943	0.976	0.961	0.693	0.892	0.865	0.883	0.817	1.077	1.404*	2.005**	2.613**	2.429**
AR	0.813	2.824**	3.429**	4.389**	1.372*	0.867	0.877	0.597*	0.650	0.704	1.222	0.433**	0.380**	0.427**	1.514*
NO											1.146	1.395*	2.186**	2.887**	2.569**
Purchases of nondurables															
GG	0.798	0.832	0.901	0.945	0.926	0.779	1.254	1.306	1.236	1.404	3.313**	2.070**	1.328	0.788	1.573*
AR	0.885	2.310**	3.148**	4.063**	1.265	0.419**	1.925**	3.188**	3.803**	3.946**	1.690**	1.145	0.928	0.703*	1.915**
NO											3.394**	1.374	0.916	0.751	1.215

Purchases of services															
GG	0.829	0.667**	0.679**	0.685**	0.785	0.445**	0.583*	0.678	0.736	0.644	1.690**	4.577**	6.553**	7.800**	4.452**
AR	0.943	2.000**	2.179**	2.644**	1.025	0.327**	0.412**	0.332**	0.343**	0.356**	1.091	1.077	1.000	0.943	2.444**
NO											3.143**	5.231**	6.554**	7.260**	4.367**
Investment															
GG	0.637**	0.757*	0.834	0.851	0.802	0.318**	0.471**	0.624	0.710	0.536*	1.446*	2.749**	3.644**	4.259**	3.148**
AR	0.767*	2.052**	2.176**	2.522**	0.957	0.308**	0.242**	0.314**	0.375**	0.305**	1.164	0.521**	0.702*	0.759	1.929**
NO											2.899**	4.417**	4.869**	5.106**	3.417**
Fixed investment, nonresidential															
GG	0.334**	0.600**	0.765*	0.842	0.762*	0.181**	0.340**	0.481**	0.571**	0.393**	1.515*	1.625**	1.878**	2.025**	2.236**
AR	0.344**	1.316*	1.827**	2.181**	0.836	0.119**	0.235**	0.359**	0.460**	0.324**	0.968	0.513**	0.587**	0.631*	1.819**
NO											2.803**	2.869**	2.988**	2.989**	2.693**
Investment in nonfarm housing															
GG	0.527	0.792	0.972	0.918	0.964	0.563**	0.675*	0.821	0.907	0.777	10.531**	23.103**	31.645**	33.830**	7.093**
AR	0.812	2.946**	5.022**	5.456**	1.554**	0.301**	0.340**	0.380**	0.370**	0.320**	3.657**	3.132**	2.835**	2.321**	2.713**
NO											9.859**	27.111**	37.463**	34.235**	7.752**
Change in business inventories[b]															
GG	0.994	0.969	0.932	0.930	0.924	0.314**	0.589**	1.014	1.036	0.560**	1.978**	1.761**	1.972**	1.940**	1.575*
AR	1.182	1.201	1.056	1.077	1.365*	0.381**	0.634*	0.913	0.950	0.708*	2.023**	1.531*	1.567*	1.534*	1.348
NO											6.271**	2.899**	1.813**	1.740**	2.600**
Net foreign balance															
GG	0.618**	0.709**	0.772*	0.837	0.696**	0.584**	0.841	1.015	1.128	0.857	4.673**	4.282**	4.284**	4.417**	3.704**
AR	0.584**	0.691**	0.813	0.922	0.745*	0.527**	0.627**	0.733	0.915	0.661*	4.462**	3.276**	2.947**	3.252**	2.671**
NO											4.944**	3.609**	3.260**	3.279**	3.010**
Imports															
GG	0.448**	0.546**	0.603**	0.673**	0.696**	0.498**	0.580*	0.716	0.870	0.630	5.324**	4.859**	5.458**	6.052**	3.704**
AR	0.460**	1.190	1.491**	1.745**	0.745*	0.411**	0.343**	0.416**	0.614*	0.411**	4.281**	1.318	1.282	1.646**	2.671**
NO											4.788**	4.576**	4.598**	4.678**	3.324**
Disposable income															
GG	0.750*	0.768*	0.829	0.875	0.890	0.880	0.612*	0.737	0.797	0.740	0.815	1.476*	2.422**	2.872**	2.236**
AR	0.778*	1.902**	2.398**	3.098**	1.116	1.400	0.829	0.642	0.653	0.856	1.250	0.808	0.729	0.664*	1.871**
NO											0.694*	1.854**	2.724**	3.151**	2.295**

(Continued)

TABLE 3.11 *(Concluded)*

	Ratio of RMS % Error by Prediction Method to NO Constant Adjustment										Ratio of Forecast Period RMS % Error to Sample Period RMS % Error				
	Sample Period: 1st Q '53–4th Q'64					Forecasting Period: 1st Q'66–3rd Q'69									
	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]
Corporate profit before taxes															
GG	0.767*	0.846	0.907	0.921	0.869	0.694	0.808	0.984	1.131	0.964	0.849	0.711*	0.779	0.721	1.288
AR	0.945	2.214**	2.592**	3.369**	1.062	0.799	1.547	2.012**	1.979**	2.508**	0.794	0.520**	0.558**	0.345**	1.739**
NO											0.939	0.744	0.718	0.587**	1.192
Unemployment rate															
GG	0.738*	0.883	0.927	0.957	0.961	0.820	0.995	0.912	0.907	1.115	0.718*	0.906	1.463*	1.707**	0.735
AR	0.852	2.377**	3.502**	5.059**	1.392*	1.601*	1.624*	0.598*	0.632	0.874	1.214	0.550**	0.254**	0.225**	0.451**
NO											0.646*	0.804	1.494*	1.801**	0.667*
Implicit GNP deflator															
GG	0.733*	0.833	0.892	0.940	0.937	0.468**	0.680	0.810	0.885	0.762	0.902	5.950**	8.273**	9.830**	3.489**
AR	0.800	2.458**	3.297**	3.900**	1.271	0.291**	0.451**	0.451**	0.481**	0.486**	1.917**	1.339	1.246	1.287	2.000**
NO											5.267**	7.292**	9.108**	10.440**	3.750**

* F-ratio—"signal" at the 5% level. If ratio exceeds 1, the numerator is "signally" larger; if smaller than 1, the numerator is "signally" smaller.

** F-ratio—"signal" at the 1% level. If ratio exceeds 1, the numerator is "signally" larger; if smaller than 1, the numerator is "signally" smaller.

[a] RMS, rather than RMS % error, is used for the 1-year-ahead prediction.

[b] RMS is used for this variable, which is in a difference form.

TABLE 3.12

Sample Period Simulations for GNP in Current Dollars, Wharton-EFU Model (1st quarter 1953–4th quarter 1964)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	6.75	8.20	7.70	8.17	6.20	5.11	5.70
UM	0.50	0.81	0.18	0.20		1.67	2.11
US	0.23	0.60	0.00	0.47		0.55	0.91
UC	44.80	65.83	59.11	66.08		23.39	29.47
RMS per cent error	1.47	1.77	1.67	1.78		1.11	1.23
RMS/RMS of Naive 1	0.83	0.54	0.35	0.29	0.35	0.63	0.37
MSE	45.56	67.24	59.29	66.75	38.44	26.11	32.49
$\sum$ MSE of components	30.57	43.28	38.80	43.71	35.67	19.21	23.26
$\sum\sum$ MSE of comp.	20.58	25.14	25.61	28.87	14.57	15.12	16.98
	GG Constant Adjustments						
RMS	6.11	8.14	8.28	8.59	6.62		
UM	0.10	0.00	0.14	0.01			
US	0.00	0.40	0.35	0.00			
UC	37.23	65.86	68.07	73.78			
RMS per cent error	1.39	1.74	1.80	1.86			
RMS/RMS of Naive 1	0.49	0.53	0.38	0.30	0.37		
MSE	37.33	66.26	68.56	73.79	43.82		
$\sum$ MSE of components	24.11	40.97	43.52	47.46	27.00		
$\sum\sum$ MSE of comp.	15.78	23.43	25.63	29.15	14.35		

(Continued)

TABLE 3.12 *(Concluded)*

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	6.87	9.29	9.92	11.07	8.41	5.15	6.17
UM	2.83	5.70	4.23	5.02		1.91	3.46
US	1.04	0.77	0.49	1.47		0.13	0.04
UC	43.44	79.83	93.69	116.05		24.48	34.57
RMS per cent error	1.49	2.03	2.18	2.44		1.12	1.34
RMS/RMS of Naive 1	0.84	0.61	0.45	0.39	0.47	0.63	0.41
MSE	47.20	86.30	98.41	122.54	70.73	26.52	38.07
$\sum$ MSE of components	28.18	49.06	55.40	68.57	38.30	16.61	24.15
$\sum\sum$ MSE of comp.	17.21	31.36	45.47	57.51		11.66	17.87
	AR Constant Adjustments and ROS Coefficients						
RMS	5.26	8.22	10.00	11.79	8.30		
UM	1.33	5.27	7.40	10.70			
US	0.22	0.14	0.20	0.69			
UC	26.12	62.16	92.40	127.61			
RMS per cent error	1.14	1.80	2.19	2.58			
RMS/RMS of Naive 1	0.65	0.54	0.46	0.42	0.47		
MSE	27.67	67.57	100.00	139.00	68.89		
$\sum$ MSE of components	29.06	38.23	53.38	72.90	36.02		
$\sum\sum$ MSE of comp.	12.75	25.36	36.04	48.98	22.77		
	Naive Models						
RMS of Naive 1	8.15	15.24	21.87	28.17	17.78		
RMS of Naive 2	5.90	12.05	18.95	26.57	15.41		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.13

Sample Period Simulations for Consumption in Current Dollars, Wharton-EFU Model (1st quarter 1953–4th quarter 1964)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	3.94	4.33	4.14	4.22	3.45	2.88	3.09
UM	0.28	0.24	0.55	1.25		0.01	0.01
US	0.00	0.04	0.00	0.00		0.11	0.33
UC	15.24	18.47	16.59	16.56		8.17	9.21
RMS per cent error	1.32	1.44	1.37	1.39		0.95	1.02
RMS/RMS of Naive 1	0.87	0.50	0.33	0.26	0.33	0.64	0.36
MSE	15.52	18.75	17.14	17.81	11.90	8.29	9.55
$\sum$ MSE of components	8.23	9.66	9.35	10.05	5.40	5.15	5.99
	GG Constant Adjustments						
RMS	3.80	4.45	4.41	4.42	3.65		
UM	0.47	0.30	0.30	0.63			
US	0.03	0.09	0.10	0.03			
UC	13.94	19.41	19.05	18.88			
RMS per cent error	1.48	1.46	1.45	1.44			
RMS/RMS of Naive 1	0.37	0.52	0.35	0.27	0.35		
MSE	14.44	19.80	19.45	19.54	13.32		
$\sum$ MSE of components	7.20	9.73	10.06	10.76	6.27		

(Continued)

TABLE 3.13 *(Concluded)*

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	4.17	4.97	5.38	5.81	4.58	2.96	3.34
UM	1.27	1.51	1.39	1.65		0.80	0.93
US	0.61	0.37	0.37	0.74		0.10	0.00
UC	15.51	22.82	27.18	31.36		7.86	10.22
RMS per cent error	1.42	1.68	1.82	1.98		1.01	1.12
RMS/RMS of Naive 1	0.92	0.58	0.43	0.35	0.44	0.65	0.39
MSE	17.39	24.70	28.94	33.76	20.98	8.76	11.15
$\sum$ MSE of components	8.22	12.35	27.95	34.02	10.45	5.15	7.64
	AR Constant Adjustments and ROS Coefficients						
RMS	3.50	4.47	5.36	6.21	4.57		
UM	1.21	1.86	2.47	3.20			
US	0.48	0.20	0.29	0.58			
UC	10.56	17.92	25.97	34.78			
RMS per cent error	1.19	1.50	1.79	2.07			
RMS/RMS of Naive 1	0.77	0.52	0.43	0.38	0.44		
MSE	12.25	19.98	28.73	38.56	20.88		
$\sum$ MSE of components	6.96	12.39	18.90	25.47	12.83		
	Naive Models						
RMS of Naive 1	4.54	8.64	12.63	16.54	10.30		
RMS of Naive 2	3.00	5.17	8.04	10.43	5.63		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.14

Sample Period Simulations for Investment in Current Dollars, Wharton-EFU Model (1st quarter 1953–4th quarter 1964)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	3.72	4.80	4.48	4.92	3.54	3.11	3.56
UM	1.40	1.91	1.35	0.41		1.85	2.46
US	0.61	1.11	1.06	0.73		0.62	1.20
UC	11.83	20.02	17.66	23.07		7.20	9.01
RMS per cent error	5.56	7.20	6.97	7.63		4.66	5.35
RMS/RMS of Naive 1	0.92	0.75	0.54	0.50	0.54	0.77	0.56
MSE	13.84	23.04	20.07	24.21	12.53	9.67	12.67
$\sum$ MSE of components	11.06	13.96	14.51	16.73	7.59	8.70	9.50
	GG Constant Adjustments						
RMS	2.97	4.46	4.75	5.13	3.57		
UM	0.07	0.18	0.73	0.43			
US	0.29	1.14	2.04	1.65			
UC	8.46	18.57	19.79	24.23			
RMS per cent error	4.57	6.60	7.41	7.95			
RMS/RMS of Naive 1	0.33	0.70	0.57	0.52	0.54		
MSE	8.82	19.89	22.56	26.31	12.74		
$\sum$ MSE of components	7.60	12.37	13.92	16.50	7.14		

(Continued)

TABLE 3.14 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	3.17	4.79	4.93	5.67	4.00	2.65	3.39
UM	0.43	1.74	1.02	1.29		0.32	1.02
US	0.01	0.00	0.29	0.32		0.01	0.03
UC	9.61	21.20	22.99	30.54		6.69	10.44
RMS per cent error	4.67	7.13	7.43	8.41		3.83	5.01
RMS/RMS of Naive 1	0.78	0.75	0.60	0.58	0.61	0.65	0.53
MSE	10.05	22.94	24.30	32.15	16.00	7.02	11.49
$\sum$ MSE of components	7.99	14.32	15.27	20.55	9.11	6.06	8.82
	AR Constant Adjustments and ROS Coefficients						
RMS	2.44	4.07	4.68	5.53	3.66		
UM	0.00	0.81	1.14	1.86			
US	0.21	0.31	0.61	0.55			
UC	5.74	15.44	20.15	28.17			
RMS per cent error	3.59	6.12	7.09	8.19			
RMS/RMS of Naive 1	0.60	0.64	0.57	0.56	0.56		
MSE	5.95	16.56	21.90	30.58	13.40		
$\sum$ MSE of components	4.78	11.17	14.15	19.40	8.07		
	Naive Models						
RMS of Naive 1	4.05	6.36	8.27	9.88	6.57		
RMS of Naive 2	5.08	9.34	14.00	19.21	10.31		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.15

Sample Period Simulations for GNP in Constant Dollars, Wharton-EFU Model (1st quarter 1953–4th quarter 1964)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	6.53	7.54	7.55	8.96	6.17	4.90	5.20
UM	0.00	0.00	0.34	2.25		0.24	0.16
US	0.25	0.62	2.74	5.86		0.02	0.30
UC	42.39	56.23	53.92	72.17		23.74	26.58
RMS per cent error	1.41	1.64	1.66	2.00		1.05	1.19
RMS/RMS of Naive 1	0.98	0.62	0.44	0.42	0.45	0.73	0.43
MSE	42.64	56.85	57.00	80.28	38.07	24.00	27.04
	GG Constant Adjustments						
RMS	6.13	7.79	7.89	8.84	6.54		
UM	0.69	0.36	0.11	0.78			
US	0.56	0.18	0.44	1.89			
UC	36.33	60.14	61.70	75.48			
RMS per cent error	1.18	1.69	1.73	1.95			
RMS/RMS of Naive 1	0.17	0.64	0.46	0.41	0.47		
MSE	37.58	60.68	62.25	78.15	42.77		

(*Continued*)

TABLE 3.15 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	7.06	9.18	9.74	11.27	8.46	5.51	6.49
UM	4.44	6.74	4.46	4.83		3.31	4.55
US	2.64	2.53	2.09	3.56		1.00	0.76
UC	42.76	75.00	88.32	118.62		20.05	36.81
RMS per cent error	1.54	2.03	2.16	2.51		1.21	1.44
RMS/RMS of Naive 1	1.06	0.75	0.57	0.53	0.61	0.83	0.53
MSE	49.84	84.27	94.87	127.01	71.57	30.36	42.12
	AR Constant Adjustments and ROS Coefficients						
RMS	5.34	8.38	10.01	11.83	8.48		
UM	2.39	6.53	8.02	10.50			
US	1.00	1.19	1.50	2.80			
UC	25.12	62.50	90.68	126.65			
RMS per cent error	1.21	1.85	2.22	2.62			
RMS/RMS of Naive 1	0.83	0.68	0.59	0.55	0.61		
MSE	28.51	70.22	100.20	139.95	71.91		
	Naive Models						
RMS of Naive 1	6.68	12.25	17.11	21.41	13.79		
RMS of Naive 2	5.45	11.78	19.05	26.97	16.50		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.16

Sample Period Simulations for the Unemployment Rate, Wharton-EFU Model
(1st quarter 1953–4th quarter 1964)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	1.39	1.45	1.40	1.57	1.21	1.25	1.20
UM	0.43	0.49	0.62	0.85		0.38	0.43
US	0.32	0.23	0.07	0.05		0.28	0.12
UC	1.18	1.38	1.27	1.56		0.90	0.89
RMS per cent error	29.84	29.67	29.09	32.18		26.92	24.09
RMS/RMS of Naive 1	2.77	1.60	1.15	1.11	1.27	2.48	1.32
MSE	1.93	2.10	1.96	2.46		1.56	1.44
	GG Constant Adjustments						
RMS	1.09	1.32	1.33	1.45	1.09		
UM	0.08	0.14	0.17	0.31			
US	0.06	0.11	0.08	0.08			
UC	1.04	1.49	1.52	1.71			
RMS per cent error	23.81	26.38	26.44	38.39			
RMS/RMS of Naive 1	2.71	1.46	1.10	1.02	1.15		
MSE	1.18	1.74	1.77	2.10	1.19		

(Continued)

TABLE 3.16 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	1.16	1.54	1.61	1.71	1.34	1.01	1.22
UM	0.08	0.13	0.08	0.07		0.06	0.09
US	0.02	0.12	0.18	0.28		0.00	
UC	1.24	2.12	2.33	2.57		0.96	1.39
RMS per cent error	25.72	31.04	30.49	31.14		23.51	26.45
RMS/RMS of Naive 1	2.29	1.69	1.32	1.21	1.41	2.01	1.35
MSE	1.34	2.37	2.59	2.92		1.02	1.49
	AR Constant Adjustments and ROS Coefficients						
RMS	0.98	1.43	1.69	1.85	1.37		
UM	0.05	0.13	0.14	0.16			
US	0.00	0.04	0.23	0.46			
UC	0.91	1.87	2.49	2.80			
RMS per cent error	21.87	29.70	32.84	34.63			
RMS/RMS of Naive 1	1.94	1.58	1.39	1.31	1.44		
MSE	0.96	2.04	2.86	3.42			
	Naive Models						
RMS of Naive 1	0.50	0.91	1.22	1.41	0.95		
RMS of Naive 2	0.45	1.07	1.80	2.54	1.62		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.17

Ex Post Forecasts for GNP in Current Dollars, Wharton-EFU Model
(1st quarter 1965–4th quarter 1968)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	21.74	24.36	17.52	15.44	14.93	24.93	28.78
UM	396.53	470.57	168.21	81.05		570.54	756.23
US	31.67	31.45	9.51	0.00		31.07	37.27
UC	44.43	91.39	129.23	157.34		19.89	34.79
RMS per cent error	2.74	3.06	2.18	1.94		3.18	3.65
RMS/RMS of Naive 1	1.35	0.77	0.37	0.25	0.39	1.55	0.91
MSE	472.63	593.41	306.95	238.39	222.90	621.50	828.29
$\sum$ MSE of components	441.37	545.80	357.35	324.39	264.78	549.89	706.23
$\sum\sum$ MSE of comp.	242.46	267.47	169.01	185.58	133.78	280.73	316.20
	GG Constant Adjustments						
RMS	11.77	16.17	15.75	14.79	10.62		
UM	95.68	178.69	126.06	71.79			
US	7.84	12.26	7.81	0.50			
UC	35.01	70.52	114.19	146.45			
RMS per cent error	1.47	2.02	1.97	1.86			
RMS/RMS of Naive 1	0.73	0.51	0.33	0.24	0.28		
MSE	138.53	261.47	248.06	218.74	112.78		
$\sum$ MSE of components	152.33	274.98	287.63	286.06	152.69		
$\sum\sum$ MSE of comp.	92.43	154.20	161.52	166.23	93.10		

(Continued)

TABLE 3.17 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	8.13	11.92	15.35	17.32	10.63	6.85	8.08
UM	22.87	38.08	43.59	42.60		22.76	35.84
US	1.19	7.11	17.67	31.80		0.47	4.70
UC	42.04	96.90	174.36	225.58		23.69	24.75
RMS per cent error	1.04	1.49	1.91	2.15		0.89	1.00
RMS/RMS of Naive 1	0.51	0.38	0.33	0.28	0.28	0.43	0.26
MSE	66.10	142.09	235.62	299.98	113.00	46.92	65.29
$\sum$ MSE of components	57.82	107.14	172.43	232.49	81.43	47.99	65.79
$\sum\sum$ MSE of comp.	51.55	73.47	108.74	136.53	51.15	45.73	54.93
	AR Constant Adjustments and ROS Coefficients						
RMS	6.80	11.56	14.84	17.48	10.72		
UM	26.59	58.00	67.83	64.16			
US	0.97	5.08	8.37	12.53			
UC	18.68	70.55	144.02	228.86			
RMS per cent error	0.88	1.46	1.87	2.20			
RMS/RMS of Naive 1	0.42	0.37	0.32	0.28	0.28		
MSE	46.24	133.63	220.22	305.55	114.92		
$\sum$ MSE of components	40.10	80.09	128.67	183.56	80.58		
$\sum\sum$ MSE of comp.	45.78	74.02	106.52	136.40	53.92		
	Naive Models						
RMS of Naive 1	16.06	31.65	47.11	61.84	38.32		
RMS of Naive 2	5.51	11.16	16.18	24.14	15.21		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.18
Ex Post Forecasts for Consumption in Current Dollars, Wharton-EFU Model
(1st quarter 1965–4th quarter 1968)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	14.54	14.70	12.85	12.22	0.62	17.72	18.61
UM	160.88	159.48	105.02	91.54		273.81	302.35
US	28.75	25.28	18.66	10.01		29.20	29.44
UC	21.78	31.33	41.44	47.78		10.99	14.54
RMS per cent error	2.89	2.91	2.53	2.40		3.58	3.75
RMS/RMS of Naive 1	1.52	0.80	0.47	0.34	0.48	1.85	1.01
MSE	211.41	216.09	165.12	149.33	112.99	314.00	346.33
$\sum$ MSE of components	101.00	100.67	85.62	80.85	54.05	120.02	130.15
	GG Constant Adjustments						
RMS	8.08	10.51	11.07	10.90	7.55		
UM	37.14	70.25	72.05	66.95			
US	8.15	13.41	14.01	8.33			
UC	20.00	26.80	36.48	43.53			
RMS per cent error	1.59	2.07	2.18	2.14			
RMS/RMS of Naive 1	0.84	0.57	0.41	0.30	0.34		
MSE	65.29	110.46	122.54	118.81	57.00		
$\sum$ MSE of components	25.23	58.44	65.29	65.85	40.05		

(Continued)

TABLE 3.18 *(Concluded)*

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	5.61	7.48	9.81	11.35	6.90	4.85	6.09
UM	8.15	20.42	30.70	41.61		8.80	20.62
US	2.08	9.29	17.90	29.11		1.58	7.79
UC	21.24	26.24	47.64	58.10		13.14	8.68
RMS per cent error	1.14	1.47	1.93	2.22		0.99	1.19
RMS/RMS of Naive 1	0.59	0.41	0.36	0.32	0.31	0.51	0.33
MSE	31.47	55.95	96.24	128.82	47.61	23.52	37.09
$\sum$ MSE of components	17.83	27.77	46.81	62.99	25.77	14.65	20.45
	AR Constant Adjustments and ROS Coefficients						
RMS	5.59	7.69	9.54	11:00	6.84		
UM	7.66	15.75	20.38	24.91			
US	1.31	4.32	6.17	8.41			
UC	12.48	14.40	22.44	29.43			
RMS per cent error	1.14	1.53	1.89	2.17			
RMS/RMS of Naive 1	0.59	0.42	0.35	0.31	0.31		
MSE	21.45	34.31	57.22	79.05	46.78		
$\sum$ MSE of components	18.78	31.89	49.00	62.75	26.75		
	Naive Models						
RMS of Naive 1	9.57	18.68	27.01	35.81	22.30		
RMS of Naive 2	5.64	8.50	13.03	16.04	8.28		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.19
Ex Post Forecasts for Investment in Current Dollars, Wharton-EFU Model
(1st quarter 1965–4th quarter 1968)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	13.78	16.80	11.80	10.47	10.54	13.92	17.58
UM	168.24	237.93	90.37	50.42		176.33	280.01
US	10.45	11.57	3.90	0.33		9.11	16.38
UC	11.20	32.74	44.97	58.87		8.33	12.67
RMS per cent error	11.67	14.13	9.87	8.75		11.76	14.78
RMS/RMS of Naive 1	2.25	2.12	1.19	0.93	1.38	2.27	2.24
MSE	189.89	282.24	139.24	106.62	111.09	193.77	309.06
$\sum$ MSE of components	117.30	139.26	82.48	69.85	58.01	135.21	156.23
	GG Constant Adjustments						
RMS	8.31	11.53	11.06	10.55	8.17		
UM	55.51	102.56	77.89	53.97			
US	2.15	4.58	3.46	1.12			
UC	11.40	25.80	40.97	56.21			
RMS per cent error	7.08	9.77	9.30	8.82			
RMS/RMS of Naive 1	1.36	1.46	1.12	0.93	1.07		
MSE	69.06	132.94	122.32	111.30	66.75		
$\sum$ MSE of components	55.78	77.89	72.44	69.89	37.56		

(Continued)

TABLE 3.19 *(Concluded)*

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	4.80	6.83	8.31	9.59	5.38	4.60	4.92
UM	8.53	9.19	8.56	6.62		7.85	7.97
US	0.11	0.33	0.07	0.00		0.00	0.53
UC	14.40	37.13	60.43	85.35		13.31	15.71
RMS per cent error	4.19	5.86	7.03	8.05		3.97	4.18
RMS/RMS of Naive 1	0.78	0.86	0.84	0.85	0.71	0.75	0.62
MSE	23.04	46.65	69.06	91.97	28.94	21.16	24.21
$\sum$MSE of components	29.04	40.80	54.66	62.88	20.55	26.50	29.58
	AR Constant Adjustments and ROS Coefficients						
RMS	3.97	6.47	8.12	9.80	5.47		
UM	6.86	12.10	12.40	9.13			
US	0.00	0.00	0.06	0.19			
UC	8.90	29.76	53.47	86.72			
RMS per cent error	3.52	5.60	6.91	8.29			
RMS/RMS of Naive 1	0.65	0.82	0.82	0.87	0.72		
MSE	15.16	41.86	65.93	96.04	29.92		
$\sum$ MSE of components	22.61	36.86	49.78	62.81	22.09		
	Naive Models						
RMS of Naive 1	6.13	7.91	9.90	11.28	7.63		
RMS of Naive 2	8.73	14.25	20.21	25.09	10.34		

NOTE: For definition of symbols. see glossary preceding this section.

TABLE 3.20

Ex Post Forecasts for GNP in Constant Dollars, Wharton-EFU Model
(1st quarter 1965–4th quarter 1968)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	16.89	15.39	11.12	13.58	8.87	19.94	18.58
UM	237.35	157.03	5.56	7.93		368.98	310.00
US	7.42	0.00	10.76	45.92		9.14	1.73
UC	40.50	79.82	107.33	130.57		19.48	33.49
RMS per cent error	2.52	2.30	1.67	2.03		2.99	2.79
RMS/RMS of Naive 1	1.86	0.88	0.43	0.41	0.42	2.20	1.07
MSE	285.27	236.85	123.65	184.42	78.68	397.60	345.22
	GG Constant Adjustments						
RMS	9.13	11.10	11.07	13.03	7.48		
UM	51.78	56.33	9.09	2.61			
US	3.67	6.66	9.68	38.03			
UC	31.21	66.30	103.77	129.13			
RMS per cent error	1.36	1.67	1.67	1.96			
RMS/RMS of Naive 1	1.01	0.64	0.43	0.39	0.35		
MSE	83.36	123.31	122.54	169.78	55.95		

(Continued)

TABLE 3.20 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	6.83	9.83	12.65	14.18	8.75	5.57	6.22
UM	11.66	13.43	7.04	1.00		11.79	12.42
US	0.37	0.58	1.60	3.02		0.43	0.23
UC	34.62	82.62	151.38	197.05		18.80	26.04
RMS per cent error	1.03	1.47	1.89	2.12		0.85	0.93
RMS/RMS of Naive 1	0.75	0.56	0.49	0.43	0.41	0.61	0.36
MSE	46.65	96.63	160.02	201.07	76.56	31.02	38.69
	AR Constant Adjustments and ROS Coefficients						
RMS	5.55	9.40	12.18	14.63	8.91		
UM	13.89	24.12	16.23	5.14			
US	0.22	0.79	4.45	11.34			
UC	16.69	63.45	127.58	197.56			
RMS per cent error	0.84	0.41	1.83	2.20			
RMS/RMS of Naive 1	0.61	0.54	0.47	0.44	0.42		
MSE	30.80	88.36	148.35	214.04	79.39		
	Naive Models						
RMS of Naive 1	9.06	12.44	25.72	33.36	21.27		
RMS of Naive 2	4.94	9.62	13.64	20.21	12.64		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.21

Ex Post Forecasts for the Unemployment Rate. Wharton-EFU Model (1st quarter 1965–4th quarter 1968)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	NO Constant Adjustments						
RMS	1.76	1.56	2.18	2.40	1.76	1.63	1.27
UM	1.39	1.07	3.62	4.97		1.05	0.51
US	1.66	1.32	1.05	0.70		1.54	1.07
UC	0.05	0.04	0.08	0.09		0.07	0.03
RMS per cent error	46.78	41.05	58.45	64.28		43.38	33.28
RMS/RMS of Naive 1	9.59	5.06	5.28	4.56	5.03	8.89	4.16
MSE	3.10	2.43	4.75	5.76	3.10	2.66	1.61
	GG Constant Adjustments						
RMS	0.89	0.88	0.98	1.18	0.88		
UM	0.12	0.02	0.25	0.75			
US	0.50	0.62	0.61	0.55			
UC	0.17	0.13	0.10	0.09			
RMS per cent error	22.89	22.10	25.67	31.84			
RMS/RMS of Naive 1	4.85	2.83	2.37	2.24	2.51		
MSE	0.79	0.77	0.96	1.39	0.77		

(Continued)

TABLE 3.21 (*Concluded*)

	Standard Version					Anticipation Version	
	Quarter Ahead				One Year Ahead	Quarter Ahead	
	First	Second	Third	Fourth		First	Second
	AR Constant Adjustments						
RMS	1.04	1.13	1.15	1.01	1.02	0.94	0.88
UM	0.24	0.10	0.07	0.07		0.25	0.11
US	0.63	0.96	1.00	0.70		0.48	0.54
UC	0.21	0.22	0.25	0.25		0.15	0.12
RMS per cent error	26.94	29.07	29.80	26.67		24.16	22.25
RMS/RMS of Naive 1	5.69	3.64	2.78	1.92	2.91	5.14	2.83
MSE	1.08	1.28	1.32	1.02	1.04	0.88	0.77
	AR Constant Adjustments and ROS Coefficients						
RMS	0.94	0.99	1.06	0.99	0.95		
UM	0.20	0.03	0.01	0.02			
US	0.52	0.77	0.91	0.70			
UC	0.16	0.18	0.20	0.26			
RMS per cent error	24.39	25.15	27.15	25.70			
RMS/RMS of Naive 1	5.14	3.18	2.57	1.87	2.71		
MSE	0.88	0.98	1.12	0.98	0.90		
	Naive Models						
RMS of Naive 1	0.18	0.31	0.41	0.53	0.35		
RMS of Naive 2	0.19	0.38	0.51	0.63	0.35		

NOTE: For definition of symbols, see glossary preceding this section.

TABLE 3.22

Wharton Model, Ratios of RMS Per Cent Prediction Errors

	Ratios of RMS Per Cent Prediction Errors, Wharton Model										Ratio of Forecast Period RMS % Error to Sample Period RMS % Error				
	Sample Period: 1st Q '53–4th Q '64					Forecasting Period: 1st Q '65–4th Q '68									
	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]
GNP in current dollars															
GG	0.946	0.983	1.078	1.045	1.068	0.536*	0.660	0.904	0.959	0.711	1.058	1.161	1.094	1.000	1.604*
AR	1.014	1.147	1.305*	1.371*	1.356*	0.380**	0.487**	0.876	1.108	0.712	0.698*	0.734	0.876	0.881	1.264
ROS	0.775*	1.017	1.311*	1.449*	1.339*	0.321**	0.477**	0.858	1.134	0.718	0.772	0.811	0.854	0.853	1.291
NO											1.864**	1.729**	1.305	1.090	2.408**
GNP in constant dollars															
GG	0.936	1.030	1.042	0.975	1.060	0.540*	0.726	1.000	0.965	0.843	1.030	0.988	0.965	1.005	1.144
AR	1.092	1.238	1.301*	1.255	1.371*	0.409**	0.639	1.132	1.044	0.986	0.669*	0.724*	0.875	0.854	1.034
ROS	0.858	1.128	1.337*	1.310*	1.374*	0.333**	0.178**	1.096	1.084	1.004	0.694*	0.222**	0.824	0.840	1.051
NO											1.787**	1.402*	1.006	1.015	1.438*
Consumption															
GG	0.948	1.014	1.058	1.036	1.058	0.550*	0.711	0.862	0.892	0.710	1.271	1.418*	1.503*	1.486*	2.068**
AR	1.076	1.167	1.328*	1.424*	1.327*	0.394**	0.505**	0.763	0.985	0.649	0.803	0.875	1.060	1.121	1.506*
ROS	0.905	1.042	1.307*	1.489**	1.325*	0.394**	0.526**	0.747	0.904	0.643	0.958	1.020	1.056	1.048	1.497*
NO											2.189**	2.021**	1.847**	1.727**	3.081**
Purchases of nondurables and services															
GG	0.995	1.000	1.062	1.086	1.078	0.532**	0.580*	0.748	0.802	0.603*	0.939	0.974	1.070	1.102	1.313
AR	1.180	1.256	1.457**	1.667**	1.470**	0.673	0.740	1.097	1.297	1.092	1.000	0.990	1.144	1.163	1.746**
ROS	1.361*	1.449**	1.778**	2.099**	1.843**	0.813	0.893	1.195	1.347	1.172	1.048	1.035	1.021	0.959	1.493*
NO											1.754**	1.679**	1.518*	1.434*	2.349**
Purchases of durables excl. autos and parts															
GG	0.987	0.993	1.055	1.042	1.054	0.635*	0.807	0.916	0.944	0.820	3.266**	3.635**	3.795**	3.827**	9.795**
AR	1.136	1.136	1.274*	1.370*	1.351*	0.170**	0.210**	0.278**	0.324**	0.211**	0.758	0.826	0.954	0.998	1.452*
ROS	0.848	0.925	1.171	1.368*	1.243	0.127**	0.163**	0.223**	0.274**	0.173**	0.758	0.789	0.833	0.845	1.293
NO											5.072**	4.469**	4.375**	4.225**	9.297**

(Continued)

TABLE 3.22 (*Concluded*)

	Ratios of RMS Per Cent Prediction Errors, Wharton Model										Ratio of Forecast Period RMS % Error to Sample Period RMS % Error				
	Sample Period: 1st Q '53–4th Q '64					Forecasting Period: 1st Q '65–4th Q '68									
	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]	1st Q	2nd Q	3rd Q	4th Q	Year[a]
Purchases of autos and parts															
GG	0.899	0.969	0.983	0.961	0.975	0.912	0.982	1.002	0.961	0.982	0.752	0.702*	0.729	0.683*	1.051
AR	0.923	1.071	1.182	1.139	1.161	1.003	1.060	1.206	1.278	1.399	0.805	0.685*	0.729	0.766	1.257
ROS	0.673**	0.879	1.039	0.990	1.006	0.842	0.897	1.059	1.197	1.256	0.928	0.707*	0.728	0.826	1.302
NO											0.741	0.692*	0.714*	0.683*	1.043
Investment															
GG	0.784*	0.917	1.063	1.042	1.008	0.607*	0.691	0.942	1.008	0.775	1.624**	1.480*	1.255	1.109	2.288**
AR	0.840	0.990	1.066	1.102	1.130	0.359**	0.415**	0.712	0.920	0.510*	0.897	0.822	0.946	0.957	1.345
ROS	0.646**	0.850	1.017	1.073	1.034	0.302**	0.396**	0.700	0.947	0.519*	0.981	0.915	0.975	1.012	1.494*
NO											2.099**	1.962**	1.416*	1.147	2.977**
Nonfarm investment in plant and equipment															
GG	0.651**	0.759*	0.952	1.073	0.901	0.552*	0.563*	0.715	0.881	0.648	1.167	1.328	1.199	1.123	2.258**
AR	0.585**	0.840	1.033	1.189	1.017	0.512**	0.365**	0.468**	0.736	0.417**	1.207	0.779	0.723	0.846	1.286
ROS	0.585**	0.713**	0.936	1.142	0.948	0.512**	0.319**	0.439**	0.712	0.405**	1.207	0.800	0.748	0.853	1.344
NO											1.379*	1.790**	1.596*	1.367	3.139**
Investment in nonfarm residential housing															
GG	0.709**	0.881	1.002	1.091	0.939	0.785	1.040	1.178	1.164	1.229	2.089**	2.259**	2.266**	2.003**	2.419**
AR	0.727*	0.964	1.148	1.399*	1.131	0.841	1.200	1.452	1.623	1.634	2.188**	2.378**	2.436**	2.178**	2.670**
ROS	0.727*	0.971	1.146	1.392*	1.131	0.835	1.186	1.432	1.597	1.617	2.174**	2.338**	2.407**	2.156**	2.643**
NO											1.892**	1.914**	1.927**	1.878**	1.848**
Change in the stock of nonfarm inventories[b]															
GG	0.880	1.024	0.986	0.948	1.031	0.703	0.839	1.169	0.896	0.891	2.799**	2.512**	2.247**	1.661**	2.284**
AR	0.908	1.084	0.976	1.015	1.146	0.472**	0.572*	1.029	0.934	0.507*	1.821**	1.619**	2.000**	1.617*	1.160
ROS	0.659**	0.948	0.965	0.988	1.068	0.398**	0.550*	0.971	0.900	0.578*	2.141**	1.779**	1.913**	1.709**	1.431*
NO											3.502**	3.066**	1.895**	1.758**	2.644**

Net foreign balance[b]															
GG	0.836	0.926	0.976	0.955	0.915	0.670	0.816	0.898	0.925	0.843	4.609**	4.973**	5.317**	5.890**	5.546**
AR	0.782*	0.975	1.167	1.226	1.085	0.288**	0.309**	0.367**	0.423**	0.346**	2.116**	1.790**	1.816**	2.098**	1.922**
ROS	0.845	1.066	1.317*	1.459**	1.245	0.269**	0.287**	0.323**	0.360**	0.309**	1.828**	1.523*	1.416*	1.500*	1.492*
NO											5.755**	5.647**	5.778**	6.083**	6.019**
Exports															
GG	1.048	0.944	0.953	0.944	0.927	0.838	0.922	0.936	0.943	0.894	1.371	1.409*	1.513*	1.713**	3.224**
AR	0.949	1.031	1.190	1.224	1.110	0.648	0.447**	0.348**	0.370**	0.332**	1.172	0.625**	0.451**	0.519**	1.000
ROS	1.043	1.197	1.431**	1.567**	1.402*	0.685	0.496**	0.419**	0.420**	0.379**	1.126	0.598**	0.452**	0.459**	0.904
NO											1.714**	1.442*	1.541*	1.715**	3.341**
Imports															
GG	0.852	0.929	0.997	1.025	0.937	0.627*	0.766	0.880	0.915	0.817	2.044**	2.483**	2.518**	2.674**	5.133**
AR	0.866	0.980	1.177	1.373*	1.125	0.398**	0.448**	0.576*	0.639	0.530*	1.278	1.376	1.397*	1.393	2.778**
ROS	0.791	0.991	1.210	1.422**	1.156	0.394**	0.453**	0.580*	0.640	0.530*	1.386*	1.375	1.368	1.349	2.703**
NO											2.779**	3.008**	2.854**	2.994**	5.891**
Implicit GNP deflator															
GG	0.814	0.786	0.866	0.919	0.833	0.886	0.733	0.800	0.878	0.846	0.886	1.345	1.634**	1.887**	2.200**
AR	0.698**	0.614**	0.695**	0.747**	0.667**	0.771	0.475**	0.503**	0.570*	0.538*	0.900	1.116	1.281	1.508*	1.750**
ROS	0.698**	0.600**	0.646**	0.713*	0.667**	0.771	0.465**	0.496**	0.564*	0.538*	0.900	1.119	1.358	1.564*	1.750**
NO											0.814	1.443*	1.768**	1.977**	2.167**
Corporate profit before taxes															
GG	0.726*	0.863	0.954	0.972	0.862	0.536*	0.846	0.850	0.883	0.628**	0.644	0.716*	0.902	1.139	1.675**
AR	0.628**	0.826	0.993	1.107	0.894	0.542*	0.856	0.808	0.841	0.564**	0.752	0.757	0.824	0.952	1.450*
ROS	0.634**	0.826	0.980	1.070	0.887	0.535*	0.837	0.782	0.830	0.546**	0.736	0.740	0.808	0.973	1.414**
NO											0.872	0.730	1.013	1.254	0.002**
Personal disposable income															
GG	0.889	0.983	1.068	1.069	1.074	0.488**	0.649	0.796	0.834	0.670	2.073**	2.217**	2.418**	2.394**	3.993**
AR	1.102	1.188	1.379*	1.529**	1.441**	0.233**	0.313**	0.449**	0.505**	0.346**	0.798	0.885	1.056	1.013	1.537*
ROS	0.889	1.060	1.379*	1.647**	1.511**	0.216**	0.315**	0.449**	0.521*	0.361**	0.917	1.000	1.056	0.970	1.532*
NO											3.778**	3.359**	3.243**	3.069**	6.404**
Unemployment rate															
GG	0.798	0.889	0.909	1.193	0.901	0.489**	0.538*	0.439**	0.495*	0.500*	0.961	0.838	0.971	0.829	0.807
AR	0.862	1.046	1.048	0.968	1.107	0.576*	0.708	0.510*	0.415**	0.579*	1.047	0.936	0.977	0.856	0.761
ROS	0.733*	1.001	1.129	1.076	1.132	0.521**	0.613*	0.464**	0.400**	0.540*	1.115	0.847	0.827	0.742	0.693*
NO											1.568**	1.383*	2.009**	1.997**	1.454*

* F-ratio – "signal" at the 5% level. If ratio exceeds 1, the numerator is "signally" larger; if smaller than 1, the numerator is "signally" smaller.

** F-ratio – "signal" at the 1% level. If ratio exceeds 1, the numerator is "signally" larger; if smaller than 1, the numerator is "signally" smaller.

[a] RMS, rather than RMS % *error*, is used for the 1-*year-ahead prediction*.

[b] RMS is used for this variable, which is in a difference form.

TABLE 3.23

Ratios of Mean Square Ex Post Prediction Errors of Standard Version TSLS to Anticipation and ROS Coefficients, Wharton Model

	Sample Period: 1st Q '53–4th Q '64						Forecast Period: 1st Q '65–4th Q '64					
	NO Constant Adjustments		AR Constant Adjustments				NO Constant Adjustments		AR Constant Adjustments			
	1st Q Ahead	2nd Q Ahead	1st Q Ahead		2nd Q Ahead		1st Q Ahead	2nd Q Ahead	1st Q Ahead		2nd Q Ahead	
	Anticip.	Anticip.	Anticip.	ROS	Anticip.	ROS	Anticip.	Anticip.	Anticip.	ROS	Anticip.	ROS
Gross National Product												
Mean square error	1.74**	2.07**	1.78**	1.71**	2.27**	1.28	0.76	0.67	1.40	1.43	2.17*	1.06
UM	0.30	0.38	1.48	2.13**	1.65	1.08	0.69	0.62	1.00	0.86	1.06	0.66
US	0.42	0.65	8.00	4.73**	19.25	5.50**	1.01	0.84	2.53	1.23	1.51	1.40
UC	1.87**	0.27	1.77**	1.66**	0.57	1.28	2.23**	2.63	1.77	2.25**	3.91**	1.37
$\sum$ MSE (Components)	1.59*	1.82**	1.70**	0.97	2.03**	1.28	0.80	0.77	1.20	1.44	1.63	1.34
$\sum\sum$ MSE (Components)	1.36	1.48*	1.41	1.35	1.57*	1.11	0.86	0.84	1.13	1.13	1.34	0.99
Consumption												
Mean square error	1.87**	1.96**	1.98**	1.42	2.21**	1.24	0.67	0.62	1.34	1.47	1.50	1.63
UM	28.00	24.00	1.58	1.05	1.68	0.81	0.59	0.53	0.93	1.06	0.99	1.30
US	0.00	0.12	6.10	1.27	—	1.85**	0.98	0.86	0.93	1.59	1.19	2.15*
UC	1.86**	2.03**	1.97**	1.47*	2.23**	1.27	1.98*	2.15*	1.61	1.60	3.02**	1.82
$\sum$ MSE (Components)	1.59*	1.61*	1.60*	1.18	1.62**	1.00	0.84	0.77	1.22	1.34	1.36	0.87
Purchases of consumer nondurables and services												
Mean square error	1.33	1.44	1.31	0.78	1.41	0.73	0.80	0.77	1.12	0.69	1.27	0.70
UM	3.20	—	1.17	0.63	1.31	0.59	0.66	0.61	0.99	0.52	1.01	0.57
US	0.20	0.88	0.11	0.33	4.10	0.20	1.00	0.88	1.17	1.14	1.15	1.29
UC	1.33	1.45	1.31	0.82	3.84	0.75	1.34	1.54	1.16	0.69	1.70	0.64

Purchases of consumer durables excluding autos and parts												
Mean square error	1.00	1.00	1.51*	1.71**	1.45*	1.42	1.00	0.87	1.47	1.96	1.52	1.76
UM	—	—	1.58	2.14**	1.29	1.29	0.95	0.83	1.45	2.35**	1.35	1.77
US	0.61	0.66	20.00	0.00	0.00	0.00	2.03	1.49	—	—	—	3.00**
UC	1.17	1.19	1.47*	1.62**	1.57*	1.49*	0.63	0.82	1.46	1.80	1.75	1.72
Net foreign balances												
Mean square error	0.96	0.97	0.89	0.86	0.94	0.84	0.95	0.93	1.00	1.14	1.01	1.16
UM	4.00	0.00	1.50	0.00	2.00	0.00	0.94	0.92	1.00	1.49	1.00	1.64
US	1.71	—	0.29	0.33	0.40	0.29	0.88	0.84	0.87	1.17	1.00	1.56
UC	0.96	0.97	0.90	0.88	0.95	0.85	1.03	1.04	1.01	1.04	1.02	0.94
$\sum$ MSE (Components)	1.01	1.02	1.05	0.93	1.03	0.81	0.95	0.92	1.00	—	1.00	—
Exports												
Mean square error	0.97	0.98	1.00	0.84	0.98	0.72	1.01	1.04	1.00	0.92	1.00	0.82
UM	1.00	1.00	—	0.00	—	0.00	1.02	1.04	1.00	4.00**	—	0.00
US	1.00	1.00	1.00	1.00	0.83	1.00	—	1.12	—	0.00	1.00	1.20
UC	0.97	0.97	1.00	0.85	0.99	0.71	0.99	1.00	1.00	0.91	1.00	0.85
Imports												
Mean square error	1.09	1.08	1.15	1.16	1.12	1.00	0.92	0.89	1.00	1.02	1.00	0.98
UM	1.00	0.25	2.00	0.00	1.75	0.00	0.88	0.85	1.00	1.19	1.00	1.06
US	—	—	2.00	0.00	—	0.00	0.99	0.96	1.00	1.50	1.12	1.29
UC	1.09	1.09	1.13	1.13	1.10	1.00	1.13	1.26	1.00	0.93	0.99	0.88
Gross National Product (in 1958 dollars)												
Mean square error	1.78**	2.10**	1.64**	1.75**	2.00**	1.20	0.72	0.69	1.50	1.51	2.50**	1.09

(Continued)

TABLE 3.23 (*Concluded*)

	Sample Period: 1st Q '53–4th Q '64						Forecast Period: 1st Q '65–4th Q '64					
	NO Constant Adjustments		AR Constant Adjustments				NO Constant Adjustments		AR Constant Adjustments			
	1st Q Ahead	2nd Q Ahead	1st Q Ahead		2nd Q Ahead		1st Q Ahead	2nd Q Ahead	1st Q Ahead		2nd Q Ahead	
	Anticip.	Anticip.	Anticip.	ROS	Anticip.	ROS	Anticip.	Anticip.	Anticip.	ROS	Anticip.	ROS
UM	0.00	0.00	a1.34	1.86**	1.48	1.03	0.64	0.51	0.99	0.84	1.08	0.56
US	12.50	2.07	2.64	2.64**	3.33	2.13**	0.81	0.00	0.86	1.68	2.52	0.73
UC	1.78**	2.10**	1.64**	1.70**	2.04**	1.20	2.08*	2.38**	1.84	2.07*	3.17**	1.30
Personal disposable income												
Mean square error	1.29	1.42	1.48*	1.53*	1.60*	1.27	0.85	0.81	1.13	1.20	1.40	1.00
UM	4.00	1.00	1.23	1.52*	1.38	1.04	0.82	0.77	0.99	0.90	1.03	0.76
US	0.00	0.46	5.17	3.10**	4.00	0.00	1.01	0.94	1.97	1.15	2.29	1.73
UC	1.30	1.43	1.48*	1.52*	1.63**	1.29	1.35	2.11	1.19	1.47	1.89	1.31
Purchases of automobiles and parts												
Mean square error	2.04**	2.13**	1.96**	1.78**	1.99**	1.51*	0.39^{++}	0.41^{+}	1.29	1.43	1.53	1.34
UM	—	27.50	5.00	1.67**	8.00	0.80	0.10	0.05	0.57	0.56	0.67	0.65
US	5.66	6.07	22.00	11.00**	100.00	0.00	0.31	0.34	0.00	0.00	0.25	0.22^{++}
UC	1.90**	1.98**	1.84**	1.70**	1.90**	1.44*	2.25	2.75	1.45	1.73	2.14*	1.82
Investment												
Mean square error	1.43	1.82**	1.43	1.69**	2.00**	1.39	0.98	0.91	1.08	1.52	1.93	1.11
UM	0.76	0.78	1.34	0.00	1.70	2.15**	0.95	0.85	1.08	1.24	1.15	0.76
US	0.98	0.92	1.00	0.05	0.00	0.00	1.15	0.71	—	0.00	0.62	0.00
UC	1.64**	2.22**	1.44	1.67**	2.03**	1.37	1.34	2.58**	1.08	1.62	2.36*	1.25
$\sum$ MSE (Components)	1.27	1.46**	1.32	1.67**	1.62**	1.28	0.87	0.89	1.10	1.28	1.38	1.11

Nonfarm investment in plant and equipment												
Mean square error	0.96	1.38	0.98	1.00	1.68**	1.33	1.76	1.23	1.03	1.00	1.56	1.34
UM	0.87	0.85	—	0.00	1.90	1.46*	1.91	1.20	0.00	0.00	4.00	0.44
US	3.00	2.14	0.00	0.00	1.33	4.00**	4.29	1.28	1.30	1.02	1.60	1.26
UC	1.06	2.03	0.98	1.00	1.67**	1.31	1.01	1.87	1.00	1.00	1.53	1.39
Investment in nonfarm residential housing												
Mean square error	4.87**	4.92**	1.99**	1.00	3.39**	1.00	4.80**	3.24**	4.89**	1.01	6.61**	1.02
UM	2.78	2.32	0.00	0.00	0.00	0.00	1.84	0.97	0.43	0.83	1.00	0.79
US	30.00	14.44	—	0.75	—	0.93	9.05	8.17	1.50	0.75	9.00	0.90
UC	4.80	5.04	1.89**	1.02	2.99**	1.01	2.73**	1.96**	5.04**	1.02	7.11**	1.03
Change in the stock of nonfarm inventories												
Mean square error	1.24	1.36	1.34	1.95**	1.51*	1.31	0.78	0.70	0.98	1.41	1.06	1.08
UM	1.00	—	1.29	0.00	1.40	2.64**	0.75	0.63	0.97	1.28	1.00	0.80
US	1.00	0.29	0.12	0.02	0.00	0.00	0.80	0.70	0.39	0.20	0.22	0.22
UC	1.24	1.44	1.36	2.08**	1.55*	0.96	1.07	1.07	1.07	2.34**	1.28	1.50
Unemployment rate (per cent)												
Mean square error	1.24	1.46*	1.31	1.40	1.59*	1.16	1.16	1.51	1.23	1.23	1.66	1.30
UM	1.13	1.14	1.33	1.60	1.44	1.00	1.32	2.09	0.96	1.20	0.91	3.33**
US	1.14	1.92	—	0.00	12.00	3.00**	1.08	1.23	1.31	1.21	1.78	1.25
UC	1.31	1.55*	1.29	1.36	1.52*	1.13	0.71	1.33	1.40	1.31	1.83	1.22

NOTE: The "signal" levels were not indicated for UM and US due to their small values and thus their sensitivity to rounding errors. All figures used to calculate the ratios are in billions of current dollars, unless otherwise stated.

* Standard MSE is "signally" higher than the comparison MSE at the 10% level.
** Standard MSE is "signally" higher than the comparison MSE at the 5% level.
+ Comparison MSE is "signally" higher than the standard MSE at the 10% level.
++ Comparison MSE is "signally" higher than the standard MSE at the 5% level.

TABLE 3.24

Mean Squared Structural Equation Residuals (SERs)

Equation	1st Q 1953–4th Q 1964					1st Q 1965–4th Q 1968				
	Standard NO	Anticip. NO	Standard AR	Anticip. AR	ROS AR	Standard NO	Anticip. NO	Standard AR	Anticip. AR	ROS AR
1 CNS	1.34	1.34	1.41	1.41	1.69	18.24	18.24	3.48	3.48	3.65
2 COD	0.49	0.60	0.24	0.29	0.24	22.82	27.19	0.75	0.63	0.53
3 CA	2.04	1.67	2.14	1.81	1.75	4.98	9.38	5.02	4.86	4.09
4 IPM	0.29	0.14	0.31	0.21	0.31	1.43	1.42	0.37	0.38	0.37
5 IPR	0.30	0.27	0.27	0.25	0.27	5.48	3.34	0.73	0.61	0.73
6 IPC	1.60	1.60	0.38	0.38	0.37	2.86	2.86	1.30	1.30	1.30
7 IH	1.96	0.18	0.54	0.26	0.53	3.34	0.48	2.12	0.34	2.12
8 IIM	1.68	1.68	1.68	1.68	1.68	7.23	7.23	7.23	7.23	7.23
9 IIN	1.45	1.45	1.45	1.45	1.90	4.42	4.42	4.42	4.42	4.86
10 FIF	0.05	0.05	0.06	0.06	0.06	0.16	0.16	0.13	0.13	0.13
11 FIM	0.08	0.08	0.06	0.06	0.05	0.85	0.85	0.44	0.44	0.41
12 FIC	0.14	0.14	0.14	0.14	0.14	3.50	3.50	0.75	0.75	0.75
13 FE	0.83	0.83	0.64	0.64	0.78	6.88	6.88	2.31	2.31	2.59
TOTAL	11.25	10.03	9.32	8.64	9.77	82.19	85.98	29.05	26.88	28.76

TABLE 3.25

Breakdown of GNP58 Mean Squared Error, Wharton Model

	M^2 Effect (1)	$\sum U^2$ Effect (2)	$\sum UW$ Effect (3)	Other (4)	Total MSE (5)
	NO Constant Adjustment, 1st Q '53–4th Q '64				
Standard Version[a]	4	|11.2	−0.4	−0.2|	= 42.6
Anticipations Version[b]	3	|10.0	−2.2	0.1|	= 24.0
	No Constant Adjustment, 1st Q '65–4th Q '68				
Standard Version[a]	4	|82.2	−68.6	57.7|	= 285.3
Anticipations Version[b]	3	|86.0	−66.4	113.0|	= 397.6
	AR Constant Adjustment, 1st Q '53–4th Q '64				
Standard Version[a]	4	|9.3	−0.1	3.2|	= 49.8
Anticipations Version[b]	3	|8.6	−1.4	2.7|	= 30.4
ROS	2	|9.8	3.4	1.0|	= 28.5
	AR Constant Adjustment, 1st Q '65–4th Q '68				
Standard Version[a]	4	|29.1	−15.3	−2.0|	= 46.7
Anticipations Version[b]	3	|26.9	−16.9	−0.3|	= 31.0
ROS	2	|28.8	−12.4	−1.0|	= 30.8
	Gain from Standard to Anticipations Version—NO[c]				
1st Q '53–4th Q '64	10.7	3.6	5.4	−0.9	18.6
1st Q '65–4th Q '68	71.3	−11.4	−6.6	−165.9	−112.3
	Gain from Standard to Anticipations Version—AR[c]				
1st Q '53–4th Q '64	12.4	2.1	3.9	1.5	19.4
1st Q '65–4th Q '68	11.8	6.6	4.8	−7.2	15.7
	Gain from Standard (TSLS) to Standard ROS Version—AR[c]				
1st Q '53–4th Q '64	24.9	−1.0	−7.0	4.4	21.3
1st Q '65–4th Q '68	23.3	0.6	−5.8	−2.0	15.9

[a] See equation 3.12.

[b] See equation 3.14.

[c] See equation 3.15. Col. (1) = term 1; Col (2) = term 2; Col. (3) = term 3; Col. (4) = terms 4–6; Col. (5) = total.

TABLE 3.26

Breakdown of Constant Dollar GNP Mean Squared Error by Major Component

	Consumption			Investment			Net Foreign Balance			Omitted GNP58		Total[a]
	Product (1)	Cross Product (2)	Total (1)+(2) (3)	Product (4)	Cross Product (5)	Total (4)+(5) (6)	Product (7)	Cross Product (8)	Total (7)+(8) (9)	Cross Prod. (10)	Rest of System (11)	(3)+(6) +(9) +(10) +(11) (12)
	NO Constant Adjustment. First Quarter of 1953–Fourth Quarter of 1964											
Standard Version	3.9	−0.2	3.7	6.2	−1.7	4.5	1.1	0.1	1.2	1.4	−0.2	10.6
Anticipations Version	3.6	−0.6	3.0	5.3	−1.7	3.5	1.1	0.1	1.2	0.0	0.1	7.9
	NO Constant Adjustment, First Quarter of 1965–Fourth Quarter of 1968											
Standard Version	46.0	−35.8	10.2	24.8	2.5	27.3	11.4	10.7	22.0	−46.0	57.7	71.3
Anticipations Version	54.8	−33.4	21.4	19.8	2.7	22.5	11.4	10.7	22.0	−46.4	113.0	132.6
	AR Constant Adjustment, First Quarter of 1953–Fourth Quarter of 1964											
Standard Version	3.8	−0.2	3.6	4.6	−1.4	3.2	0.9	0.0	0.9	1.5	3.2	12.4
Anticipations Version	3.5	−0.6	2.9	4.2	−1.5	2.7	0.9	0.0	0.9	0.7	2.7	9.9
ROS	3.7	−0.6	3.1	5.1	0.2	5.3	1.0	0.0	1.0	+3.8	1.0	14.2
	AR Constant Adjustment. First Quarter of 1965–Fourth Quarter of 1968											
Standard Version	9.3	0.2	9.5	16.2	−6.4	9.8	3.6	−1.3	2.3	−7.8	−2.0	11.8
Anticipations Version	9.0	−0.3	8.7	14.3	−4.1	10.2	3.6	−1.3	2.3	−11.8	−0.3	9.7
ROS	8.3	1.6	9.9	16.6	−4.4	12.2	3.9	−1.8	2.1	7.8	−1.0	15.4

	Gain from the Standard to the Anticipations Version—NO Constant Adjustment											
Sample period[b]	0.9	1.2	2.1	2.7	0.0	3.0	0.0	0.0	0.0	4.2	0.9	8.1
Forecast period[c]	−26.4	−7.2	−33.6	15.0	−0.6	14.4	0.0	0.0	0.0	1.2	−165.9	−183.9
	Gain from the Standard to the Anticipations Version—AR Constant Adjustment											
Sample period[b]	0.9	1.2	2.1	1.2	0.3	1.5	0.0	0.0	0.0	2.4	1.5	7.5
Forecast period[c]	0.9	1.5	2.4	5.7	−6.9	−1.2	0.0	0.0	0.0	10.2	−7.2	4.2
	Gain from the Standard (TSLS) to the ROS Version—AR Constant Adjustment											
Sample period[b]	0.2	0.8	1.0	−1.0	−3.2	−4.2	−0.2	0.0	−0.2	−4.6	4.4	−3.6
Forecast period[c]	2.0	−2.8	−0.8	−0.8	−4.0	−4.8	−0.6	+1.0	+0.4	+0.0	−2.0	−7.2

[a] This is also the total of columns 2–4 on Table 3.25.
[b] First quarter of 1953–fourth quarter of 1964.
[c] First quarter of 1965–fourth quarter of 1968.

TABLE 3.27
Sum of SERs in Period t Multiplied by SERs in Period $t + 1$ for GNP58 Components

	Product,	Cross Product	Total
	NO Constant Adjustment, 1st Q '53–4th Q '64		
Standard Version	5.67	0.93	6.60
Anticipations Version	4.80	−0.60	4.18
	NO Constant Adjustment, 1st Q '65–4th Q '68		
Standard Version	64.61	−57.74	6.88
Anticipations Version	68.43	−53.87	14.56
	AR Constant Adjustment,[a] *1st Q '53–4th Q '64*		
Standard Version	5.40	1.39	6.79
Anticipations Version	4.71	0.04	4.75
ROS	6.22	3.82	10.03
	AR Constant Adjustment.[a] *1st Q '65–4th Q '68*		
Standard Version	15.37	−5.52	9.84
Anticipations Version	12.40	−6.88	5.53
ROS	14.09	−0.69	13.40

[a] The AR adjustment for 1 is also used for 2 to conform with the forecasting procedure.