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7 The Impact of the 1976 NIPA Benchmark Revision on the Structure and Predictive Accuracy of the BEA Quarterly Econometric Model

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7.1 Introduction

This study investigates the effects of the January 1976 benchmark revision of the national income and product accounts (NIPAs) on both the structure of a working quarterly econometric model—that is, on its estimated parameters and, where changes are warranted, on its specification—and on the accuracy of model predictions. The published revision included definitional and classificational revisions of historical data as well as statistical revisions from 1959-I through 1975-III. For purposes of the present study, however, the definitional and classificational revisions have been removed from the published data, because only the statistical component of the revision is of interest. The econometric model used is the Bureau of Economic Analysis (BEA) quarterly model as it existed just prior to the revision.[1]

The main purposes of the study are: (1) to evaluate the robustness of a model's structure and reduced form with respect to the most extensive kind of revision of NIPA data, and (2) to determine whether earlier availability of the revised (and presumably more accurate) data would have resulted in improved predictive performance. Improved predictions could come about either because the "better" data result in a better model (i.e., with more nearly correct parameter estimates and possibly some better specifications), or because more accurately estimated initial conditions improve the model's predictive capacity (or both).

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The authors are greatly indebted to the staff of the National Income and Wealth Division of BEA—in particular to John Gorman—for providing unpublished data that made this study possible, to Mark Rees for developing the needed computer software and managing the extensive data processing underlying the study, and to Carolyn Kennedy for computational and clerical assistance. They also wish to thank Saul Hymans for providing helpful comments on the preliminary draft of the paper.

The first major part of this paper (Sec. 7.2) concerns the impact of the revised data on the model structure. First, the extent of changes in estimated structural parameters when the pre-benchmark NIPAs replaced by the series containing the statistical component of the benchmark revision are examined. For this purpose, the last pre-benchmark version of the model had to be reestimated, using the same sample period as before, with the statistically revised data. Also examined is the equation respecification called for by excessive deterioration of previous forms when these were estimated with the revised data. Finally, a comparison is made of values of key multipliers in the original model, the model with reestimated parameters but without respecified equations, and the reestimated model with selected respecifications. The multipliers provide comparative measures of the overall sensitivity of the model structure to the benchmark revision.

Section 7.3 examines the comparative predictive accuracy of the three models—as determined from ex-post simulations—using unrevised data for initial conditions and exogenous variables for one model and revised data for all three models. With the four sets of error statistics, it is possible to assess the separate contributions of changes in initial conditions and exogenous variables, changes in estimated model parameters (for the original equation specifications), and changes in specification. In addition to measures of predictive accuracy, the comparative degrees of bias and efficiency in predictions are also examined.[2]

This study differs from earlier investigations of the effects of data revisions on econometric models (Denton and Kuiper 1965; Cole 1969; Denton and Oksanen 1972) in several respects: (1) except for Cole, these studies dealt only with revisions of preliminary data for the most recent observations not benchmark revisions; (2) only extremely simple models constructed on an ad hoc basis for purposes of the study (Denton and Kuiper) or single equations (Cole) were analyzed;[3] and (3) the impact of revisions on specification was not considered. Thus, the present study complements earlier investigations by analyzing the impact of a benchmark revision on a full-scale econometric model which was being used in regular forecasting and policy applications at the time of revision.

The present study does, however, share with earlier studies the shortcoming that it is (necessarily) confined to examining simulation with known values of exogenous variables and nonjudgmental constant adjustments, thus excluding direct tests of the effects of data revision on actual (ex-ante) forecasting performance. Such tests are precluded because we cannot construct, in an objective manner, judgmental projections of exogenous variables and revised constant adjustments (compared with those used in original ex-ante forecasts) purely on the basis of data revisions and consequent model changes.

7.1.1 Main Structural Features of the Econometric Model

The version of the BEA quarterly used in this study contains 148 structural equations of which 80 are stochastic equations. It has a typical post-Keynesian structure with many nonlinear equation forms.

The model has equations—all specified in real terms—for personal consumption expenditures (12 components), residential and nonresidential fixed investment, inventory investment (two components), and imports (two components). The basic output variable in the model is private domestic nonfarm GNP except housing (*XNF*); this output variable is not disaggregated further. A single equation relates *XNF* (and corresponding potential output) to employment. Average weekly hours are determined by a similar function. Labor force is determined by two participation rate equations. Unemployment is determined residually from labor force and employment.

The average money wage for the sector defined by *XNF* is determined by a variant of the Phillips-curve relationship. A single equation determines the implicit price deflator for *XNF* as a variable markup on "standard" unit labor cost. Implicit deflators for most GNP final demand components are determined primarily by empirical relationships of component deflators to the *XNF* deflator. Other equations determine nonwage personal income components, corporate profits, and the main components reconciling GNP and national income. A unique feature of the model is the method of income-product reconciliation: the statistical discrepancy is initially solved as a residual in the income-product identity. If the trial solution value exceeds preset limits on the absolute values of the level and first difference in the discrepancy, the initial value is replaced by the binding limit value, and the excess is allocated among income components.[4]

Completing the model are equations for manufacturers' new orders and shipments, federal and state and local receipts and federal net interest payments, state unemployment benefits, and a monetary sector. Broadly speaking, the monetary sector represents the *LM* component of an *IS-LM* construct, while the rest of the model may be considered an elaborate *IS* structure.[5]

7.2 Model Reestimation: Methodology and Impact on Model Characteristics

Three versions of the BEA quarterly model were needed in order to conduct the analyses contained in this paper. The first, model A, is the version that existed just before the benchmark revision, which included the originally estimated parameters (hereafter abbreviated as "parameters"), except for needed transformations to conform to the shift from 1958-base deflators to 1972-base deflators in the benchmark revision; the latter transformations are made for purposes of comparison with models B and C. In the second, model B, which uses the specifications and sample periods of model A, all parameters have been reestimated using post-benchmark data. The third, model C, contains respecified equations where indicated by deterioration of estimated parameters from model A to model B.

7.2.1 Data Preparation

In order to estimate models B and C, it was first necessary to recreate the data available at the time of the benchmark revision, that is, without subsequent further revisions. For NIPA variables, it was necessary to purge the new published NIPA series of the definitional and classificational revisions (hereafter abbreviated as "definitional" revisions), leaving only the statistical component of the revision.[6] Data for non-NIPA variables are those that existed just before the benchmark revision; they are left unrevised in models B and C in order that we may study the effect of the NIPA revision alone.

Fifty-seven NIPA series, including 30 current-dollar series, 19 constant-dollar series, four deflators, and four other NIPA series (e.g., the personal saving rate), had to be revised. For 1958 through 1974, the records of definitional revisions for seven current-dollar series were available only on an annual basis.[7] Quarterly values for the definitional revisions for these series were calculated using BEA's MCVIM interpolating program.[8] In addition, the definitional revisions for four constant-dollar series were available only on annual basis.[9] Quarterly interpolations of these series were obtained using the corresponding (quarterly) current-dollar series. For most of the definitional revisions, only annual values were available before 1958; for these, most of which moved smoothly on an annual basis, quarterly values were interpolated judgmentally.

No attempt was made to adjust GNP component price deflators at the model's level of disaggregation for changes in composition resulting from definitional revisions. The resulting adjustments would have been small and the calculations necessary to produce them prohibitively time consuming. (While the other revisions could be calculated using the model's data handling system, the calculation of deflators is done by the National Income and Wealth Division [NIWD] at the most detailed level of information available for GNP components; this is at least one order of fineness greater than is either published or carried in the model's data system.) However, the aggregate deflator was adjusted for compositional changes.

Although 1974 is the last year used in estimating the model's equations and for which definitional revisions were available from the NIWD, estimates of the revisions for 1975–77 were needed for the experiments described in Section 7.3. These estimates were calculated with the aid of NIWD personnel. In general, the estimates were made by linking movements of the revisions to existing detailed NIPA information. For a few series, it was necessary to extrapolate from past trends.

7.2.2 Adjustments for Conversion of the Deflator Base

The NIPA benchmark revision converted deflators from a 1958 base to a 1972 base. As a result, in order to make model A comparable with models B and C, some parameters in model A's equations—specifically in equations that include constant-dollar variables, relative prices, or levels of deflators—had to be recalculated to take into account this base change. These changes were made by assuming that the 1958-base deflator is equal to the 1972-base deflator times a scalar—a simplifying assumption at the level of aggregation of deflators used in the model. The scalar used is the ratio of the 1958-base deflator to the 1972-base deflator in 1975-II. For the ith component's deflator in the tth time period, the assumption may be written as

$$(1) \qquad P_i^{58}(t) = \left(\frac{P_i^{58}(752)}{P_i^{72}(752)}\right) P_i^{72}(t).$$

For linear equations with constant-dollar dependent variables, all coefficients are changed. For example,

$$(2) \qquad \frac{Y\$(t)}{P_Y^{58}(t)} = a_0 + a_1 X(t)$$

can be transformed to

$$(3) \qquad \frac{Y\$(t)}{P_Y^{72}(t)} = \left(\frac{P_Y^{58}(752)}{P_Y^{72}(752)}\right)\left(a_0 + a_1 X(t)\right).$$

For linear equations with constant-dollar explanatory variables, only the coefficients of those variables are changed. For example,

$$(4) \qquad Y(t) = a_0 + a_1\left(\frac{X\$(t)}{P_X^{58}(t)}\right)$$

can be transformed to

$$(5) \qquad Y(t) = a_0 + a_1\left(\frac{P_X^{72}(752)}{P_X^{58}(752)}\right)\left(\frac{X\$(t)}{P_X^{72}(t)}\right).$$

Linear equations with relative price terms have only the coefficients of these terms changed. For example,

(6) $$Y(t) = a_0 + a_1\left(\frac{P_i^{58}(t)}{P_j^{58}(t)}\right)$$

can be transformed to

(7) $$Y(t) = a_0 + a_1\left(\frac{P_i^{58}(752)}{P_i^{72}(752)}\right)\left(\frac{P_j^{72}(752)}{P_j^{58}(752)}\right)\left(\frac{P_i^{72}(t)}{P_j^{72}(t)}\right).$$

For log-linear equations with constant-dollar dependent variables, only the constant term is changed. For example,

(8) $$\log\left(\frac{Y\$(t)}{P_Y^{58}(t)}\right) = a_0 + a_1 \log X(t)$$

can be transformed to

(9) $$\log\left(\frac{Y\$(t)}{P_Y^{72}(t)}\right) = \log\left(\frac{P_Y^{58}(752)}{P_Y^{72}(752)}\right) + a_0 + a_1 \log X(t).$$

For log-linear equations with constant-dollar explanatory variables, only the constant term is changed. For example,

(10) $$\log Y(t) = a_0 + a_1 \log\left(\frac{X\$(t)}{P^{58}(t)}\right)$$

can be transformed to

(11) $$\log Y(t) = a_0 + a_1 \log\left(\frac{P_X^{72}(752)}{P_X^{58}(752)}\right) + a_1 \log\left(\frac{X\$(t)}{P^{72}(t)}\right).$$

In a similar manner, relative price terms in log-linear equations require only changes in the constant term. Combinations of the above examples within the same equation lead to multiple adjustments. No other types of nonlinear equations in the model have terms that required adjustment.

7.2.3 Estimation of Model B

The parameters of model B were estimated using the revised data.[10] The method of estimation was the same as used to estimate the base model—ordinary least squares with Cochrane-Orcutt corrections for serial correlation where needed. The time periods used for estimating the equations were the same as those used in estimating model A. The sample periods in model A were distributed as shown below.[11]

Sample Period	Number of Equations
1955-I to 1972-IV	8
1955-I to 1973-III	7
1955-I to 1973-IV	35
1955-I to 1974-IV	21
Other	9

Table 7.1 shows, in the form of a frequency distribution, the extent of changes in the structural parameters from model A to model B.[12] There are, excluding constant terms, 180 structural parameters in the 64 reestimated equations. Of these, 93 parameters increased in absolute size, 84 decreased, and three changed sign. There is a surprisingly large range of changes in parameter sizes: 25 parameters increased more than 50%, and, correspondingly, 26 parameters decreased more than 33.3%. Conversely, 39 parameters increased less than 10%, and, correspondingly, 20 parameters decreased less than 9.2%.

Table 7.1 also shows the distribution of changes in autocorrelation coefficients. Thirty-seven equations had serial correlation corrections in model A. All of these equations also had significant autocorrelation coefficients in model B. Of these, 15 had lower and 22 had higher values. In addition, seven equations had newly significant serial correlation coefficients. Counting these new corrections as increases, the hypothesis of no change in mean serial correlation correction in the 64 equations reestimated may be rejected at the 95% level of confidence (using the sign test).

Finally, table 7.1 summarizes the changes in the goodness of fit of the equations as measured by their standard errors of estimate. (Wherever a dependent variable is affected by the shift in the deflator base, the corresponding standard error in model A was adjusted accordingly.) There is no particular tendency in the goodness of fit: 34 equations had increases in standard errors, and 30 had decreases. Somewhat disturbingly, five equations showed increases of more than 100%; however, the importance of most of these increases is mitigated by the fact that the standard errors remained small relative to the variance of the dependent variables.

While it is interesting to examine the degree of change in individual structural parameters and associated regression statistics, this does not suffice for evaluating changes in the response characteristics of the model as a system. Specifically, the relatively frequent occurrence of large changes in individual parameters may give an exaggerated impression of the degree of change in the model's responsiveness to exogenous shocks and even of that of particular model sectors. For example, within equations there may be large offsetting changes in coefficients of variables that are not merely collinear in the statistical sense but that move jointly in response to a given exogenous shock. When offsetting changes occur between the coefficients of an explanatory variable and a lagged dependent variable, there will be large differences in initial responses, followed by diminishing differences over time (i.e., the "final form" of the equation is more stable than the structural form). As another example, there may be large offsetting changes among equations in the coefficients of common explanatory variables, for example, income coefficients in equations for consumption components. Finally, for variables that have comparatively little impact on the system, large changes in associated parameters may not matter much.

It is possible to illustrate the relationship between changes in individual parameters and system responses by focusing on the parameter changes in a specific sector. Table 7.2 shows how the benchmark revision affected the parameters for real disposable personal income and relative price in each of the equations in the consumption sector. The "direct" changes are those in the coefficients of the (current and lagged) explanatory variables. The "total" changes combine the direct changes with the changes in the indirect effects that are transmitted over the long run through lagged dependent variables where these are present.

The direct changes in the income parameters are relatively large, with four increases and six decreases. In the nondurables and services equations with lagged dependent variables, however, the total changes are smaller in all cases. This probably reflects primarily collinearity between income and the lagged consumption variable, which results in offsetting changes in parameters. To some (unknown) extent, it may be that the revised data correctly imply a shorter lag structure. The largest negative change—in the income parameter for other durables—is due to collinearity. Income has a correlation of .995 with a wealth measure, whose coefficient increases substantially.

The overall effect of the various changes in income parameters can be evaluated by calculating the marginal propensity to consume (MPC) for each model. Model A has a one-quarter MPC of .36 and a long-run MPC of .61. Model B has modestly higher MPCs: The one-quarter value is .40, and the long-run value is .66.[13] These relatively moderate changes in the aggregate MPCs, in contrast to the large relative changes for many of the consumption components, of course reflect offsetting changes.

The relative price coefficients show generally larger percentage changes than do the income coefficients. Again, there is a wide range in the extent of change, with four increases and three decreases in both direct effects and total effects. In contrast to the result for income, three of the four equations with lagged dependent variables show larger changes in the total effect than in the direct effect.

7.2.4 Estimation of Model C

Normally, when in the process of model reestimation previously used equation forms break down, substantial experimental research takes place before new forms are settled upon. Since it is in the nature of such experimentation that one cannot sort out respecifications made strictly in response to the breakdown of old equation forms from those made in response to new ideas that could have been applied previously, certain explicit and fairly restrictive rules for respecification had to be adopted consistent with the objective nature of this study.

Two criteria were adopted as indicating the need for respecification: (1) *t*-ratios below 1.0 for parameters whose *t*-ratios were 1.0 or higher in model A, and (2) changes in the sign of parameters. Using these criteria, it was necessary to respecify 10 equations. These were for new orders received by manufacturers, personal consumption expenditures (PCE) for durables, PCE for food, the consumer price index (CPI), average weekly hours, fixed nonresidential investment, the deflator for gross private nonfarm business GNP, the 90-day Treasury bill rate, thrift institution deposits, and rental income of persons. In each instance, one of three alternative rules was adopted for making specification changes: (1) drop the variable with the bad parameter, (2) drop a variable highly collinear with the variable with the bad parameter, or (3) adopt the revised specification used in the model that was estimated right after the benchmark revisions. The third alternative was a last resort because, when respecifications were adopted after the benchmark revision, they often resulted from considerable experimentation with alternative specifications.

Rule (1) was used in eight equations; rules (2) and (3) were used for one equation each.[14] The relatively small number of respecifications and the relatively minor changes in specification needed under the rules of this experiment suggest that the much more extensive respecification of the model following the benchmark revision (31 equations were respecified on the basis of regression tests with the new data) resulted largely from incorporating the very turbulent 1974–75 period into the sample rather than from the benchmark revision.

In the eight equations that were respecified according to the first rule, 15 out of 18 coefficients of remaining explanatory variables changed less than 5% in absolute value from model B to model C. The other three parameters whose values changed by more than 5% were relatively unimportant.

7.2.5 Comparative Multipliers in the Three Models

Examination of the effects of specific parameter changes on the implied overall marginal propensity to consume illustrates a partial summarization of the impact of data revision on model structure. A broader, more inclusive approach is to study key multipliers (i.e., reduced-form coefficients) which indicate the sensitivity of the model's response mechanism to the structural parameter changes that resulted from the revision. The multipliers automatically weight the parameter changes by their relative importance and measure the net impacts of offsetting parameter changes on variables of major interest.

Because of the nonlinearity of the model, the multipliers are variable, depending on the state of the economy and, to some extent, on the size of assumed changes in exogenous variables. Hence, multipliers are derived by simulation under specified conditions rather than by mathematical analysis. For purposes of comparing multipliers among models A, B, and C, any exogenous variables could have been chosen as instruments. As a matter of convenience, three policy instruments were chosen for the multiplier calculations: nonborrowed reserves of Federal Reserve System member banks; federal corporate profits taxes; and federal government purchases of goods and services other than compensation of government employees.[15] These instruments were selected for their differing ways of impacting on the system.

Multipliers were calculated for one through 20 quarters after the assumed change in the value of each instrument. A baseline solution for calculating the multipliers was obtained by forcing the model to track the actual course of the economy over the period 1970-I through 1974-IV. In the "disturbed" solution, the level of the policy instrument in question was increased by a constant $5 billion over its historical levels, and the model was re-solved. Differences between the disturbed and baseline solution values of the endogenous variables were then divided by 5 to yield normalized multipliers.[16]

For each of the three instruments, the corresponding multipliers in models B and C are very similar. This is not surprising given the limited changes in specification between model B and model C (most changes were simply the deletion of highly insignificant variables with small resulting changes in remaining parameters). Accordingly, in the following discussion, comparisons are generally made between model A on the one hand and the two reestimated models (models B and C) on the other.

Table 7.3 shows the multipliers for nonborrowed reserves. All three models agree that this instrument is strongly stimulative in terms of both current- and constant-dollar gross national product. The large multipliers reflect the fact that a $1 billion increase in nonborrowed reserves represents about a 3% increase in reserves in the period for which the multipliers were calculated. For the first four quarters, the current-dollar GNP multipliers are quite close for all three models. Thereafter, the differences widen and peak at about eight quarters and shrink slightly thereafter. Model C's multipliers are somewhat lower than model B's, which are in turn weaker than model A's. This pattern also holds generally for the components of GNP: the greatest relative differences in multipliers are in fixed nonresidential investment where early quarter multipliers are substantially lower than those of model A. Multipliers for personal income, corporate profits, and the federal surplus are similar among all three models up to eight quarters. Multipliers for non-NIPA variables are also similar among the models.

The most striking difference between model A on the one hand and models B and C on the other is in the price level responses. The GNP deflator multiplier, which begins to be noticeably large by the fourth quarter, is about twice as large in model B as in model A by the eighth quarter; the 2:1 ratio holds through the sixteenth quarter and then drops somewhat.

Several factors appear to account for the stronger price response. First, the revised data show a slightly slower trend rate of growth in labor productivity (.2 percentage points annually); this factor, interacting with the money wage rate in the "standard" unit labor cost term of the overall price equation, produces a stronger price impact for a given demand stimulus. Second, the unemployment rate has a larger effect in the wage rate equation. Finally, the demand terms in the general price equation yield a stronger price response. These factors more than offset the weakening effect of a somewhat lower coefficient on lagged prices in the wage rate equation.

The stronger price multipliers in models B and C become reflected (with a lag) in smaller constant-dollar GNP multipliers: higher prices result in weaker demand. By the twelfth quarter, the real GNP multiplier is 29% smaller in model B than in model A; this compares with a 5% lower current-dollar GNP multiplier.

Table 7.4 shows the multipliers for a $1 billion decrease in corporate profits taxes. As is typical for this policy instrument, the multipliers are relatively small in all cases. Models B and C have larger current-dollar GNP multipliers than model A. The spread in the multipliers, which is initially modest, builds up gradually over time and is still increasing, though slowly, at 20 quarters. Constant-dollar GNP multiplier differences mirror those for current-dollar GNP: although the reestimated models again have somewhat larger deflator multipliers, the values for these are quite small in all three models, and the difference is not large enough to produce smaller real GNP multipliers, as occurred in the case of nonborrowed reserves. Personal income and corporate profits multipliers are larger in models B and C, reflecting larger current-dollar GNP multipliers. Similarly, the federal surplus multipliers are less negative in models B and C, reflecting larger receipts due to larger increases in taxable income and corporate profits in these models. The unemployment rate and short- and long-term interest rate multipliers are very small for all three models.

Table 7.5 shows multipliers for an increase of $1 billion in federal purchases of goods and services other than compensation of government employees. The current-dollar GNP multipliers are generally similar for all models up to eight quarters. Thereafter, multipliers in models B and C are substantially larger than those in model A. These differences are spread throughout the components of GNP. The differences are due entirely to price multipliers: the potentially stronger final demand responses of models B and C are offset by the negative effects of higher prices. As a result, model A's real GNP multipliers are almost identical to those of models B and C. The comparative price multiplier patterns among models are similar to those for nonborrowed reserves (although the size of the multipliers is smaller because of the weaker stimulus). The real GNP multipliers peak at six to seven quarters and then decline. This reflects the diminishing real stimulus of government purchases as the price level for purchases rises, the demand weakening effects of higher prices in general, and negative accelerator feedbacks, which occur mainly through business fixed investment and inventory investment.

Differences among models in personal income and corporate profits multipliers again reflect those for current-dollar GNP. Federal deficit multipliers are similar for the first four quarters and are smaller in models B and C than in model A thereafter. The small differences in unemployment rate multipliers reflect the differences in constant-dollar GNP multipliers.

To summarize: changes in early quarter multipliers due to the parameter and specification changes that resulted from the benchmark revision are moderate in comparison with the rather large changes in many structural parameters. (This result is analogous to the comparison of changes in the overall marginal propensity to consume with changes in income parameters in the consumption component equations.) The increasing differences in multipliers after four to eight quarters are the result of a dynamic feeding forward of smaller differences in the earlier periods. In particular, the reestimated models produce, over longer periods, substantially larger price multipliers; for two of the three policy instruments investigated, this ultimately results in smaller real GNP multipliers. It should be noted, however, that differences for horizons beyond 12 quarters are of limited interest in a model whose focus is on short-run behavior.

7.3 Comparative Error Characteristics

7.3.1 Methodology

In order to test the effect of the benchmark revision on the predictive accuracy of the BEA quarterly model, ex-post simulations using models

A, B, and C were run. Ex-post simulations use historical data for the initial conditions (i.e., lagged values of model variables up to and including the base period) and for the exogenous variables in the simulation period.

Two sets of simulations were run with model A: (1) using pre-benchmark data for initial conditions and exogenous variables ("old ICEVs"), and (2) using revised post-benchmark data ("new ICEVs"). Models B and C were run only with new ICEVs. In all four cases, the latest revised values were used for variables against which predicted values were compared to determine prediction errors. Comparisons among the four sets of error statistics permit evaluation of both the overall effect of the benchmark revision on predictive accuracy and the contribution of the separate aspects of the adaptation of the model to the revision: (1) the substitution of new ICEVs for old ICEVs, (2) reestimation of the model, and (3) respecification of equations induced by the revision.

Twenty overlapping eight-quarter dynamic simulations were run with base periods from 1970-IV through 1975-III (thus covering the period 1971-I through 1977-III). The full set of simulations is divided into two subsets. The first subset (12 simulations) lies essentially within the period for which data are used to estimate the model (the sample period), and the second subset lies largely outside the sample period (the postsample period). The dividing line is between the simulations, whose base periods are 1973-III and 1973-IV, respectively.

Ideally, only postsample data should be used because, in principle, predictive tests should only be made against data that were not used to estimate the model (Christ 1976). Moreover, in the within-sample tests, there is a natural bias in favor of the reestimated models (B and C) because the revised data are used for error measurement. However, because of the paucity of postsample observations for each prediction horizon—a degrees-of-freedom problem that is aggravated by the fact that the simulations are overlapping, so that observed errors are not truly independent—within-sample statistics were derived and used to provide needed supplementary evidence; thus, statistics for the combined sets of simulations as well as for the subsets are analyzed.

The within-sample/postsample partioning also groups the simulations into those dominated by the 1974–75 recession and early recovery (the postsample period) and those in which recession quarters carry relatively little weight. To a considerable degree, therefore, it serves to isolate the exceptionally poorly predicted 1974–75 period.

In each simulation, adjustments were made to (normalized) equation intercepts according to the following formula for the ith time horizon:

$$\text{Adj}_i = \frac{1}{2}\hat{\rho}^i\left[(r_0 - \bar{r}_{-0:7}) + \hat{\rho}(r_{-1} - \bar{r}_{-0:7})\right] + \bar{r}_{-0:7}, \tag{12}$$

where $\hat{\rho}$ is the estimated first-order autocorrelation coefficient and $\bar{r}_{-0:7}$ is the mean single-equation residual for the eight consecutive quarters ending in the base period. For equations in first difference form, the adjustment is simply $\bar{r}_{-0:7}$. This formula provides a mechanical adjustment rule intended to correct both for serial correlation and specification errors that tend to result in systematic underpredictions or overpredictions, especially beyond the sample period. (This formula long served as an adjustment rule in actual forecasts made with the BEA econometric model when alternative judgmentally derived adjustments did not override it.)[17]

Further Data Compilation

Further modifications and extensions of data (in comparison with those described in Part I) were needed for this portion of the study. First, while the NIPA data used to derive models B and C were (appropriately) those from the initial benchmark revision, the "actual" data that were used both as a basis for error measurement and as new ICEVs are the latest revised data, which incorporate successive July revisions of the NIPAs. These revisions modify the benchmark revised NIPAs as far back as 1973-I. These data again had to be adjusted to remove the definitional and classificational components of the benchmark revision. In this connection, definitional and classificational revisions, which were available only through 1974, had to be extrapolated through the period covered by the simulations; this was done as discussed in Section 7.1.

Second, for the simulation with model A using old ICEVs, implicit deflators and constant-dollar values had to be converted from a 1958 base to a 1972 base. The same conversion factors were used as were used for the formulas employed in converting the coefficients in model A.[18] Also, for these simulations, exogenous variables had to be projected beyond 1975-III—the last quarter for which pre-benchmark data were published. These were derived by linking the latest revised cumulative changes (adjusted, where necessary, for definitional revisions) from 1975-III to the pre-benchmark levels for that quarter.

Error Statistics

The basic error statistics compiled from the four sets of model simulations are the mean absolute error or, in cases of some trending variables, the mean absolute percent error. They are compiled separately for simulations one quarter ahead, two quarters ahead, . . . , eight quarters ahead. The formulas for the mean absolute error (MAE) and mean absolute percent error (MAPE) for the ith quarter ahead are, respectively,

$$\text{MAE}_i = \frac{1}{n}\,\Sigma_j \left| P_i - A_i \right|, j = 1, \ldots, n; \qquad (13)$$

and

(14) $$\text{MAPE}_i = \frac{100}{n}\Sigma_j \left|\frac{P_i - A_i}{A_i}\right|, j = 1, \ldots, n;$$

where A is the actual value of the variable (defined, as noted above, by the latest revised data), P is the corresponding predicted value, and n is the number of simulations.

In the case of simulations with model A using old ICEVs, the predicted level of each variable analyzed is adjusted for the revision of the variable in the base period. This is done because of the bias in the pre-benchmark data in relation to the (presumably more accurate) revised data and because in the case of NIPA data we are usually interested in cumulative changes rather than in levels. (If base-period values in simulations are identical or are adjusted to be identical to actual values, then amount or percent errors for any horizon i are also the errors in the cumulative change to period i.) The adjustment formula for predicted values in the ith quarter ahead is

(15) $$P_i' = P_i + A_o^r - A_o^u$$

where $A_o^r - A_o^u$ is the difference between revised and unrevised values in the base period.

It might seem at first blush that the base-period adjustment of predicted values neutralizes the differences in measured predictive accuracy between simulations of model A using old and new ICEVs. This is, however, not necessarily so for two reasons: (1) the adjustments apply to output, not input variables (for instance, revisions in the initial levels of stocks affect the subsequent dynamic behavior of certain flow variables); (2) revisions in the trajectories of lagged variables up to the base period and of exogenous variables during the simulation period modify the dynamic behavior of output variables. (Because of the way in which unrevised exogenous variables are projected after 1975-III, there is no differences in their trajectories after 1975-III.)

Also examined, in addition to MAEs or MAPEs of variables in level form, are the MAEs of the quarterly percent changes (at annual rates) in real GNP and the GNP implicit price deflator. For these measures, no base-period adjustment is needed.

MAEs and MAPEs, rather than the frequently used root mean square errors (RMSEs), are examined here because the latter are penalized by extreme errors, thus giving a less clear picture of average performance. In addition, we show the mean error (indicating bias), the t-statistic for the mean error, and the Theil inequality coefficient which for errors of type P-A in the ith quarter is

$$(16) \qquad U_i = \sqrt{\frac{\Sigma(P_i - A_i)^2}{\Sigma(A_i - A_o)^2}}, \ j = 1, \ldots, n.$$

A U_i value of zero implies perfect predictions and a value of unity implies predictions that are, on the average, no better than a prediction of no (cumulative) change. An advantage of this statistic is that because it is a "pure" (i.e., dimensionless) number, it permits comparisons of predictive efficiency among different variables and over varying horizons.

The *t*-statistic, which purports to indicate the significance of bias, should be interpreted with great caution because of the nonindependence of observed errors for a given horizon: serial interdependence arises from the fact that the mean errors are compiled for overlapping forecasts and that in any given simulation prediction errors are strongly autocorrelated.

7.3.2 Results

Table 7.6 shows mean absolute errors, mean errors, *t*-tests of the mean error, and Theil coefficients for major NIPA aggregates and endogenous final demand components of real GNP, the GNP implicit price deflator, the unemployment rate, and representative short- and long-term interest rates. The data are grouped as within-sample, postsample, and combined in accordance with the partitioning of the simulation period described in the previous section.

The first column in each block of statistics (designated A^u) results from the simulations with model A using old ICEVs. The remaining three columns (denoted with the superscript r) are statistics from simulations with models A, B, and C using new ICEVs.

Before comparisons are made among results for the A^u, A^r, B^r, and C^r simulations, some generalizations can be made concerning the overall results. First, as is typical for dynamic simulations (and ex-ante forecasts), MAEs (or MAPEs) for level variables generally grow with the prediction horizon. The extent of deterioration is, however, better indicated by the Theil coefficient, which takes into account the greater difficulty of forecasting over long than over short horizons.[19] Second, MAEs and even MAPEs for trending variables in the postsample simulations are generally larger than corresponding MAEs and MAPEs in the within-sample simulations. This is to be expected, not only because it is a typical property but also because the postsample simulations are dominated by the period of the 1974–77 recession and recovery.[20] Third, prices are systematically and substantially underpredicted in all the simulations; this appears to reflect both inherent deficiencies in the price and wage equations in capturing the inflationary process and the lack of explicit (exogenous) treatment of the energy and other material prices, which exploded on a worldwide scale during the period under review. Finally, the Theil coefficients typically either steadily decrease with lengthening of the prediction horizon, or follow an inverted V pattern (i.e., at first rise and then fall).

For the real GNP simulations (table 7.6A, D, and L) the largest reduction in both MAEs (or MAPEs) and the Theil coefficients occurs from the A^r to the B^r simulations, that is, as a result of reestimation with the statistically revised data. This holds for the within-sample and post-sample simulations as well as for the combined simulations. Differences in prediction errors between the A^u and A^r simulations and between the B^r and C^r simulations are very small in the combined statistics. Indeed, differences in error statistics between the B^r and C^r simulations are generally very small—analogous to multiplier results in Part Section 7.2—and will, accordingly, not be discussed hereafter.

Looking more closely at the comparative results for within-sample and postsample simulations, however, one notes substantial differences. In the postsample subset, the A^r simulations yield somewhat more accurate predictions than the A^u simulations, while in the within-sample subset the reverse is true. More important, in the postsample simulations, the degree of improvement from the A^r to the B^r predictions increases dramatically with lengthening of the time horizon; in the within-sample simulations it does not. Two quarters ahead, for example, the B^r MAPE for the postsample real GNP predictions is 22% smaller than the A^r MAPE, but eight quarters ahead the B^r MAPE is 37% smaller. Bias is generally not significant at high confidence levels for the real GNP predictions.

In the within-sample and combined simulations, the greatest improvement in the price-level predictions (table 7.6B) occurs from the A^u to the A^r simulations; that is, revisions in the estimated initial conditions and exogenous variables improve the accuracy of the price level predictions more than do revisions in the parameters. Improvement diminishes sharply with the prediction horizon, however: in the combined set, the relative reduction in the MAPE between A^u and A^r simulations falls from 49% one quarter ahead to 23% eight quarters ahead.

In the postsample simulations, the pattern is quite different. Substantial reductions in the MAPE occur between the A^r and B^r simulations as well as between the A^u and A^r simulations. Indeed, the former dominate the latter with long prediction horizons; in the eighth quarter the relative reduction is 29%. Thus, there is a repetition of the comparative pattern of prediction errors observed for real GNP. Because prices are almost consistently underpredicted, the pattern of mean errors faithfully reflects that of the MAPE's.

The MAPEs for current-dollar GNP are sharply reduced proceeding from A^u to A^r to B^r simulations. In the A^u simulations, MAPEs for current-dollar GNP are almost always larger than MAPEs for corresponding constant-dollar GNP predictions; this reflects reinforcing (i.e., same-signed) errors in the deflators and real GNP predictions. In the A^r and B^r simulations, the MAPEs for current-dollar GNP are smaller than corresponding MAPEs for constant-dollar GNP, indicating offsetting price and real GNP errors. The reduction of prediction errors from the A^u to A^r to B^r simulations is most pronounced in the postsample subset. The relatively frequent occurrence of significant negative bias in the current-dollar GNP predictions reflects that found in the price level predictions.

Error statistics for major endogenous components of real GNP are shown in parts E through I of table 7.6. For the combined simulations, the tendency for the improvement in accuracy in predicting real GNP to occur mainly from the A^r to B^r simulations is most clearly mirrored in fixed nonresidential investment and, to a lesser extent, in inventory investment.

MAEs for personal consumption expenditures decrease markedly from the A^u to A^r to B^r simulations in the postsample subset—decreases are strongest in the early and late quarters; but for the within-sample simulations, MAEs are progessively larger for long horizons. The strong negative bias in the postsample A^u predictions largely disappears in the other postsample simulations.

For residential investment, the MAEs from the combined sets of simulations differ very little among the various model versions. Mirroring the error patterns for other variables, MAEs in the postsample subsets do diminish somewhat from the A^u to the B^r simulations for the longer horizons. The postsample prediction errors from the A^r, B^r, and C^r simulations have a significant positive bias.

MAEs for real imports show an anomalous substantial deterioration from the A^u to the A^r simulations—a pattern which is most pronounced for the within-sample subset. Such an anomaly in all likelihood reflects inadequacy in the specification of the imports function. There is slight further deterioration from the A^r to the B^r simulations; this tendency is again centered in the within-sample simulations. The within-sample simulations are strongly negative biased.

The comparative patterns of error statistics for personal income (pt. J, table 7.6) roughly mirror those for the GNP implicit deflator. Presumably this reflects the predictions of the average money wage rate, which is a major common element to the two variables. Specifically, there is again substantial reduction in MAPEs from the A^u to the A^r simulations, with relatively little further change to the B^r simulations, except for the longer horizons in the postsample simulations. Moreover, predictions are again uniformly negatively biased.

In the combined and within-sample simulations, predictions of corporate profits (pt. K, table 7.6) show the greatest relative improvement in the early quarters from the A^u to the B^r simulations. In the postsample simulations, there is sharp improvement from the A^r to the B^r simulations for longer horizons. Bias is generally not significant at high confidence levels.

In comparing MAEs for rates of growth of real GNP among simulations, the only persistent tendency one finds is a moderate improvement from the A^r to the B^r simulations. For the inflation rate (% change in the GNP implicit price deflator—pt. M, table 7.6), there is consistent improvement in predictions from the A^u to the B^r simulations, though MAEs for the A^r simulations are in some instances larger than for the A^u simulations. For both of these change variables, the greatest improvement from the A^u to the B^r simulations occurs in the postsample predictions for the longer horizons.

MAEs for the unemployment rate predictions show substantial improvement from the combined A^u to the A^r simulations. There is significant positive bias in the errors of the within-sample simulations; in the postsample simulations, bias is negligible except for the longest prediction horizons.

There is a slight deterioration in the MAEs for the Treasury bill rate and long-term bond yield from the A^u to the B^r simulations. In the postsample simulations, errors in the Treasury bill rate predictions generally show a significant positive bias.

To summarize: on the basis of the combined simulations, slight gains result on balance from substituting revised initial conditions and exogenous variables for the pre-benchmark data; however, such gains are far from consistent among the variables examined. There is, on the whole, clearer evidence of improved predictive accuracy from reestimation of the model than from replacing old with new ICEVs; the opposite is true, however, for the GNP implicit deflator. Generally, negligible differences in MAEs or MAPEs result when the respecified equations are inserted into the reestimated model.

For many variables there are marked differences in the comparative error statistics between the within-sample and postsample subsets of simulations. For instance, in some cases, where there is deterioration from the A^u to the A^r simulations in the within-sample subset, there is improvement in the postsample subset. More significantly, there is a persistent tendency for relatively large reductions in MAEs or MAPEs from the postsample A^u to B^r simulations for the longest horizons, compared with much smaller gains or even deterioration for the shorter horizons; this tendency is largely absent in the within-sample simulations.

Finally, there are relatively few instances where significant bias occurring in the predictions from the A^u simulations is reduced to nonsignificant levels in the A^r, B^r, or C^r simulations. Comparative efficiency of prediction among types of simulations, as measured by the Theil coefficient, generally reflects the comparative patterns of predictive accuracy as measured by the MAEs or MAPEs.

An obviously interesting question—not adequately handled by the error statistics—is whether adaptation of the model to the benchmark revision resulted in better tracking of the 1974–75 recession. When individual simulations used for the calculation of the postsample error statistics are studied, tracking is generally so poor that no meaningful comparisons among simulations result. One can only conclude that the overwhelming failure to capture the cyclical path is inherent in the model structure (and perhaps in the mechanical method of constant adjustments) and not in measurement error.

An important missing element in the model structure is the explicit treatment of energy prices. The emergence of the OPEC cartel's power was evidently an important contributing factor to the downturn.[21] Moreover, experimentation revealed that the use of the moving eight-quarter average residual as the basis for constant adjustment (see eq. [12]) also contributed substantially to the poor tracking. As a result, new simulations were run with price deflators made exogenous and automatic adjustments replaced by zero adjustments. Specifically, eight-quarter simulations with 1973-III and 1974-IV as the initial periods were tried, and the behavior of real GNP, inventory and investment, and final sales examined.

Although all of these simulations showed much better tracking—including the prediction of turning points—than those used for the error calculations, they fail to show unequivocal improvements in tracking due to the revision, either through replacement of ICEVs or reestimation. It was widely believed, for instance, that initial underestimation of inventory increases in 1973 contributed to failure to predict the 1974 downturn; yet the A^r simulation initiated in 1973-III substantially overpredicts inventory investment in 1974, while both the A^u and B^r paths are closer to the actual levels. Accuracy in tracking of final sales, however, yields a different relative ordering: the A^r simulation initiated in 1973-III does somewhat better than the A^u simulation, and the B^r simulation does most poorly. Similarly equivocal results obtain for the simulation initiated in 1974-IV.

7.4 Conclusions

The statistical component of the benchmark revision had only moderate effects on both the structure and the predictive accuracy of the BEA quarterly econometric model. Although many structural parameters underwent large relative changes upon reestimation with the revised data, the early quarter multipliers changed relatively little. The revision, on balance, moderately improved model predictive accuracy both as a result of better measures of initial conditions and exogenous variables and as a result of revised parameter estimates. These improvements, however, were not uniform across all variables examined or when comparing within-sample with postsample accuracy or for all time horizons. There is no clear evidence that the revision improved the model's tracking of the 1974–75 recession. Finally, within the rules adopted for this experiment, there were few equation specification changes necessitated by the revision; these changes, moreover, had very little effect either on the multipliers or on predictive accuracy.

Table 7.1 **Distribution of Parameter Revisions: Model B versus Model A**

	Number of Coefficients Revised		
Percent Revision	Explanatory Variables	Serial Correlation Correction	Standard Error of Estimate
200 +	2	0	1
100 to 200	12	0	4
50 to 100	11	4	6
20 to 50	14	4	5
10 to 20	15	4	6
5 to 10	15	4	3
0 to 5	24	6	9
−0 to −4.8	15	12	6
−4.9 to −9.1	5	1	9
−9.2 to −16.7	13	1	3
−16.8 to −33.3	25	1	8
−33.4 to −50.0	13	0	4
−50.0 to 66.7	4	0	0
−66.7 to −100.0	9	0	0
Change in sign	3	n.a.	n.a.
Totals	180	37	64

Note: n.a. = not applicable.

Table 7.2 Percent Changes in Absolute Value of Selected Parameters of Consumption Sector Equations

	Real Disposable Income		Relative Prices	
Dependent Variable	Direct	Total	Direct	Total
Automobiles	29.9	29.9	−45.9	−45.9
Auto parts, tires, and accessories	n.a.	n.a.	n.a.	n.a.
Furniture and equipment	−12.6	−12.6	n.a.	n.a.
Other durables	−80.3	−80.3	121.8	121.8
Clothing and shoes	−19.8	−19.8	−18.7	−18.7
Food	146.2	9.4	167.1	7.3
Gasoline and oil	−11.5	−2.5	32.9	46.4
Other nondurables	−16.6	−4.1	14.8	32.0
Housing	n.a.	n.a.	n.a.	n.a.
Household operations	42.7	4.3	n.a.	n.a.
Transportation	35.5	34.0	−39.9	−40.5
Other services	−28.4	4.2	n.a.	n.a.

Note: n.a. = not applicable.

Table 7.3 **Multipliers for Nonborrowed Reserves: GNP Components and Related Measures (Change, in $Billions, Unless Otherwise Noted, per $Billions of Increase in Nonborrowed Reserves)**

	Quarters after Change										
	1	2	3	4	5	6	7	8	12	16	20
Gross national product:											
Model A	.35	1.06	1.82	2.48	3.12	3.74	4.27	4.74	5.88	6.78	7.73
Model B	.35	1.08	1.81	2.36	2.89	3.41	3.82	4.22	5.58	6.92	7.33
Model C	.33	1.02	1.72	2.23	2.69	3.15	3.52	3.88	5.10	6.52	7.15
Personal consumption expenditures:											
Model A	.21	.52	.86	1.19	1.65	1.99	2.23	2.48	3.20	3.68	4.38
Model B	.19	.48	.81	1.12	1.56	1.88	2.09	2.33	3.07	3.43	3.93
Model C	.16	.41	.71	.99	1.38	1.66	1.85	2.06	2.72	3.15	3.75
Fixed nonresidential investment:											
Model A	.03	.12	.27	.44	.63	.80	.96	1.09	1.37	1.46	1.64
Model B	.02	.07	.16	.29	.43	.57	.70	.83	1.26	1.67	1.78
Model C	.01	.06	.15	.27	.40	.52	.64	.75	1.12	1.50	1.66
Residential investment:											
Model A	.21	.57	.74	.74	.71	.76	.87	.96	1.22	1.86	2.24
Model B	.21	.58	.74	.74	.70	.75	.86	.94	1.09	1.82	2.20
Model C	.22	.59	.76	.75	.72	.76	.87	.96	1.20	1.84	2.24
Change in business inventories:											
Model A	−.10	−.12	.01	.20	.31	.41	.44	.45	.47	.24	.13
Model B	−.07	−.02	.15	.30	.36	.43	.42	.41	.49	.56	.18
Mobel C	−.06	−.02	.14	.28	.33	.39	.38	.37	.43	.52	.22
Imports of goods and services:											
Model A	.01	.03	.06	.09	.17	.23	.27	.32	.45	.56	.78
Model B	.01	.03	.06	.09	.17	.22	.25	.29	.43	.56	.77
Model C	−.00	.02	.04	.07	.14	.18	.21	.25	.37	.50	.72

Personal income:											
Model A	.14	.45	.82	1.16	1.50	1.82	2.10	2.37	3.14	3.91	4.86
Model B	.11	.40	.77	1.09	1.38	1.66	1.90	2.13	2.85	3.55	4.24
Model C	.10	.38	.73	1.03	1.29	1.54	1.75	1.96	2.61	3.33	4.09
Corporate profits (share):											
Model A	.18	.52	.84	1.09	1.34	1.58	1.80	1.98	2.33	2.35	2.29
Model B	.22	.61	.92	1.11	1.30	1.50	1.65	1.82	2.41	3.04	2.70
Model C	.20	.58	.89	1.05	1.21	1.39	1.53	1.68	2.21	2.88	2.67
Federal surplus or deficit (−):											
Model A	.12	.36	.62	.84	1.01	1.20	1.37	1.51	1.86	2.09	2.43
Model B	.13	.40	.65	.85	1.01	1.21	1.37	1.51	2.01	2.44	2.53
Model C	.12	.38	.62	.80	.95	1.11	1.26	1.39	1.83	2.29	2.47
GNP (billions of $1972):											
Model A	.38	1.10	1.83	2.38	2.94	3.44	3.87	4.25	4.76	4.56	4.41
Model B	.37	1.09	1.77	2.20	2.56	2.88	3.11	3.29	3.39	3.22	3.03
Model C	.35	1.04	1.68	2.08	2.39	2.66	2.86	3.01	3.10	3.10	3.05
Implicit price deflator, GNP (1972 = 100):											
Model A	.00	.01	.01	.02	.03	.04	.05	.05	.09	.14	.20
Model B	.00	.01	.02	.03	.04	.06	.07	.09	.18	.27	.31
Model C	.00	.01	.02	.03	.04	.05	.07	.08	.18	.28	.33
Unemployment rate (%):											
Model A	−.01	−.02	−.04	−.06	−.08	−.09	−.10	−.11	−.11	−.09	−.09
Model B	−.01	−.03	−.05	−.07	−.08	−.10	−.10	−.11	−.11	−.09	−.09
Model C	−.01	−.02	−.05	−.06	−.08	−.09	−.10	−.10	−.10	−.09	−.09
Treasury bill rate (%):											
Model A	−.56	−.53	−.49	−.46	−.40	−.37	−.36	−.34	−.31	−.35	−.36
Model B	−.58	−.54	−.50	−.47	−.41	−.39	−.38	−.36	−.34	−.37	−.38
Model C	−.60	−.55	−.52	−.48	−.42	−.40	−.39	−.37	−.35	−.39	−.39
Corporate bond rate (%):											
Model A	−.13	−.14	−.17	−.22	−.25	−.28	−.31	−.32	−.36	−.39	−.42
Model B	−.14	−.14	−.18	−.22	−.26	−.29	−.32	−.34	−.38	−.42	−.45
Model C	−.14	−.15	−.18	−.23	−.26	−.30	−.33	−.35	−.39	−.43	−.46

Table 7.4 Multipliers for Corporate Profits Taxes: GNP, GNP Components, and Related Measures (Change, in $Billions, Unless Otherwise Noted, per $Billions of Tax Reduction)

	Quarters after Change										
	1	2	3	4	5	6	7	8	12	16	20
Gross national product:											
Model A	.03	.06	.12	.20	.30	.41	.53	.64	.92	1.08	1.25
Model B	.03	.07	.15	.25	.39	.54	.70	.85	1.30	1.62	1.83
Model C	.03	.07	.15	.25	.39	.55	.71	.86	1.32	1.64	1.85
Personal consumption expenditures:											
Model A	.03	.04	.07	.09	.13	.17	.21	.26	.39	.52	.68
Model B	.02	.03	.06	.09	.14	.19	.25	.31	.53	.71	.89
Model C	.02	.03	.06	.09	.14	.20	.26	.32	.54	.72	.90
Fixed nonresidential investment:											
Model A	.01	.03	.08	.13	.19	.25	.32	.36	.48	.57	.65
Model B	.01	.04	.10	.17	.25	.33	.43	.50	.72	.90	1.07
Model C	.01	.04	.10	.17	.25	.33	.43	.51	.72	.90	1.08
Residential investment:											
Model A	−.00	−.00	−.01	−.00	−.00	.00	.01	.01	.02	.01	.01
Model B	−.00	−.00	−.00	−.00	−.00	.00	.01	.01	.03	.02	.00
Model C	−.00	−.00	−.00	−.00	.00	.00	.01	.01	.03	.02	.01
Change in business inventories:											
Model A	−.01	−.00	−.00	.00	.01	.02	.04	.06	.10	.08	.06
Model B	−.00	.00	.00	.01	.02	.05	.06	.08	.12	.14	.08
Model C	−.00	.00	.00	.01	.02	.05	.06	.08	.12	.14	.08
Imports of goods and services:											
Model A	.01	.01	.01	.02	.02	.03	.04	.05	.07	.10	.15
Model B	.00	.01	.01	.02	.03	.03	.04	.06	.10	.14	.21
Model C	.00	.01	.01	.02	.03	.03	.05	.06	.10	.14	.21

Personal income:											
Model A	.08	.10	.15	.19	.26	.33	.40	.47	.69	.88	1.09
Model B	.06	.09	.14	.19	.28	.36	.46	.55	.88	1.14	1.38
Model C	.06	.09	.14	.20	.28	.37	.46	.56	.88	1.15	1.39
Corporate profits (share):											
Model A	.01	.03	.05	.09	.14	.19	.24	.29	.40	.42	.41
Model B	.02	.04	.08	.13	.20	.27	.34	.40	.56	.67	.66
Model C	.02	.04	.08	.13	.20	.27	.34	.41	.58	.68	.66
Federal surplus or deficit (−):											
Model A	−.99	−.96	−.95	−.87	−.92	−.90	−.90	−.86	−1.03	−1.11	−1.08
Model B	−.99	−.94	−.93	−.83	−.87	−.82	−.81	−.74	−.86	−.88	−.75
Model C	−.99	−.94	−.93	−.82	−.86	−.82	−.81	−.74	−.85	−.87	−.74
GNP (billions of $1972):											
Model A	.04	.07	.12	.20	.29	.39	.50	.60	.80	.81	.80
Model B	.03	.07	.15	.24	.37	.50	.63	.74	.98	1.01	.99
Model C	.03	.08	.15	.25	.37	.50	.64	.75	.99	1.02	1.00
Implicit Price deflator (1972 = 100):											
Model A	.00	.00	.00	.00	.00	.00	.00	.01	.01	.02	.02
Model B	.00	.00	.00	.00	.00	.01	.01	.01	.03	.04	.05
Model C	.00	.00	.00	.00	.00	.01	.01	.01	.03	.04	.06
Unemployment rate (%):											
Model A	−.00	−.00	−.00	−.00	−.01	−.01	−.01	−.02	−.02	−.02	−.02
Model B	−.00	−.00	−.00	−.01	−.01	−.01	−.02	−.02	−.03	−.03	−.03
Model C	−.00	−.00	−.00	−.01	−.01	−.02	−.02	−.02	−.03	−.03	−.03
Treasury bill rate (%):											
Model A	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.02
Model B	.00	.00	.01	.01	.01	.01	.01	.01	.02	.02	.02
Model C	.00	.00	.00	.00	.01	.01	.01	.01	.02	.02	.02
Corporate bond rate (%):											
Model A	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.02
Model B	.00	.00	.00	.00	.00	.00	.00	.01	.01	.02	.02
Model C	.00	.00	.00	.00	.00	.00	.00	.01	.01	.02	.02

Table 7.5 Multipliers for Federal Government Purchases: GNP, GNP Components, and Related Measures (Change, in $Billions, Unless Otherwise Noted, per $Billions Added Government Purchases)

	Quarters after Change										
	1	2	3	4	5	6	7	8	12	16	20
Gross national product:											
Model A	.87	1.40	1.82	2.08	2.28	2.39	2.41	2.39	1.96	1.80	1.93
Model B	.95	1.55	1.96	2.20	2.41	2.57	2.63	2.68	2.75	2.93	2.83
Model C	.95	1.55	1.96	2.21	2.41	2.57	2.63	2.69	2.76	2.92	2.82
Personal consumption expenditures:											
Model A	.13	.30	.47	.55	.67	.72	.75	.76	.69	.78	1.04
Model B	.13	.32	.53	.64	.80	.88	.94	1.00	1.12	1.27	1.47
Model C	.13	.32	.53	.64	.80	.88	.94	1.00	1.12	1.26	1.46
Fixed nonresidential investment:											
Model A	.03	.12	.22	.31	.37	.41	.43	.41	.22	.16	.13
Model B	.04	.12	.24	.34	.44	.51	.56	.58	.58	.67	.65
Model C	.04	.12	.24	.35	.44	.51	.56	.58	.58	.66	.65
Residential investment:											
Model A	.00	.00	.01	.01	.02	.03	.03	.03	.03	.01	.01
Model B	−.00	.00	.01	.02	.03	.04	.04	.04	.05	.01	−.01
Model C	−.00	−.00	.01	.02	.03	.04	.04	.04	.05	.02	−.01
Change in business inventories:											
Model A	−.28	.03	.20	.30	.33	.35	.33	.31	.15	−.01	−.06
Model B	−.20	.15	.28	.21	.28	.29	.24	.22	.17	.19	.01
Model C	−.20	.15	.27	.31	.28	.29	.24	.22	.17	.19	.00
Imports of goods and services:											
Model A	.02	.05	.08	.09	.11	.12	.13	.13	.12	.13	.18
Model B	.02	.05	.09	.11	.13	.14	.15	.16	.17	.22	.29
Model C	.02	.05	.09	.11	.13	.14	.15	.16	.17	.21	.29

Personal income:											
Model A	.32	.62	.83	.98	1.09	1.17	1.22	1.24	1.17	1.23	1.48
Model B	.32	.69	.95	1.14	1.27	1.38	1.45	1.50	1.58	1.72	1.88
Model C	.32	.69	.95	1.14	1.27	1.38	1.45	1.50	1.58	1.72	1.88
Corporate profits (share):											
Model A	.49	.67	.84	.94	1.01	1.04	1.01	.98	.69	.45	.27
Model B	.59	.73	.90	.94	.99	1.04	1.02	1.02	1.04	1.08	.79
Model C	.59	.79	.90	.94	1.00	1.04	1.03	1.04	1.05	1.07	.78
Federal surplus or deficit (−):											
Model A	−.67	−.50	−.36	−.27	−.23	−.20	−.20	−.22	−.37	−.44	−.42
Model B	−.64	−.44	−.31	−.22	−.17	−.11	−.09	−.08	−.05	−.02	−.07
Model C	−.64	−.44	−.31	−.22	−.17	−.11	−.09	−.07	−.05	−.02	−.08
GNP (billions of $1972):											
Model A	1.08	1.56	1.91	2.08	2.22	2.27	2.28	2.22	1.62	1.14	.98
Model B	1.13	1.66	1.98	2.11	2.17	2.17	2.14	2.05	1.50	1.10	.87
Model C	1.13	1.66	1.99	2.11	2.17	2.18	2.14	2.05	1.50	1.10	.86
Implicit deflator, GNP (1972 = 100):											
Model A	−.01	−.00	.01	.01	.02	.02	.02	.02	.03	.04	.06
Model B	−.00	.00	.01	.02	.03	.04	.05	.06	.10	.14	.15
Model C	−.01	.00	.01	.02	.03	.04	.05	.06	.10	.14	.15
Unemployment rate (%):											
Model A	−.02	−.04	−.05	−.06	−.06	−.06	−.06	−.06	−.04	−.02	−.02
Model B	−.02	−.04	−.06	−.07	−.08	−.08	−.08	−.07	−.05	−.03	−.01
Model C	−.02	−.04	−.06	−.07	−.08	−.08	−.08	−.07	−.05	−.03	−.03
Treasury bill rate (%):											
Model A	.01	.01	.02	.03	.03	.03	.03	.03	.02	.02	.02
Model B	.01	.02	.02	.02	.03	.03	.03	.04	.03	.03	.04
Model C	.01	.01	.02	.02	.03	.03	.03	.04	.04	.04	.04
Corporate bond rate (%):											
Model A	.00	.00	.01	.01	.01	.01	.02	.02	.03	.03	.03
Model B	.00	.00	.01	.01	.01	.01	.02	.02	.03	.03	.04
Model C	.00	.00	.01	.01	.01	.01	.02	.02	.03	.03	.04

Table 7.6 **Error Statistics**
A. Gross National Product, Constant Dollars—Percent Errors

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	.44	.54	.40	.42	.07	−.08	−.00	−.03	.41	−.43	−.01	−.20	.39	.45	.34	.37
2	.79	.97	.74	.78	.15	−.20	−.20	−.24	.53	−.60	−.78	−.89	.37	.44	.34	.36
3	1.06	1.38	1.04	1.07	.13	−.28	−.43	−.47	.34	−.59	−1.23	−1.27	.36	.44	.34	.37
4	1.40	1.79	1.36	1.42	.07	−.31	−.63	−.67	.14	−.50	−1.41	−1.39	.36	.45	.35	.37
6	2.40	2.91	2.48	2.53	−.06	.21	−.50	−.51	−.07	.19	−.57	−.57	.45	.55	.45	.46
8	2.86	3.54	3.18	3.21	.64	1.16	.08	.11	.62	.90	.07	.10	.47	.59	.49	.50
Postsample																
1	1.39	.98	.81	.85	−.53	.34	.28	.32	−.80	.78	.75	.86	1.20	.79	.68	.68
2	2.55	2.40	1.88	1.75	−.33	.81	.91	.84	−.31	.87	1.17	1.13	1.08	.97	.85	.81
3	3.51	3.29	2.52	2.43	−.42	1.05	1.32	1.19	−.28	.77	1.25	1.13	1.09	1.04	.86	.84
4	4.19	4.12	3.14	2.98	−.68	1.12	1.64	1.46	−.40	.68	1.37	1.20	1.05	1.03	.81	.80
6	4.96	4.62	3.03	3.17	−2.56	.25	1.42	1.19	−1.36	.13	1.17	.94	1.07	.94	.67	.68
8	5.03	4.26	2.69	2.75	−4.27	−1.14	.71	.48	−2.54	−.66	.65	.43	.91	.69	.44	.43
Combined																
1	.82	.71	.56	.59	−.17	.09	.11	.11	−.61	.42	.65	.62	.84	.62	.52	.53
2	1.49	1.54	1.20	1.17	−.04	.21	.25	.19	−.09	.49	.69	.55	.76	.71	.61	.59
3	2.04	2.14	1.63	1.62	−.09	.25	.27	.19	−.14	.41	.54	.38	.74	.74	.61	.60
4	2.52	2.72	2.07	2.04	−.23	.26	.28	.18	−.32	.35	.47	.31	.70	.72	.57	.57
6	3.42	3.59	2.70	2.78	−1.06	.22	.27	.17	−1.14	.23	.37	.23	.69	.69	.52	.53
8	3.73	3.83	2.98	3.03	−1.32	.24	.33	.26	−1.26	.23	.43	.33	.66	.63	.47	.48

Note: Superscript denotes version of model and status of initial conditions and exogenous variables (u = unrevised, r = revised).

B. Implicit Price Deflator for GNP—Percent Errors

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	.59	.16	.17	.17	−.59	−.02	.05	.05	−7.76	−.28	.88	.87	.46	.13	.14	.14
2	.69	.20	.23	.24	−.69	−.05	.05	.04	−11.60	−.67	.54	.48	.26	.10	.10	.10
3	.71	.34	.38	.39	−.71	−.16	−.03	−.03	−9.13	−1.26	−.17	−.21	.18	.11	.12	.12
4	.87	.52	.57	.57	−.87	−.33	−.13	−.14	−6.15	−1.77	−.59	−.63	.17	.12	.13	.13
6	1.40	1.07	1.20	1.18	−1.40	−.98	−.59	−.61	−3.79	−2.41	−1.26	−1.29	.19	.17	.18	.18
8	2.88	1.98	1.95	1.92	−2.88	−1.95	−1.33	−1.34	−4.94	−3.11	−1.89	−1.92	.27	.22	.21	.20
								Postsample								
1	1.34	.89	.76	.76	−1.34	−.89	−.76	−.76	−6.17	−6.79	−6.30	−6.30	.65	.42	.36	.37
2	1.93	1.37	1.09	1.12	−1.93	−1.37	−1.09	−1.12	−16.88	−9.72	−8.80	−8.42	.45	.33	.26	.27
3	2.39	1.83	1.42	1.47	−2.39	−1.83	−1.42	−1.47	−15.34	−7.38	−5.14	−5.48	.39	.31	.26	.26
4	2.91	2.32	1.76	1.82	−2.91	−2.32	−1.76	−1.82	−10.94	−6.37	−4.19	−4.44	.38	.32	.27	.27
6	3.75	3.25	2.37	2.43	−3.75	−3.25	−2.37	−2.43	−8.73	−6.24	−3.83	−4.01	.38	.34	.28	.28
8	5.16	4.32	3.05	3.08	−5.16	−4.32	−3.05	−3.08	−10.23	−7.34	−4.22	−4.34	.42	.36	.28	.28
								Combined								
1	.89	.45	.40	.40	−.89	−.36	−.27	−.27	−7.06	−3.17	−2.56	−2.57	.59	.35	.30	.30
2	1.19	.67	.57	.59	−1.19	−.58	−.41	−.43	−7.92	−3.53	−2.82	−2.84	.39	.26	.22	.22
3	1.38	.94	.79	.82	−1.38	−.83	−.58	−.61	−6.79	−3.71	−2.78	−2.86	.32	.25	.21	.21
4	1.69	1.24	1.05	1.07	−1.69	−1.13	−.79	−.81	−6.39	−3.95	−2.82	−2.91	.30	.25	.21	.22
6	2.34	1.94	1.67	1.68	−2.34	−1.89	−1.31	−1.33	−6.15	−4.69	−3.13	−3.21	.29	.26	.23	.23
8	3.79	2.91	2.39	2.38	−3.79	−2.90	−2.02	−2.04	−8.06	−5.70	−3.77	−3.84	.33	.28	.24	.24

Table 7.6 (continued)

C. Gross National Product, Current Dollars—Percent Errors

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	.65	.53	.37	.44	−.52	−.10	.05	.02	−3.23	−.50	.31	.10	.28	.25	.20	.21
2	1.01	.97	.63	.69	−.55	−.25	−.15	−.20	−1.73	−.80	−.67	−.79	.24	.22	.16	.18
3	1.25	1.29	.81	.91	−.60	−.44	−.46	−.51	−1.49	−1.08	−1.64	−1.60	.21	.20	.15	.17
4	1.50	1.57	.94	1.05	−.85	−.65	−.78	−.82	−1.85	−1.34	−2.56	−2.28	.19	.19	.14	.16
6	1.95	2.12	1.57	1.60	−1.52	−.82	−1.13	−1.15	−2.73	−1.17	−2.43	−2.27	.18	.19	.14	.15
8	2.53	2.07	1.77	1.80	−2.34	−.90	−1.33	−1.31	−4.25	−1.30	−2.78	−2.54	.17	.14	.12	.13
								Postsample								
1	1.95	.74	.79	.75	−1.89	−.55	−.48	−.44	−2.35	−1.43	−1.36	−1.28	1.24	.51	.46	.44
2	2.65	1.80	1.62	1.47	−2.32	−.57	−.20	−.30	−2.13	−.73	−.29	−.45	.82	.48	.40	.39
3	3.49	2.56	1.90	2.02	−2.90	−.83	−.14	−.31	−2.17	−.76	−.16	−.38	.69	.46	.34	.34
4	4.00	3.02	2.04	2.06	−3.71	−1.26	−.18	−.41	−2.52	−.99	−.21	−.47	.62	.42	.26	.27
6	6.31	3.65	1.73	1.94	−6.31	−3.08	−1.04	−1.32	−4.40	−2.33	−1.54	−1.83	.57	.36	.16	.18
8	9.30	5.47	2.40	2.67	−9.30	−5.47	−2.40	−2.67	−7.92	−4.79	−4.23	−5.03	.56	.36	.16	.17
								Combined								
1	1.17	.61	.53	.56	−1.07	−.28	−.16	−.17	−2.98	−1.44	−.94	−.96	.76	.36	.31	.31
2	1.66	1.30	1.02	1.00	−1.25	−.38	−.17	−.24	−2.52	−1.07	−.57	−.81	.53	.34	.28	.27
3	2.15	1.80	1.25	1.36	−1.52	−.60	−.33	−.43	−2.44	−1.23	−.90	−1.16	.45	.32	.24	.24
4	2.50	2.15	1.38	1.45	−1.99	−.90	−.54	−.66	−2.83	−1.57	−1.42	−1.65	.41	.29	.19	.21
6	3.70	2.73	1.63	1.74	−3.44	−1.72	−1.09	−1.22	−4.11	−2.45	−2.90	−2.99	.38	.27	.15	.16
8	5.24	3.43	2.02	2.15	−5.13	−2.73	−1.76	−1.86	−5.34	−3.46	−4.67	−4.67	.38	.26	.14	.15

D. Gross National Product (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				*t*-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	5.15	6.29	4.66	4.90	1.04	−.73	.15	−.17	.53	−.32	.09	−.09	.40	.46	.35	.38
2	9.33	11.52	8.76	9.19	2.08	−2.06	−2.15	−2.60	.62	−.52	−.72	−.82	.38	.44	.34	.36
3	12.74	16.50	12.32	12.74	1.92	−2.98	−4.91	−5.37	.41	−.53	−1.19	−1.21	.37	.44	.34	.37
4	16.79	21.42	16.19	16.92	1.14	−3.40	−7.36	−7.75	.19	−.46	−1.38	−1.35	.36	.45	.35	.37
6	28.54	34.74	29.64	30.19	−.85	2.28	−6.20	−6.28	−.08	.18	−.60	−.59	.44	.54	.44	.45
8	34.31	42.46	38.25	38.58	7.26	13.34	.40	.75	.58	.87	.03	.06	.46	.57	.48	.49
								Postsample								
1	16.71	11.76	9.76	10.16	−6.43	3.97	3.30	3.74	−.81	.76	.73	.84	1.22	.79	.69	.69
2	30.82	28.77	22.46	20.90	−4.54	9.29	10.52	9.75	−.35	.83	1.14	1.10	1.09	.96	.83	.79
3	42.68	39.55	30.16	28.98	−6.13	11.62	15.15	13.62	−.34	.83	1.14	1.10	1.09	1.03	.84	.82
4	51.26	49.86	37.71	35.74	−9.89	12.15	18.91	16.76	−.47	.62	1.32	1.15	1.06	1.01	.79	.78
6	62.27	57.22	37.14	38.89	−33.58	1.39	16.54	13.68	−1.43	.06	1.11	.89	1.07	.92	.64	.65
8	65.29	54.66	34.09	34.91	−56.02	−16.04	8.12	5.14	−2.56	−.72	.59	.37	.91	.69	.42	.42
								Combined								
1	9.77	8.48	6.70	7.00	−1.95	1.15	1.41	1.39	−.58	.47	.69	.67	.87	.63	.53	.54
2	17.93	18.42	14.24	13.87	−.57	2.48	2.92	2.34	−.10	.49	.69	.57	.77	.72	.60	.59
3	24.72	25.72	19.46	19.24	−1.30	2.86	3.12	2.22	−.17	.39	.53	.38	.75	.74	.60	.60
4	30.58	32.80	24.80	24.45	−3.27	2.82	3.15	2.06	−.36	.31	.45	.29	.72	.72	.56	.56
6	42.03	43.73	32.64	33.67	−13.94	1.92	2.90	1.71	−1.21	.16	.33	.19	.70	.69	.51	.52
8	46.70	47.34	36.59	37.11	−18.05	1.59	3.49	2.51	−1.36	.12	.37	.26	.67	.62	.46	.46

Table 7.6 (continued)

E. Personal Consumption Expenditures (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	4.68	5.11	4.36	4.68	−2.15	−.73	−1.45	−1.88	−1.33	−.41	−.97	−1.21	.57	.58	.51	.54
2	6.68	7.17	6.61	6.90	−4.13	−2.49	−3.85	−4.28	−1.77	−.99	−1.80	−1.86	.47	.46	.43	.47
3	8.05	9.19	8.62	9.17	−3.20	−4.34	−6.59	−6.97	−1.12	−1.40	−2.47	−2.36	.38	.42	.42	.45
4	8.65	11.14	10.77	11.46	−5.54	−6.45	−9.91	−10.19	−1.84	−1.88	−3.36	−3.02	.34	.39	.41	.45
6	12.40	16.17	18.31	18.32	−7.26	−7.39	−13.74	−13.68	−1.82	−1.42	−2.94	−2.71	.33	.41	.45	.47
8	16.34	20.87	22.60	22.99	−6.48	−4.78	−14.92	−14.45	−1.33	−.72	−2.50	−2.29	.33	.42	.47	.48
Postsample																
1	12.19	4.86	5.61	4.90	−11.30	−1.61	−1.86	−1.22	−3.44	−.62	−.67	−.46	1.62	.80	.86	.81
2	14.03	10.51	10.09	9.51	−13.37	−1.04	−1.62	−1.22	−2.62	−.22	−.37	−.29	1.17	.75	.73	.68
3	17.22	14.76	14.12	13.89	−12.88	−.99	−1.74	−1.63	−1.87	−.15	−.29	−.28	.96	.75	.69	.66
4	20.16	19.23	16.29	16.36	−15.14	−.87	−1.21	−1.51	−1.84	−.11	−.18	−.23	.87	.69	.59	.58
6	29.87	25.30	20.06	20.36	−26.24	−7.76	−6.98	−8.06	−2.50	−.74	−.85	−.99	.81	.61	.48	.48
8	39.60	25.49	19.88	20.35	−38.99	−16.00	−13.87	−15.56	−4.02	−1.62	−1.77	−2.02	.73	.48	.39	.40
Combined																
1	7.69	5.01	4.86	4.77	−5.81	−1.08	−1.61	−1.62	−3.08	−.75	−1.17	−1.18	1.04	.66	.64	.64
2	9.62	8.51	8.00	7.94	−7.83	−1.91	−2.96	−3.05	−3.00	−.83	−1.39	−1.44	.78	.58	.55	.55
3	11.72	11.42	10.82	11.06	−7.07	−3.00	−4.65	−4.83	−2.13	−.95	−1.64	−1.68	.64	.56	.52	.53
4	13.25	14.37	12.98	13.42	−9.38	−4.22	−6.43	−6.71	−2.48	−1.13	−1.95	−1.98	.58	.51	.48	.50
6	19.38	19.82	19.01	19.14	−14.85	−7.54	−11.03	−11.43	−2.90	−1.49	−2.60	−2.63	.57	.50	.46	.47
8	25.64	22.71	21.51	21.93	−19.48	−9.27	−14.50	−14.89	−3.27	−1.66	−3.13	−3.13	.56	.45	.43	.44

F. Fixed Nonresidential Investment (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	2.87	1.59	1.44	1.42	2.47	−.36	−.24	−.25	3.68	−.66	−.49	−.52	1.11	.62	.54	.53
2	2.66	2.44	2.10	2.10	1.45	−.72	−.65	−.68	1.68	−.80	−.84	−.90	.58	.55	.47	.47
3	2.97	3.23	2.42	2.46	−1.08	−1.19	−1.37	−1.44	−1.10	−1.09	−1.74	−1.86	.44	.49	.37	.37
4	3.47	4.06	2.48	2.54	−.45	−1.60	−2.22	−2.32	−.37	−1.12	−3.08	−3.35	.40	.49	.32	.32
6	7.06	8.22	5.34	5.17	−.74	−.79	−2.69	−2.81	−.28	−.26	−1.42	−1.52	.58	.69	.46	.45
8	10.70	11.63	8.89	8.84	.76	1.65	−1.39	−1.47	.20	.39	−.44	−.48	.68	.76	.56	.55
Postsample																
1	4.55	2.68	2.26	2.28	4.09	1.52	1.14	1.15	3.16	1.44	1.31	1.30	1.39	.83	.67	.68
2	7.36	5.86	4.18	4.20	3.88	2.88	3.08	3.07	1.38	1.19	1.95	1.97	1.13	.95	.70	.69
3	11.01	10.03	6.72	6.70	1.99	4.10	5.92	5.87	.44	1.02	2.67	2.74	1.15	1.09	.79	.78
4	15.25	14.49	9.18	9.05	2.39	4.74	9.18	9.05	.39	.84	3.54	3.63	1.25	1.20	.88	.86
6	20.09	19.48	15.15	14.94	−1.93	3.76	15.15	14.94	−.24	.48	5.35	5.39	1.37	1.36	1.10	1.08
8	20.39	21.01	18.93	18.78	−7.72	−.03	18.93	18.78	−.95	−.00	6.22	6.43	1.52	1.48	1.37	1.35
Combined																
1	3.54	2.03	1.76	1.77	3.12	.39	.32	.31	4.72	.70	.68	.66	1.26	.74	.61	.61
2	4.54	3.81	2.93	2.94	2.42	.72	.84	.82	1.98	.63	.98	.95	.92	.79	.61	.60
3	6.19	5.95	4.14	4.16	.15	.92	1.55	1.48	.08	.52	1.22	1.19	.90	.87	.64	.63
4	8.18	8.23	5.16	5.14	.69	.93	2.34	2.23	.28	.38	1.39	1.35	.95	.93	.67	.66
6	12.27	12.73	9.26	9.08	−1.22	1.03	4.44	4.29	−.36	.29	1.75	1.71	.99	1.02	.79	.78
8	14.58	15.38	12.90	12.82	−2.63	.98	6.74	6.63	−.66	.24	2.13	2.12	1.01	1.03	.88	.87

Table 7.6 (continued)

G. Residential Investment (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	1.55	1.49	1.23	1.24	−1.53	−.87	−.67	−.66	−4.22	−1.93	−1.66	−1.62	.71	.63	.54	.54
2	3.67	3.63	3.30	3.31	−2.14	−1.50	−1.16	−1.12	−2.09	−1.33	−1.07	−1.03	.74	.74	.70	.70
3	5.23	5.58	5.31	5.32	−1.79	−1.71	−1.22	−1.16	−1.11	−.98	−.71	−.67	.73	.78	.75	.76
4	6.51	6.81	6.73	6.76	−1.78	−1.50	−.84	−.78	−.86	−.68	−.38	−.35	.72	.76	.75	.75
6	8.67	8.99	9.12	9.13	.33	.38	1.30	1.36	.12	.13	.44	.46	.68	.71	.72	.72
8	10.12	10.68	11.03	11.02	3.20	3.37	4.46	4.52	1.00	.98	1.30	1.32	.68	.73	.75	.75
								Postsample								
1	1.34	2.90	2.63	2.60	.36	2.90	2.63	2.60	.63	6.00	5.31	5.32	.55	1.12	1.04	1.03
2	3.21	4.52	4.05	3.97	1.54	4.52	4.05	3.97	1.19	4.72	4.72	4.77	.73	1.01	.90	.88
3	4.94	5.56	4.92	4.83	2.82	5.56	4.92	4.83	1.50	3.71	3.56	3.56	.81	.97	.87	.86
4	5.94	6.59	5.86	5.75	2.99	6.18	5.49	5.40	1.27	3.06	2.89	2.88	.82	.97	.89	.87
6	7.04	6.97	6.45	6.35	1.97	5.46	4.93	4.83	.68	2.08	1.97	1.95	.77	.87	.81	.80
8	7.40	6.64	6.36	6.28	−1.43	1.90	1.70	1.61	−.47	.69	.65	.62	.64	.59	.57	.56
								Combined								
1	1.47	2.05	1.79	1.79	−.78	.64	.65	.65	−2.07	1.20	1.35	1.35	.65	.86	.79	.78
2	3.49	3.98	3.60	3.58	−.67	.91	.92	.91	−.76	.89	.99	.99	.74	.85	.78	.77
3	5.11	5.57	5.15	5.13	.05	1.20	1.24	1.23	.04	.83	.92	.93	.76	.85	.80	.80
4	6.28	6.72	6.38	6.35	.13	1.57	1.69	1.69	.08	.90	1.03	1.03	.75	.83	.79	.79
6	8.02	8.18	8.05	8.02	.98	2.41	2.75	2.75	.49	1.15	1.35	1.36	.71	.76	.74	.74
8	9.03	9.06	9.16	9.12	1.35	2.78	3.36	3.36	.59	1.22	1.47	1.48	.67	.69	.70	.70

H. Change in Business Inventories (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	3.08	2.95	2.90	2.86	−1.88	−.30	.93	.98	−1.69	−.30	.97	1.04	.96	.77	.76	.75
2	3.45	2.97	2.37	2.38	.24	−.06	.68	.60	.21	−.06	.82	.73	.74	.65	.55	.53
3	3.99	3.00	2.76	2.88	2.61	.47	.22	.09	2.27	.44	.22	.09	.79	.61	.57	.58
4	5.21	4.47	3.48	3.66	3.37	1.04	.07	−.06	2.02	.65	.05	−.05	.93	.77	.62	.62
6	6.73	6.91	5.32	5.41	3.37	2.81	.84	.74	1.21	.91	.32	.29	.80	.86	.71	.70
8	8.30	8.42	6.91	7.01	6.33	5.79	3.60	3.55	2.12	1.72	1.16	1.14	.75	.80	.69	.69
Postsample																
1	5.93	5.59	5.11	5.06	−.29	.98	1.24	1.17	−.09	.39	.58	.55	.64	.52	.45	.44
2	10.02	8.93	8.00	7.46	2.28	2.97	5.16	4.11	.54	.76	1.37	1.16	.71	.68	.70	.64
3	11.74	11.44	10.82	9.80	3.35	3.34	6.63	5.11	.64	.65	1.44	1.10	.79	.77	.76	.73
4	12.78	13.07	11.77	11.29	1.92	2.92	6.63	4.91	.34	.50	1.32	.93	.70	.73	.68	.68
6	10.94	10.54	7.99	9.59	−2.75	.71	5.05	3.36	−.63	.16	1.39	.75	.59	.60	.54	.61
8	10.30	8.03	4.99	5.35	−7.86	−4.60	.06	−1.28	−2.58	−1.42	.03	−.52	.63	.55	.36	.37
Combined																
1	4.22	4.01	3.78	3.74	−1.25	.21	1.05	1.05	−.91	.18	1.06	1.08	.69	.56	.50	.50
2	6.08	5.35	4.62	4.41	1.05	1.15	2.47	2.00	.60	.70	1.54	1.34	.72	.67	.68	.63
3	7.09	6.38	5.98	5.65	2.91	1.61	2.78	2.10	1.36	.77	1.40	1.07	.79	.75	.74	.72
4	8.23	7.91	6.80	6.71	2.79	1.79	2.69	1.93	1.17	.73	1.23	.86	.73	.73	.68	.67
6	8.41	8.36	6.39	7.08	.92	1.97	2.52	1.79	.38	.77	1.17	.77	.67	.70	.61	.64
8	9.10	8.27	6.14	6.34	.65	1.63	2.18	1.62	.25	.62	1.05	.76	.70	.70	.57	.57

Table 7.6 (continued)

I. Imports (Billions of $1972)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	2.04	1.98	1.94	2.00	−.90	−1.81	−1.85	−1.92	−1.38	−3.13	−3.20	−3.39	.60	.68	.69	.69
2	2.66	2.90	2.93	3.01	−1.83	−2.82	−2.93	−3.00	−2.38	−4.34	−4.60	−4.88	.65	.74	.75	.76
3	2.89	3.85	4.10	4.17	−1.74	−3.85	−4.10	−4.17	−2.00	−5.92	−6.54	−6.62	.65	.84	.88	.89
4	3.06	5.13	5.56	5.61	−2.24	−5.13	−5.56	−5.61	−2.44	−8.36	−9.33	−8.97	.59	.87	.92	.94
6	3.80	7.24	8.06	8.07	−3.80	−7.24	−8.06	−8.07	−5.04	−9.67	−10.46	−10.19	.53	.90	.99	1.00
8	4.96	8.92	9.51	9.46	−3.14	−7.31	−8.65	−8.60	−2.46	−4.20	−5.35	−5.32	.46	.81	.88	.88
								Postsample								
1	1.92	3.11	3.10	3.23	1.92	−.18	−.14	−.04	2.71	−.14	−.10	−.03	.66	.87	.86	.89
2	2.77	4.34	4.34	4.31	1.34	.05	.15	.19	1.08	.02	.08	.10	.49	.70	.70	.69
3	3.75	5.05	4.97	4.77	1.54	.38	.57	.55	.90	.17	.24	.24	.50	.64	.66	.64
4	4.06	5.14	5.01	4.80	1.28	.81	1.18	1.09	.71	.36	.51	.49	.43	.53	.55	.53
6	3.49	4.20	3.47	3.25	.45	.78	1.61	1.40	.31	.46	1.28	1.15	.28	.33	.27	.25
8	3.52	3.44	2.43	2.50	−2.93	−2.69	−1.29	−1.59	−2.37	−1.91	−1.22	−1.65	.30	.31	.21	.20
								Combined								
1	1.99	2.43	2.41	2.49	.23	−1.16	−1.17	−1.17	.40	−1.81	−1.82	−1.78	.63	.76	.76	.78
2	2.70	3.48	3.50	3.53	−.56	−1.67	−1.70	−1.73	−.75	−1.89	−1.91	−1.95	.56	.71	.72	.72
3	3.23	4.33	4.45	4.41	−.43	−2.16	−2.23	−2.28	−.47	−2.01	−2.02	−2.08	.55	.71	.73	.73
4	3.46	5.14	5.34	5.29	−.83	−2.76	−2.86	−2.93	−.86	−2.38	−2.35	−2.44	.49	.66	.69	.69
6	3.68	6.02	6.23	6.14	−2.10	−4.03	−4.19	−4.28	−2.45	−3.38	−3.29	−3.42	.39	.60	.64	.63
8	4.38	6.73	6.67	6.68	−3.06	−5.46	−5.71	−5.79	−3.43	−4.30	−4.31	−4.49	.38	.60	.63	.63

J. Personal Income—Percent Errors

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	.44	.21	.26	.27	−.41	−.06	−.15	−.16	−3.23	−.80	−1.70	−1.73	.23	.10	.13	.14
2	.74	.42	.46	.51	−.70	−.25	−.39	−.42	−3.02	−1.76	−2.69	−2.62	.22	.11	.13	.14
3	.93	.56	.78	.80	−.92	−.49	−.77	−.80	−3.38	−2.92	−4.37	−3.98	.18	.11	.14	.15
4	1.48	.79	1.23	1.26	−1.48	−.79	−1.23	−1.26	−5.39	−4.75	−6.91	−5.98	.18	.10	.14	.15
6	2.21	1.35	1.96	1.98	−2.21	−1.16	−1.96	−1.98	−9.37	−4.00	−7.95	−7.65	.17	.11	.15	.16
8	3.15	1.53	2.64	2.63	−3.15	−1.38	−2.64	−2.63	−13.18	−4.26	−10.36	−10.34	.18	.10	.15	.15
								Postsample								
1	1.99	.77	.83	.83	−1.99	−.45	−.56	−.55	−4.06	−1.48	−1.85	−1.81	1.02	.40	.42	.41
2	2.47	1.49	1.53	1.46	−2.45	−.50	−.61	−.66	−3.64	−.82	−1.05	−1.20	.66	.37	.36	.35
3	2.91	1.91	1.89	1.83	−2.90	−.71	−.77	−.86	−3.33	−.85	−1.05	−1.22	.55	.34	.31	.31
4	3.59	2.22	1.91	1.94	−3.59	−1.05	−.98	−1.09	−3.57	−1.07	−1.25	−1.43	.51	.32	.26	.26
6	5.57	2.85	2.30	2.40	−5.57	−2.65	−2.09	−2.23	−4.80	−2.29	−2.69	−2.95	.49	.31	.23	.23
8	8.25	4.81	3.58	3.72	−8.25	−4.81	−3.58	−3.72	−7.88	−4.52	−4.89	−5.27	.51	.32	.24	.24
								Combined								
1	1.06	.43	.49	.49	−1.04	−.22	−.31	−.31	−3.87	−1.63	−2.31	−2.32	.64	.25	.27	.27
2	1.44	.85	.89	.89	−1.40	−.35	−.48	−.52	−3.97	−1.40	−2.00	−2.20	.44	.24	.24	.24
3	1.72	1.10	1.22	1.21	−1.71	−.58	−.77	−.82	−3.97	−1.73	−2.57	−2.79	.37	.23	.22	.22
4	2.32	1.37	1.50	1.53	−2.32	−.90	−1.13	−1.19	−4.82	−2.30	−3.54	−3.74	.34	.21	.20	.20
6	3.55	1.95	2.09	2.14	−3.55	−1.75	−2.01	−2.08	−5.92	−3.48	−6.07	−6.31	.33	.21	.18	.19
8	5.19	2.84	3.02	3.07	−5.19	−2.75	−3.02	−3.07	−7.28	−4.63	−8.98	−9.22	.34	.21	.19	.19

Table 7.6 (continued)

K. Corporate Profits and IVA—Percent Errors

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				*t*-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	6.09	4.46	3.61	3.93	2.44	−.07	1.98	1.79	1.17	−.04	1.36	1.16	1.48	1.08	1.05	1.09
2	9.78	7.26	5.69	6.17	6.24	.43	2.26	2.00	1.94	.16	1.14	.94	1.62	1.13	.91	.96
3	13.39	10.97	8.21	8.91	8.13	1.58	2.89	2.62	1.75	.41	1.10	.93	1.78	1.30	.93	.99
4	17.73	15.46	12.04	12.88	12.40	3.81	4.93	4.71	1.98	.72	1.31	1.19	1.89	1.41	1.04	1.08
6	25.36	23.17	19.26	20.26	20.39	9.36	11.32	11.28	2.64	1.24	1.94	1.86	1.92	1.57	1.32	1.35
8	24.92	22.23	20.97	22.13	19.52	10.68	14.95	15.16	2.66	1.47	2.35	2.26	1.67	1.42	1.39	1.45
								Postsample								
1	14.59	7.02	7.36	7.22	9.54	−4.29	−2.92	−2.71	1.77	−1.41	−.89	−.84	1.76	.94	.94	.92
2	20.28	14.08	10.18	10.81	9.27	−3.75	1.08	.08	1.15	−.66	.24	.02	1.39	.93	.73	.80
3	24.09	19.62	12.76	13.81	4.85	−4.39	2.54	1.14	.50	−.57	.46	.18	1.16	.93	.66	.73
4	23.72	21.40	12.35	14.02	−.55	−7.07	1.85	.24	−.06	−.88	.35	.04	.96	.84	.52	.60
6	18.08	18.00	8.19	10.84	−13.01	−15.49	−1.79	−3.45	−2.23	−3.09	−.48	−.73	.65	.66	.32	.42
8	21.73	20.56	7.29	8.87	−21.73	−20.56	−3.17	−4.75	−7.28	−8.39	−1.16	−1.51	.64	.60	.22	.26
								Combined								
1	9.49	5.48	5.11	5.25	5.28	−1.75	.02	−.01	2.08	−1.11	.01	−.01	1.68	.98	.97	.97
2	13.98	9.99	7.48	8.02	7.45	−1.24	1.79	1.23	2.05	−.46	.85	.53	1.45	.98	.77	.84
3	17.67	14.43	10.03	10.87	6.81	−.81	2.75	2.03	1.47	−.22	1.04	.70	1.32	1.02	.73	.80
4	20.13	17.84	12.16	13.34	7.22	−.55	3.70	2.92	1.33	−.12	1.23	.88	1.27	1.02	.70	.76
6	22.45	21.10	14.83	16.49	7.03	−.58	6.08	5.39	1.11	−.10	1.52	1.24	1.20	1.03	.78	.83
8	23.65	21.56	15.50	16.83	3.02	−1.82	7.70	7.20	.47	−.32	1.75	1.53	1.05	.91	.76	.80

L. Gross National Product, Constant Dollars—Percent Change (Annual Rate)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	2.04	2.24	1.65	1.74	−.01	−.37	−.04	−.16	−.01	−.48	−.06	−.24	.41	.45	.34	.37
2	1.87	2.07	1.78	1.79	−.23	−.55	−.86	−.91	−.36	−.72	−1.27	−1.32	.40	.48	.45	.45
3	1.61	2.04	1.62	1.68	−.31	−.41	−1.01	−1.02	−.52	−.53	−1.64	−1.57	.37	.49	.43	.45
4	1.63	2.17	1.94	2.00	−.33	−.23	−.91	−.88	−.55	−.29	−1.30	−1.20	.38	.50	.46	.48
6	2.47	3.07	2.84	2.89	.98	1.47	.71	.77	.94	1.26	.62	.68	.63	.73	.67	.68
8	2.84	3.22	2.76	2.81	.83	1.51	.81	.88	.69	1.25	.71	.77	.67	.70	.63	.64
Postsample																
1	3.23	3.91	3.24	3.38	.74	1.18	.99	1.14	.49	.67	.64	.76	.67	.79	.69	.68
2	4.60	5.86	5.46	5.29	.00	1.63	2.32	1.88	.00	.66	1.09	.86	.90	1.00	.90	.89
3	5.06	5.67	4.76	4.70	−.86	.62	1.40	1.13	−.37	.25	.70	.55	.91	.94	.79	.81
4	4.90	5.05	4.14	4.23	−1.40	.01	1.09	.88	−.63	.00	.58	.46	.88	.86	.74	.75
6	4.35	3.86	3.56	3.58	−4.28	−3.00	−1.55	−1.61	−2.99	−2.04	−1.08	−1.11	.90	.78	.65	.66
8	3.37	2.79	2.10	2.11	−3.32	−2.44	−1.06	−1.05	−2.79	−2.23	−1.00	−1.01	.83	.68	.54	.53
Combined																
1	2.52	2.91	2.29	2.39	.29	.25	.37	.36	.40	.30	.53	.51	.53	.61	.51	.52
2	2.96	3.59	3.25	3.19	−.14	.32	.41	.21	−.14	.30	.42	.21	.70	.79	.72	.71
3	2.99	3.49	2.88	2.89	−.53	.00	−.05	−.16	−.55	.00	−.06	−.17	.71	.76	.64	.66
4	2.94	3.32	2.82	2.89	−.75	−.14	−.11	−.18	−.81	−.14	−.13	−.20	.68	.71	.62	.64
6	3.22	3.38	3.13	3.17	−1.12	−.32	−.20	−.18	−1.11	−.31	−.22	−.20	.76	.75	.66	.67
8	3.05	3.05	2.50	2.53	−.83	−.07	.06	.11	−.86	−.07	.08	.13	.73	.70	.60	.60

Table 7.6 (continued)

M. Implicit Price Deflator for GNP—Percent Change (Annual Rate)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	.99	.65	.71	.71	.15	−.07	.20	.20	.40	−.29	.87	.87	.21	.13	.14	.14
2	1.00	.43	.48	.48	−.39	−.16	−.02	−.04	−1.07	−1.15	−.12	−.21	.21	.08	.09	.09
3	.95	.69	.85	.84	−.02	−.48	−.32	−.33	−.04	−1.42	−.82	−.84	.22	.18	.20	.20
4	1.35	.94	1.00	.99	−.70	−.76	−.50	−.51	−1.29	−1.87	−1.10	−1.12	.26	.21	.21	.21
6	2.50	1.81	1.81	1.79	−2.13	−1.71	−1.27	−1.28	−2.67	−2.50	−1.77	−1.78	.40	.33	.31	.31
8	4.01	2.29	2.10	2.09	−3.90	−2.29	−1.77	−1.77	−5.05	−3.44	−2.58	−2.59	.52	.36	.32	.32
Postsample																
1	3.64	3.82	3.27	3.27	−2.93	−3.82	−3.27	−3.27	−2.99	−6.79	−6.35	−6.35	.41	.43	.37	.37
2	2.56	2.12	2.00	1.78	−2.56	−2.12	−1.48	−1.63	−3.71	−3.45	−2.02	−2.48	.34	.29	.26	.26
3	1.89	2.07	1.78	1.72	−1.86	−2.07	−1.46	−1.53	−2.39	−2.93	−1.85	−2.01	.33	.33	.30	.30
4	2.16	2.12	1.57	1.60	−2.16	−2.12	−1.53	−1.56	−2.64	−2.85	−1.89	−1.93	.40	.38	.35	.35
6	2.25	2.00	1.26	1.24	−2.25	−2.00	−1.26	−1.23	−6.23	−5.94	−3.47	−3.33	.44	.39	.28	.28
8	3.61	2.42	1.49	1.45	−3.61	−2.42	−1.49	−1.45	−15.56	−10.57	−4.92	−4.77	.66	.45	.30	.30
Combined																
1	2.05	1.92	1.73	1.74	−1.08	−1.57	−1.19	−1.19	−1.95	−3.18	−2.59	−2.59	.35	.35	.31	.31
2	1.62	1.11	1.09	1.00	−1.26	−.95	−.60	−.67	−3.00	−2.84	−1.77	−2.07	.30	.23	.21	.21
3	1.33	1.24	1.22	1.20	−.76	−1.11	−.78	−.81	−1.69	−2.93	−1.93	−2.04	.28	.27	.26	.26
4	1.67	1.41	1.23	1.24	−1.28	−1.31	−.91	−.93	−2.69	−3.24	−2.14	−2.18	.33	.29	.28	.28
6	2.40	1.88	1.59	1.57	−2.18	−1.82	−1.27	−1.26	−4.43	−4.30	−2.83	−2.83	.41	.34	.31	.31
8	3.85	2.34	1.86	1.84	−3.78	−2.34	−1.66	−1.64	−8.14	−5.81	−3.93	−3.91	.55	.38	.32	.32

N. Unemployment Rate (Percent)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	.32	.20	.17	.18	.26	.13	.09	.10	2.67	2.11	1.69	1.75	2.60	1.53	1.31	1.36
2	.59	.36	.27	.28	.52	.28	.22	.24	3.24	2.89	2.51	2.62	2.44	1.40	1.23	1.27
3	.87	.56	.50	.52	.81	.48	.44	.46	4.54	3.95	4.13	4.16	2.46	1.52	1.38	1.43
4	1.17	.74	.70	.72	1.16	.69	.70	.71	6.74	5.51	7.26	7.19	2.38	1.48	1.41	1.45
6	1.70	1.05	1.09	1.09	1.51	.78	.92	.93	5.32	2.96	4.43	4.68	1.35	.89	.87	.87
8	1.86	1.25	1.28	1.28	1.48	.61	.95	.94	3.65	1.66	3.03	3.10	1.01	.68	.71	.70
Postsample																
1	.46	.53	.53	.53	.00	.07	.12	.11	.01	.29	.52	.50	.73	.78	.77	.77
2	1.08	1.14	1.20	1.16	.05	−.01	.09	.12	.10	−.03	.18	.26	.84	.89	.91	.87
3	1.40	1.46	1.47	1.42	.14	−.07	.08	.14	.23	−.12	.13	.22	.83	.86	.86	.83
4	1.61	1.68	1.65	1.58	.23	−.09	.07	.14	.35	−.13	.11	.21	.77	.80	.78	.77
6	1.78	1.75	1.51	1.56	.98	.48	.57	.65	1.41	.67	.93	1.04	.87	.82	.72	.73
8	2.18	1.69	1.50	1.58	2.12	1.47	1.43	1.52	3.43	2.25	2.65	2.82	1.24	1.05	.94	.96
Combined																
1	.37	.33	.32	.32	.16	.11	.10	.11	1.48	1.09	1.12	1.13	.94	.84	.81	.82
2	.79	.67	.64	.63	.33	.16	.17	.19	1.59	.82	.87	1.02	1.02	.93	.93	.90
3	1.08	.92	.89	.88	.54	.26	.30	.33	2.05	1.00	1.19	1.35	1.01	.91	.90	.88
4	1.35	1.11	1.08	1.07	.79	.38	.45	.48	2.68	1.31	1.64	1.80	1.00	.87	.84	.84
6	1.73	1.33	1.26	1.28	1.29	.66	.78	.82	4.05	2.07	2.91	3.06	1.04	.84	.77	.78
8	1.99	1.43	1.37	1.40	1.74	.95	1.14	1.17	5.04	2.77	4.03	4.17	1.11	.86	.82	.82

Table 7.6 (continued)

O. Three-Month Treasury Bill Rate (Percent)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
								Within-Sample								
1	.56	.57	.60	.60	−.05	−.07	−.10	−.14	−.26	−.33	−.49	−.65	.71	.72	.76	.78
2	.63	.64	.67	.68	−.11	−.13	−.21	−.25	−.50	−.56	−.86	−1.05	.56	.58	.62	.63
3	.68	.71	.73	.73	−.13	−.14	−.27	−.32	−.52	−.54	−1.06	−1.24	.52	.53	.56	.58
4	.88	.90	.94	.95	−.01	−.01	−.19	−.23	−.02	−.02	−.56	−.68	.55	.56	.57	.58
6	1.03	1.07	1.11	1.16	.00	.06	−.20	−.23	.00	.14	−.53	−.60	.46	.48	.47	.49
8	1.04	1.06	1.09	1.17	−.08	.06	−.23	−.26	−.26	.19	−.69	−.72	.38	.40	.40	.43
								Postsample								
1	.71	.71	.85	.91	.43	.43	.57	.62	1.27	1.34	1.61	1.68	1.26	1.21	1.38	1.46
2	.92	.93	.97	1.00	.62	.70	.88	.91	1.67	1.90	2.40	2.42	.89	.92	1.00	1.03
3	.96	.95	1.12	1.15	.76	.90	1.12	1.15	2.09	2.54	3.61	3.52	.83	.88	.94	.97
4	.87	.98	1.15	1.14	.65	.86	1.11	1.12	2.00	2.63	3.84	3.77	.69	.79	.87	.89
6	1.10	1.29	1.33	1.30	.33	.69	1.03	1.02	.77	1.46	2.35	2.35	.63	.75	.81	.81
8	1.27	1.45	1.41	1.43	.08	.56	1.00	1.00	.15	.99	2.01	1.97	.69	.81	.85	.86
								Combined								
1	.62	.63	.70	.72	.14	.13	.16	.16	.76	.73	.82	.78	.92	.91	1.00	1.05
2	.74	.75	.79	.81	.18	.20	.23	.21	.86	.94	.97	.87	.71	.73	.79	.81
3	.79	.81	.89	.90	.23	.28	.29	.27	1.01	1.19	1.15	1.03	.65	.68	.72	.74
4	.88	.93	1.02	1.03	.26	.34	.33	.31	1.06	1.35	1.24	1.13	.60	.64	.67	.69
6	1.06	1.16	1.20	1.21	.13	.31	.29	.27	.48	1.04	.95	.86	.51	.56	.57	.59
8	1.13	1.22	1.22	1.27	−.02	.26	.26	.25	−.07	.87	.85	.77	.47	.53	.54	.56

P. Corporate Bonds Yield (Percent)

Quarters Ahead	Mean Absolute Percent Error				Mean Percent Error				t-(Mean Percent Error)				Theil U			
	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r	A^u	A^r	B^r	C^r
Within-Sample																
1	.18	.18	.19	.19	−.01	−.01	−.02	−.03	−.07	−.12	−.23	−.35	1.01	1.00	1.02	1.03
2	.17	.18	.19	.20	−.03	−.03	−.05	−.07	−.41	−.46	−.71	−.87	.86	.87	.91	.92
3	.18	.19	.21	.21	−.04	−.04	−.08	−.09	−.50	−.54	−1.00	−1.20	.65	.66	.70	.72
4	.23	.23	.26	.28	−.05	−.05	−.11	−.12	−.48	−.51	−1.06	−1.25	.52	.52	.55	.56
6	.26	.26	.32	.32	−.11	−.10	−.20	−.23	−1.04	−.94	−1.90	−2.14	.35	.35	.39	.41
8	.28	.30	.35	.36	−.12	−.08	−.24	−.27	−1.11	−.72	−2.06	−2.29	.31	.31	.36	.37
Postsample																
1	.25	.25	.26	.27	.10	.10	.13	.15	.79	.77	.97	1.05	1.05	1.07	1.14	1.18
2	.38	.39	.39	.39	.10	.12	.16	.17	.53	.62	.82	.87	.83	.85	.90	.90
3	.42	.42	.43	.43	.10	.14	.20	.22	.47	.63	.89	.95	.77	.79	.85	.84
4	.49	.52	.54	.53	.12	.18	.27	.28	.50	.72	1.02	1.08	.84	.88	.97	.96
6	.62	.68	.69	.68	.15	.28	.44	.45	.51	.90	1.36	1.43	1.05	1.14	1.25	1.23
8	.68	.77	.83	.82	.08	.30	.54	.55	.26	.87	1.55	1.63	1.22	1.38	1.52	1.50
Combined																
1	.20	.21	.21	.22	.04	.04	.04	.04	.56	.53	.61	.60	1.03	1.04	1.09	1.12
2	.26	.26	.27	.28	.02	.03	.03	.03	.25	.30	.35	.31	.84	.85	.90	.91
3	.28	.28	.30	.30	.02	.03	.04	.03	.20	.32	.34	.29	.74	.75	.81	.81
4	.33	.34	.37	.38	.02	.04	.05	.04	.18	.37	.37	.31	.70	.73	.79	.79
6	.40	.43	.47	.47	−.00	.05	.05	.04	−.03	.38	.35	.28	.62	.67	.73	.73
8	.44	.49	.54	.54	−.04	.07	.07	.06	−.29	.45	.41	.34	.57	.63	.70	.70

Notes

1. The model has since undergone substantial modification and enlargement. However, use of a pre-benchmark version of the model, rather than a more recent version containing structural improvements that derive from both improvements in knowledge or methodology and the benefit of additional hindsight, was necessary because it would be impossible to sort out the changes in specification that have occurred in response to data revisions—an element that is the subject of testing in this study.

2. The related question of how information concerning biases in preliminary relative to revised data can be used to improved predictive accuracy has been recently investigated by Howrey (1978).

3. Cole (1969) also evaluated ex ante business forecasts for the effects on accuracy of errors in unrevised data.

4. More precisely, equations for income components are adjusted by amounts such that on re-solving the model the excess discrepancy is eliminated.

5. Duggal, Klein, and McCarthy (1976) contains an explanation of this view as it pertains to the Wharton quarterly model.

6. A description of the definitional and classification revisions is found in Bureau of Economic Analysis (1976). This article also contains a summary table of the amounts of these revisions on an annual basis for several postwar years.

7. These series were interest paid by consumers to business, net interest paid by the federal government, net interest paid by state and local governments, corporate profits federal tax liability, corporate dividends, federal government transfer payments, and state and local government transfer payments.

8. For a description of this program and its theoretical basis, see McGeary (1977).

9. These series are personal consumption expenditures for automobiles, furniture and equipment, housing services, and other services.

10. Sixteen equations (included in the tabulation) had no NIPA series as either explanatory or dependent variables. The parameters of these equations were thus the same in all three models used in this study.

11. There are several reasons for the varying sample periods in the original model. The equations whose sample periods ended in 1972-IV had problems when the sample periods were extended. Equations whose sample periods extended through 1974-IV had been respecified and reestimated during the second half of 1975. The "other" equations had sample periods which began after 1955-I due to the unavailability of data in the early years.

12. The table is set up in terms of relative changes in the absolute values of parameters: e.g., a parameter which is estimated as -1.0 in model A and -1.1 in model B would be said to have increased 10%. Also, the table takes into account the fact that parameter increases are bounded by 0 and infinity, while decreases are bounded by 0 and minus 100%. The % decrease intervals were calculated by the formula

$$\left(\frac{1}{1+X} - 1 \right) * 100,$$

where X is the corresponding increase interval boundary (expressed in decimal form). Hence, e.g., the interval 0 to -4.8% corresponds to the positive interval 0 to 5.0%.

13. Cole also found that sets of considerably different coefficients are associated with the same long-run marginal propensity to consume (Cole 1969, pp. 75–77).

14. In the PCE for other durables equation, the wealth variable was dropped rather than the income variable. In the thrift institution deposits equation, it was necessary to substitute the 90-day Treasury bill rate for the commercial bank time deposit rate and to constrain the coefficient of this rate to be equal but of opposite sign to the savings and loan association deposit rate.

15. A more complete discussion of the methodology underlying the calculation of multipliers is found in Hirsch (1977).

16. Changes of $5 billion rather than $1 billion were used because of the nonconstancy of multipliers referred to above and because such amounts are more representative of realistic changes.

17. It was also used in a previous comparative study of predictive accuracy (Hirsch, Grimm, and Narasimham 1976).

18. In order to avoid accounting inconsistencies, aggregate real magnitudes and price deflators were derived by adding (or weighting) components rather than by direct application of scalar conversion factors to the aggregate measures.

19. For an extended discussion of alternate measures of forecast deterioration, see McNees (1975).

20. It should be noted that even the simulations beginning after the 1975-I trough yielded poor predictions, in part because the use of the mechanical formula (eq. [12]) led to much more negative constant adjustments than would judgmental adjustments, because the latter would have given less weight to the anomalous residuals of the recession period.

21. Using the Data Resources Inc. quarterly model, Eckstein (1978) estimates that the "energy crisis" contributed 1.7 percentage points to 1974's inflation rate and 1.9 percentage points to 1975's unemployment rate.

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Comment Saul H. Hymans

Let me begin by laying out the situation being confronted by Grimm and Hirsch. They have (1) an estimated macroeconometric model, the respected BEA model of the U.S. Department of Commerce; (2) the data used to estimate the model; and (3) a massive revision of the data, including the original sample period and subsequent years.

What interesting questions can be asked? The authors suggest that the following questions are of principal interest:

1. Is the model robust to the data revision? That is,
   a) Do the new—and presumably better—data lead to large revisions in estimated parameters and/or in specification?
   b) Do the new—and presumably better—data lead to large revisions in the estimated dynamic properties of the model?
2. Do the new—and presumably better—data lead to better within-sample forecasts?
   a) Through improvement in estimation of initial conditions even without reestimating the model, or
   b) only if the model is reestimated?
3. Question 2 repeated for postsample forecasts.

These do indeed seem to be the right questions to ask; but the more one thinks about the questions, the harder they are to answer. The simplest question would seem to be: Do parameter values change much? But how

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do we interpret "much"? Are we looking for a statistically significant change? Do we even know how to test for statistical significance in the situation at hand? And suppose statistical significance does not coincide with substantive significance? Do we care if two estimated price elasticities of $-2\frac{1}{2}$ and -3 are different at a 5% significance level, or even a .5% level? How much do we care about individual coefficients when regressors are not orthogonal? Suppose the old data suggest the following estimated dynamic consumption function:

$$(1) \qquad C = .5YD + .4C_{-1},$$

where C is consumption and YD is disposable income. Consider two alternative possibilities for the effects of data revision:

$$(2) \qquad C = .7YD + .4C_{-1},$$

$$(3) \qquad C = .7YD + .16C_{-1}.$$

There is an obvious sense in which (2) looks closer to (1) than (3) does. But we know that (2) would be rejected by the old data set whereas (3) might not be; that is, the estimated covariance matrix of coefficients would tell us to expect the coefficients of YD and C_{-1} to move in opposite directions. And indeed equations (1) and (3) have identical steady-state versions. The long-run multiplier properties of a stable linear model would be invariant to equations (1) and (3).

All of this suggests that the authors were correct in resisting the temptation to focus great attention on the matter of individual parameter stability. Indeed, if some parameters *do* change, *model* stability in at least some useful senses fairly requires that quite a few parameters change.

Studying the robustness of the model's multiplier properties strikes me as a far more fruitful venture, and the results displayed in tables 6.3 and 6.5 of the paper are really quite fascinating. It appears that the big story in the model revision is that sometime during the second year following a perturbation the reestimated model (model B) begins to develop a much stronger price-level response than the original model (model A). In the experiment in which unborrowed reserves are increased (table 3), higher inflation begins to slow down real growth in the economy of model B relative to that of model A. That seems fairly clear, and the authors make some effort to trace down the source of the extra price-level response in model B. A clue to where the extra inflation comes from is in the behavior of the unemployment rate. Despite smaller real growth in model B, the unemployment rate is at the same level as in model A. Thus, productivity behavior must be worse in model B, which leads eventually to a higher inflation rate. Note that the lower productivity growth which appears to exist in model B must be purely a data-revision phenomenon, since model B has the same terminal estimation date as model A—1974.4 at the latest.

What about forecasting performance? The first conclusion which seems clear from the reported results is that the within-sample forecasting properties of the BEA system are better than the postsample forecasting properties. This is never a surprising conclusion; it's even predicted by theory whenever forecasting accuracy is measured by mean squared error–type statistics. Further, for reasons well-documented by the authors, the post-1974 period is a particularly severe test of the system.

As to whether model A with unrevised initial conditions (A^u), or model A with revised initial conditions (A^r), or model B wins the horse race—the answer is that for within-sample forecasting there is no simple verdict: A^r is unambiguously the worst at forecasting real GNP within sample for any horizon, A^r is unambiguously best at forecasting the price level, A^u and B are about equally good or bad when A^r is either the best or the worst. The way I read the results, no reasonable aggregation would produce a significant ordering of the models—it's all in where and when you want to make your errors.

The forecasting results are quite different for the postsample case. What distinguishes between the models in postsample forecasting is the time horizon. For two-year-ahead forecasts, the results are absolutely unambiguous: B is the best, A^r is the second-best, and A^u is the worst. That conclusion is independent of whether one gauges the forecast on real GNP, the rate of growth of real GNP, the price level, or the unemployment rate, and whether the gauge is absolute error, bias, or Theil's U-statistic. The results are in the same direction for one-year-ahead forecasts, though the weight of the evidence is not nearly so overwhelming as in the two-year-ahead case, and for some measures of accuracy and some variables the rank-ordering of the models would differ. For forecasting over a short horizon, one to two quarters ahead, there is simply no defensible rank ordering of the models, much as in the within-sample analysis. To be honest, as a model builder, I find the results of these forecasting experiments to be encouraging.

Let me close with a criticism of what I find generally to be a solid and useful paper. I would like a more complete reporting and evaluation of the forecasting results. Error statistics are useful, but they can easily hide the richest information. The authors, for example, provide a very limited analysis of the question of which version of the model better traces a path that is qualitatively like the 1974–76 period. How about the matter of lead time and how well turning points are identified? Many important questions related to short-term dynamics could have been addressed and might well have provided more complete information regarding the value of an improved data base.