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### III

## Relative Accuracy of the Provisional Estimates

It was shown in the last Chapter that the revisions can be considered, at least in part, to be a measure of extrapolation error in the provisional estimates. This result suggests that the accuracy of other forecasts (or extrapolations) would be a relevant standard, or yardstick, by which to assess the accuracy of the provisional estimates.

The body of information on which forecasts draw is also available for use in preparing the advance and provisional estimates. This information falls roughly into two classes: data currently available but referring to the future, such as anticipations series, and data referring to the past. The latter set includes past values of the variable to be predicted and historical relationships between this variable and others. Such relationships may be suggested by theoretical considerations, or they may merely summarize a tendency for movements in a particular variable or combination of variables to lead and hence anticipate movements in the target variable. Forecasts may consist of only a combination of past values of the series (as do naive and autoregressive model projections) or they may rely on historical relationships with other variables.

The job of the forecaster, just as of the data compiler, is to combine all of the relevant information at hand into an accurate prediction of the true value,  $A$ , such that the sequence of forecasts ( $P$ ), advance ( $A_{00}$ ), provisional ( $A_0$ ), and revised estimates ( $A_j$ ) is a sequence of predictions each more accurate than the last. A minimum requirement, then, for the accuracy of the official estimates is that they should be more accurate than the best forecasts of  $A$ .

### *Provisional Estimates Compared with Forecasts*

Chart 1 shows the root mean square errors of a sequence of forecasts and estimates of annual levels of GNP and its major components covering the period 1953–62. The forecasts are averages from Zarnowitz' sample of several hundred forecasts.<sup>22</sup>

In the case of GNP, forecasts ( $P_1$ ) of the annual level in year  $T$  are made in July of year  $T - 1$  and revised in December ( $P_2$ ). Further revisions take place in July ( $P_3$ ) and December ( $P_4$ ) of year  $T$ . Strictly considered,  $P_3$  and  $P_4$  are no longer bona fide forecasts inasmuch as they contain information from year  $T$ . Provisional estimates of the value of GNP in the first quarter of year  $T$  are available for use in  $P_3$  so only the last three quarters need to be forecast. Similarly,  $P_4$  contains a forecast only of the fourth quarter. Advance estimates ( $A_{00}$ ) are published in January and provisional estimates ( $A_0$ ) in February of year  $T + 1$ . The estimates are further revised in July of years  $T + 1$ ,  $T + 2$ , and  $T + 3$  ( $A_1$ ,  $A_2$ , and  $A_3$  respectively.)

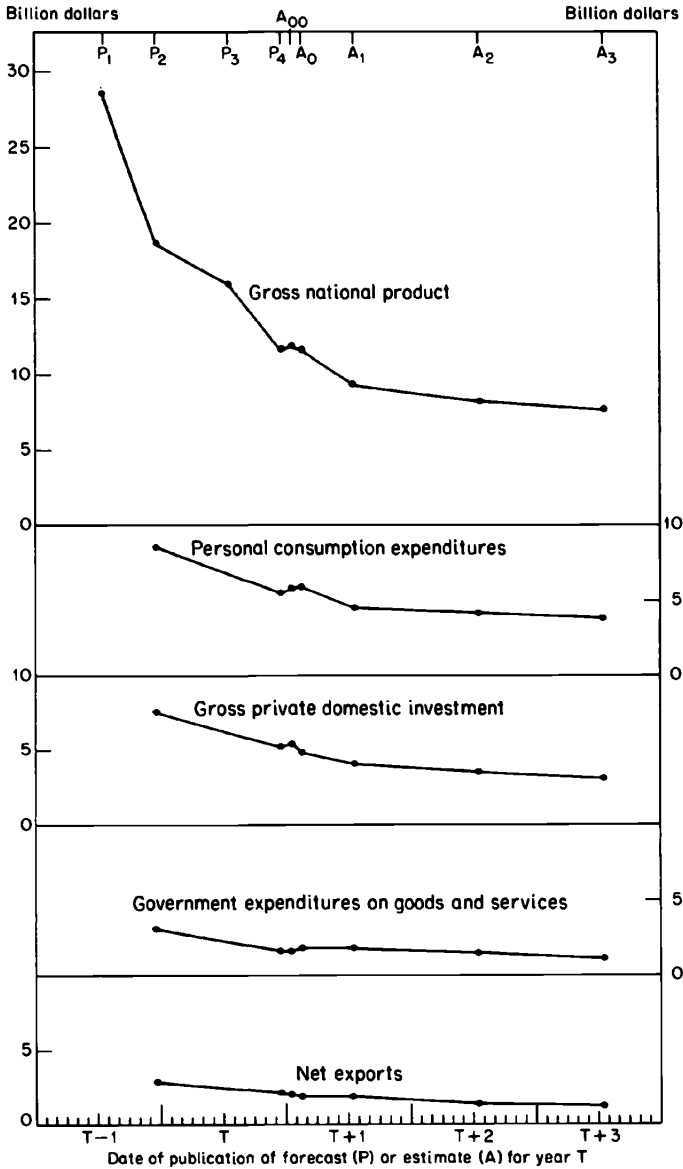
Zarnowitz' sample contains no forecasts of the major GNP components made at the same time as the GNP forecasts  $P_1$  and  $P_3$ . The first component forecasts (denoted as  $P_2$  only to indicate that they were prepared at the same time as the GNP forecasts  $P_2$ ) were made in December of year  $T - 1$  and revised one year later ( $P_4$ ).

Chart 1 not surprisingly shows that on the average the business forecasts are considerably less accurate than the official estimates of annual levels in GNP and its major components during the period 1953–62. But the chart also shows the advance ( $A_{00}$ ) and provisional estimates ( $A_0$ ) to be only about as accurate or, in some cases, slightly less accurate than forecasters' estimates of current levels ( $P_4$ ).

Table 5 gives error statistics for the forecasts and estimates shown in Chart 1. The mean errors for GNP and three of its four major components are negative, indicating that the forecasts as well as the official

<sup>22</sup> There are no official forecasts of GNP in the sense that no government agency publishes a series of GNP anticipations. Since the early sixties, however, forecasts of GNP for the coming year, prepared by the Council of Economic Advisers, have been published in the *Economic Report of the President*. These forecasts might be considered official, but their record is too short for use here.

CHART 1. Root Mean Square Errors of Successive Forecasts ( $P_j$ ) and Estimates ( $A_j$ ) of Gross National Product and Its Components, Annual Levels, 1953-62 <sup>a</sup>



<sup>a</sup> See Table 5, note a, for a description of the forecasts and estimates.

TABLE 5. Errors in Successive Forecasts and Estimates of Annual Levels of Gross National Product and Its Major Components, 1953-62<sup>a</sup>

Line	Code of Forecasts and Estimates of Value of Variable in Year $T^b$	Time Forecast or Estimate For Year $T$ Published	Mean Error (1)	Standard Deviation of Error (billion dollars) (2)	Mean Absolute Error (dollars) (3)	Root Mean Square Error (4)
<i>GROSS NATIONAL PRODUCT</i>						
1	$P_1$ : Average business forecast	July, $T - 1$	-23.7	16.9	23.7	28.6
2	$P_2$ : Revised forecast	Oct.-Dec., $T - 1$	-16.2	9.6	16.2	18.6
3	$P_3$ : Revised forecast	July, $T$	-14.0	8.2	14.0	16.0
4	$P_4$ : Revised forecast	Oct.-Dec., $T$	-10.6	5.1	10.7	11.6
5	$A_{00}$ : Advance estimates	Jan., $T + 1$	-11.0	4.6	11.0	11.9
6	$A_0$ : Provisional estimates	Feb., $T + 1$	-10.8	4.5	10.8	11.6
7	$A_1$ : First July revised estimates	July, $T + 1$	-8.9	3.0	8.9	9.3
8	$A_2$ : Second July revised estimates	July, $T + 2$	-7.8	2.7	7.8	8.3
9	$A_3$ : Third July revised estimates	July, $T + 3$	-7.3	2.4	7.3	7.7
<i>PERSONAL CONSUMPTION EXPENDITURES</i>						
10	$P_2$	Dec., $T - 1$	-7.5	4.5	7.5	8.6
11	$P_4$	Dec., $T$	-4.4	3.4	5.3	5.5
12	$A_{00}$	Jan., $T + 1$	-5.6	1.2	5.6	5.7
13	$A_0$	Feb., $T + 1$	-5.7	1.1	5.7	5.8
14	$A_1$	July, $T + 1$	-4.3	1.4	4.3	4.5
15	$A_2$	July, $T + 2$	-4.0	1.4	4.0	4.2
16	$A_3$	July, $T + 3$	-3.7	1.5	3.7	3.9
<i>GROSS PRIVATE DOMESTIC INVESTMENT</i>						
17	$P_2$	Dec., $T - 1$	-5.6	5.4	6.1	7.6
18	$P_4$	Dec., $T$	-4.4	3.0	4.6	5.3
19	$A_{00}$	Jan., $T + 1$	-4.3	3.2	4.9	5.3
20	$A_0$	Feb., $T + 1$	-4.1	2.8	4.4	4.9
21	$A_1$	July, $T + 1$	-3.7	1.7	3.7	4.1
22	$A_2$	July, $T + 2$	-3.2	1.7	3.2	3.6
23	$A_3$	July, $T + 3$	-3.0	0.8	3.0	3.1
<i>GOV'T. EXPENDITURES ON GOODS AND SERVICES</i>						
24	$P_2$	Dec., $T - 1$	1.6	2.8	2.4	3.1
25	$P_4$	Dec., $T$	0.9	1.3	1.3	1.6
26	$A_{00}$	Jan., $T + 1$	0.7	1.5	1.3	1.6
27	$A_0$	Feb., $T + 1$	0.8	1.7	1.4	1.8
28	$A_1$	July, $T + 1$	1.0	1.5	1.4	1.8
29	$A_2$	July, $T + 2$	0.8	1.4	1.1	1.5
30	$A_3$	July, $T + 3$	0.6	1.1	.9	1.2

TABLE 5. Errors in Successive Forecasts and Estimates of Annual Levels of Gross National Product and Its Major Components, 1953-62<sup>a</sup> (concluded)

Line	Code of Forecasts and Estimates of Value of Variable in Year $T^b$	Time Forecast or Estimate For Year $T$ Published	Mean Error (1)	Standard Deviation of Error (billion dollars) (2)	Mean Absolute Error (3)	Root Mean Square Error (4)
<i>NET EXPORTS</i>						
31	$P_2$	Dec., $T - 1$	-2.1	1.9	2.5	2.8
32	$P_4$	Dec., $T$	-1.8	1.0	1.8	2.1
33	$A_{00}$	Jan., $T + 1$	-1.9	0.6	1.9	2.0
34	$A_0$	Feb., $T + 1$	-1.8	0.7	1.8	1.9
35	$A_1$	July, $T + 1$	-1.8	0.6	1.8	1.9
36	$A_2$	July, $T + 2$	-1.0	1.1	1.4	1.4
37	$A_3$	July, $T + 3$	-0.8	0.9	1.2	1.2

<sup>a</sup>Forecasts and estimates are of current dollar GNP and components. Errors are computed as  $E_j = P_j - A_n$  for forecasts and  $\epsilon_j = A_j - A_n$  for the official estimates.

<sup>b</sup>The forecasts are from Zarnowitz' sample of business forecasts (see note 21 in text). The GNP forecasts  $P_2$  and  $P_4$  are averages based on the eight sets of forecasts, coded A through H and described in his Occasional Paper *Appraisal of Short-Term Forecasts*, Chapter 1, as well as a ninth set which was not available in time to be included in his paper.  $P_1$  and  $P_3$  are averages of two sets (G and the new set, coded I). The component forecasts are averages of two sets (B and F).

The advance estimates ( $A_{00}$ ) are taken from the *Economic Report of the President*. The provisional estimates ( $A_0$ ) are published in the *Survey of Current Business* in February of the following year. For example, provisional estimates of the values of GNP and its components in 1954 are from the February 1955 issue of *SCB*. The first July revised estimates ( $A_1$ ) are published in the following July issue of *SCB* (in the example, July 1955). Further annual July revisions ( $A_2$  and  $A_3$ ) are published in July issues of *SCB* for the next two years (July 1956 and 1957).

The 1965 major revision of the estimates is from the report article in the August 1965 *SCB*. The figures published are the result of both statistical and definitional revisions. The major definitional change was to exclude interest paid by consumers from the estimates (see the preliminary report article, "National Income and Product Estimates," Tables 2 and 3). This item is added to the published figures to obtain estimates of the statistically revised figures. The procedure does not entirely eliminate the definitional changes so the resulting series ( $A_n$ ) includes some minor definitional revisions.

estimates underestimated the annual levels of these variables. Government expenditures on goods and services were overestimated on the average.<sup>23</sup>

<sup>23</sup> As noted in footnote b of Table 5, definitional changes have not been entirely eliminated from the 1965 data. Consequently, the forecast and data errors reflect in addition to statistical error some minor definitional changes.

The 1965 definitional changes tended to lower the official estimates while the statistical revisions tend to raise them. As an average for the years 1953, 1957, 1958, and 1960, definitional changes lowered the figures for GNP by \$6.5 billions; personal consumption expenditures by \$6.6 billions; gross private domestic investment by \$.4 billion; and government expenditures on goods and services by \$.3 billion. The estimates of net exports were raised by \$.9 billion. (See the preli-

Even though they are slightly more efficient, the advance ( $A_{00}$ ) and provisional estimates ( $A_0$ ) are also slightly more biased than forecasters' estimates of the current levels ( $P_4$ ) of GNP, personal consumption expenditures, and net exports. The opposite is true of the errors in gross private domestic investment and government expenditures;  $P_4$  is slightly more efficient, but also more biased than  $A_{00}$  and  $A_0$ .

Although the differences in accuracy are small, the results are nevertheless surprising. One might have expected  $A_{00}$  and  $A_0$  to be consistently more accurate (i.e., less biased and more efficient) than  $P_4$ .<sup>24</sup>

The only differences among  $A_{00}$ ,  $A_0$ , and  $P_4$  occur in the estimates of the fourth quarter of year  $T$ . In other words, all three are averages of the values of the target variable in the four quarters of the year and the same figures for the first three quarters are used in each. Thus any differences in the accuracy of the three sets of annual estimates arise from errors in estimating the fourth quarter.

However, the accuracy of  $P_4$  is by no means an indication of typical forecasting accuracy.  $P_4$  is constructed as an average of many forecasters' estimates and, because of the possibility of offsetting errors, it may be considerably more accurate than typical forecasts.  $P_4$  might therefore be considered an unreasonably high, or unfair, standard of accuracy. For this reason, the quarterly data will be compared with a "typical" forecast.<sup>25</sup>

When all four quarters of the year are considered, the advance and provisional estimates compare very favorably with a *typical* forecast. The

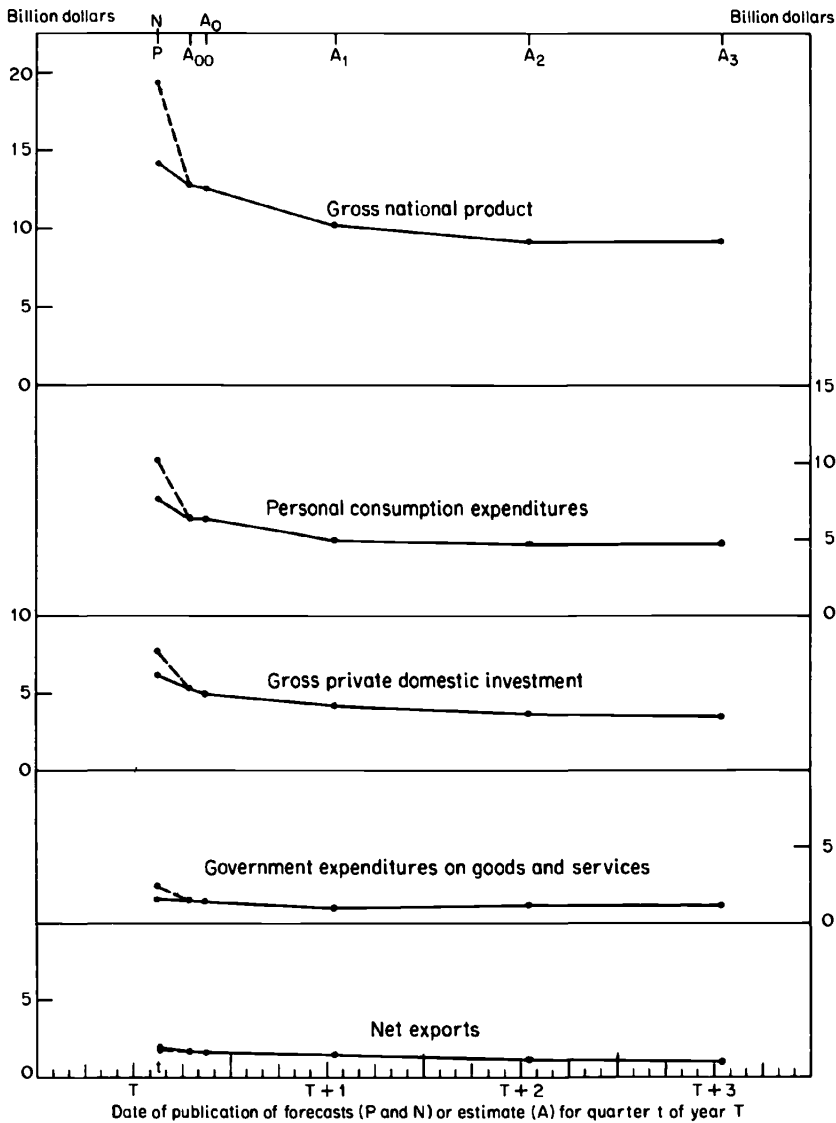
inary report article on the 1965 major revision, "National Income and Product Account", *SCB*, August 1965, Table 2.)

It was noted earlier that the major definitional change was to exclude interest paid by consumers from the product estimates. This item averaged \$5.7 billions for the years just mentioned. It was added to the estimates to obtain the series of 1965 statistically revised data. Somewhat under 15 per cent of the definitional changes, therefore, remain in the data used as "final" estimates.

<sup>24</sup> Other results are also contrary to this expectation. H. Theil finds over the same period, 1953-62, that the estimates of current annual changes in roughly half of the variables included in the Dutch official forecasts are more accurate than the Central Bureau of Statistics first (preliminary) figures (*Applied Economic Forecasting*, Chicago, 1966, pp. 140-150).

<sup>25</sup> Only one set of forecasts (Set C) in Zarnowitz' sample contains forecasts of GNP and its major components in quarterly units. The period covered by Chart 2 and Table 6 is therefore limited to the period for which these forecasts are available, 1957 IV-1962 IV. Comparisons of this set's annual forecasts with those of other sets justify its classification as "typical" (see Zarnowitz, *Appraisal of Short-Term Forecasts*, Chapter 7).

**CHART 2. Root Mean Square Errors of Naive Projections (*N*), Forecasts (*P*), and Successive Estimates (*A<sub>j</sub>*) of Quarterly Levels in Gross National Product and Its Major Components, 1957 IV–1962 IV <sup>a</sup>**



<sup>a</sup> See Table 6 and text for description of naive projections, forecasts, and estimates.



error statistics presented in Chart 2 and Table 6 suggest that a typical forecaster's estimates of current quarterly levels are considerably less accurate than the first official estimates of GNP, personal consumption expenditures, and gross private domestic investment. There is practically no difference, however, in the accuracy of the three estimates of government expenditures on goods and services and net exports.<sup>26</sup>

The root mean square error of a typical forecaster's estimates of current quarterly levels ( $P$ ) and of the official estimates ( $A_t$ ) of GNP and its major components for the period 1957 IV–1962 IV are plotted in Chart 2. Errors that would be made by naive model projections are also shown. The naive model ( $N$ ) projects the last known quarterly value; namely, the value for the preceding quarter as published two months following the end of that quarter.

These simple projections of no change would err by the amount of the change which in fact takes place from period  $t - 1$  to  $t + 1$ . To be of any value, a forecasting model should be able to predict the essential features of this change and the resulting new level of the series in period  $t$ . Consequently, predictions as well as the model generating them, could be considered worthless if their errors exceed those of the naive model  $N$ .

The statistics in Chart 2 and Table 6 show that the forecasters' estimates ( $P$ ) are more accurate than the naive projections ( $N$ ) and that the official estimates ( $A_{00}$  and  $A_0$ ) are in turn more accurate than  $P$  for GNP and all components save one. For this component, net exports, there is almost no difference between the accuracy of  $N$  and the three sets of estimates:  $P$ ,  $A_{00}$ , and  $A_0$ . In other words, neither the forecasts nor the official estimates give us very reliable current information on net exports.<sup>27</sup>

### *Provisional Estimates Compared with Extrapolations*

The preceding tables and charts cover only part of the period for which estimates of gross national product and its components have been pub-

<sup>26</sup> The errors shown for the forecasts as well as the official estimates of these components reflect definitional changes in addition to statistical error (see footnote 23). This does not, however, affect comparisons between forecast and data errors. Differences in the errors arise only from differences in statistical error; the element of error due to definitional changes is the same in each set of predictions.

<sup>27</sup> Zellner, *A Note on Provisional Estimates*, in his study covering the 1947 II–1955 IV period, found net exports, a component estimated as a residual, to be one of the least accurate.

TABLE 6. Errors in Forecasts, Naive Model Projections, and Successive Estimates of Quarterly Levels of Gross National Product and Its Major Components, 1957 IV-1962 IV<sup>a</sup>

Line	Code of Forecasts and Estimates <sup>b</sup>	Mean Error (1)	Standard Deviation of Error (billion dollars) (2)	Mean Absolute Error (3)	Root Mean Square Error (4)
<i>GROSS NATIONAL PRODUCT</i>					
1	<i>N</i> : Naive projection of last known level	-17.5	8.3	17.5	19.3
2	<i>P</i> : Typical business forecast	-12.8	6.4	12.8	14.2
3	<i>A</i> <sub>00</sub> : Advance estimates	-11.9	4.7	11.9	12.7
4	<i>A</i> <sub>0</sub> : Provisional estimates	-11.6	4.7	11.6	12.5
5	<i>A</i> <sub>1</sub> : First July revised estimates	-9.7	3.1	9.7	10.1
6	<i>A</i> <sub>2</sub> : Second July revised estimates	-8.9	2.4	8.9	9.2
7	<i>A</i> <sub>3</sub> : Third July revised estimates	-9.0	2.2	9.0	9.2
<i>PERSONAL CONSUMPTION EXPENDITURES</i>					
8	<i>N</i>	-9.8	2.9	9.8	10.2
9	<i>P</i>	-6.6	3.8	6.6	7.6
10	<i>A</i> <sub>00</sub>	-5.8	2.3	5.8	6.3
11	<i>A</i> <sub>0</sub>	-6.0	2.1	6.0	6.3
12	<i>A</i> <sub>1</sub>	-4.5	1.9	4.5	4.9
13	<i>A</i> <sub>2</sub>	-4.4	1.6	4.4	4.7
14	<i>A</i> <sub>3</sub>	-4.5	1.4	4.5	4.7
<i>GROSS PRIVATE DOMESTIC INVESTMENT</i>					
15	<i>N</i>	-4.7	6.3	6.7	7.7
16	<i>P</i>	-4.5	4.2	4.8	6.1
17	<i>A</i> <sub>00</sub>	-4.6	2.7	4.6	5.3
18	<i>A</i> <sub>0</sub>	-4.2	2.6	4.2	4.9
19	<i>A</i> <sub>1</sub>	-3.7	2.0	3.7	4.2
20	<i>A</i> <sub>2</sub>	-3.3	1.6	3.3	3.7
21	<i>A</i> <sub>3</sub>	-3.3	1.1	3.3	3.5
<i>GOV'T. EXPENDITURES ON GOODS AND SERVICES</i>					
22	<i>N</i>	-1.6	1.8	2.0	2.4
23	<i>P</i>	-0.1	1.6	1.3	1.6
24	<i>A</i> <sub>00</sub>	0.1	1.5	1.2	1.5
25	<i>A</i> <sub>0</sub>	0.0	1.5	1.2	1.4
26	<i>A</i> <sub>1</sub>	-0.1	1.0	0.9	1.0
27	<i>A</i> <sub>2</sub>	-0.3	1.1	0.7	1.1
28	<i>A</i> <sub>3</sub>	-0.3	1.0	0.7	1.1

TABLE 6. (concluded)

Line	Code of Forecasts and Estimates <sup>b</sup>	Mean Error (1)	Standard Deviation of Error (billion dollars) (2)	Mean Absolute Error (3)	Root Mean Square Error (4)
<i>NET EXPORTS</i>					
29	<i>N</i>	-1.5	1.0	1.5	1.8
30	<i>P</i>	-1.6	1.1	1.7	1.9
31	<i>A</i> <sub>00</sub>	-1.5	0.8	1.5	1.7
32	<i>A</i> <sub>0</sub>	-1.5	0.6	1.5	1.6
33	<i>A</i> <sub>1</sub>	-1.3	0.5	1.3	1.4
34	<i>A</i> <sub>2</sub>	-1.1	0.2	1.1	1.1
35	<i>A</i> <sub>3</sub>	-1.0	0.2	1.0	1.0

NOTE: Forecast and estimates refer to quarter *t* of year *T*.

Forecast of Estimate	Date of Publication
<i>N</i>	Second month of <i>t</i>
<i>P</i>	First to third month of <i>t</i>
<i>A</i> <sub>00</sub>	First month of <i>t</i> + 1
<i>A</i> <sub>0</sub>	Second month of <i>t</i> + 1
<i>A</i> <sub>1</sub>	July, <i>T</i> + 1
<i>A</i> <sub>2</sub>	July, <i>T</i> + 2
<i>A</i> <sub>3</sub>	July, <i>T</i> + 3

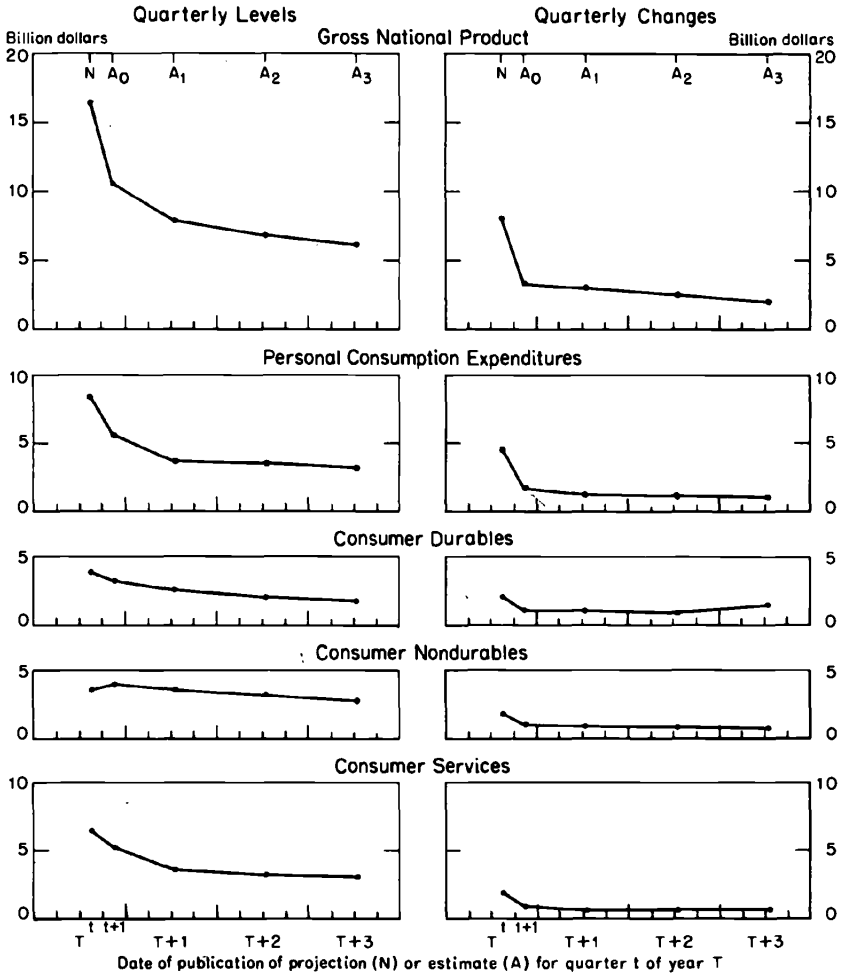
<sup>a</sup>Variables are in current dollars, seasonally adjusted, at annual rates. Errors are computed as  $E = P - A_n$  for forecasts and  $\epsilon_j = A_j - A_n$  for the official estimates.

<sup>b</sup>The forecasts are from Zarnowitz' sample, set C. The advance estimates (*A*<sub>00</sub>) are from *Economic Indicators* one month following the close of the quarter covered. Provisional estimates (*A*<sub>0</sub>) are from the *Survey of Current Business* two months following the close of each quarter and the first July revised estimates (*A*<sub>1</sub>) are from the following July issue of *SCB*. The second July revised estimates (*A*<sub>2</sub>) are published one year later and the third July revised estimates (*A*<sub>3</sub>) are published the year thereafter (see Table 1, note b).

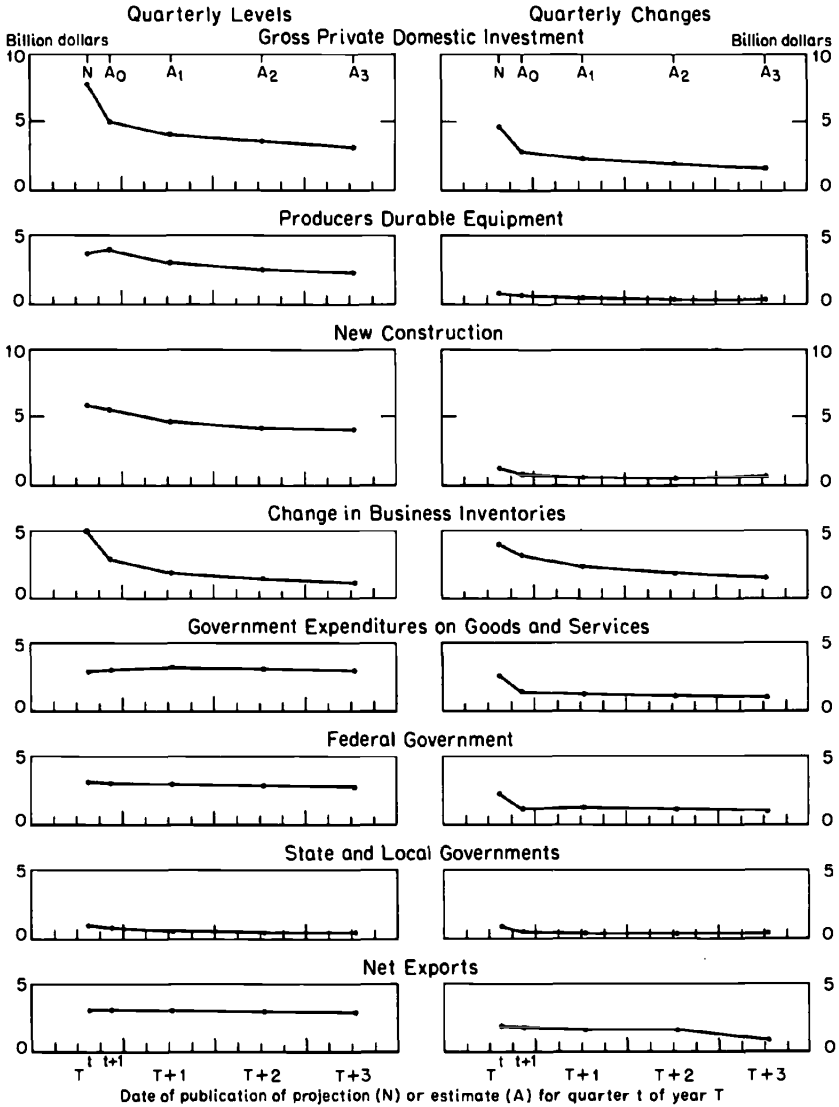
lished on a current basis. Errors in successive estimates over the longer period 1947 II–1961 IV are summarized in Chart 3. The errors refer to estimates of both quarterly levels and of quarterly changes. The record of none of the forecasts in Zarnowitz' sample matches this period; therefore, errors in the official estimates are compared with those in naive projections of the last known quarter, or projections of "no change" (*N*).

Though they are widely used, the naive projections (*N*) provide only a minimum benchmark or standard of accuracy. The provisional data,

CHART 3. Root Mean Square Errors of Naive Projections (*N*) and Successive Estimates (*A<sub>j</sub>*) of Quarterly Levels and Changes in Gross National Product and Its Components, 1947 II–1961 IV <sup>a</sup>



<sup>a</sup> See Table 7 and text for description of projections and estimates.



to be useful in analyzing current business conditions, should not only be more accurate than simple projections of no change; they should also accurately reflect the systematic changes in the series.<sup>28</sup> Errors in each of the sequence of estimates of GNP and its components are therefore compared both with the errors of  $N$  and with the errors of unbiased and efficient extrapolations,  $X$ , in Table 7 (columns 4–5 and 9–10).<sup>29</sup>

<sup>28</sup> A similar requirement for the accuracy of preliminary statistics is suggested by Geoffrey Moore and Julius Shiskin in *Indications of Business Expansions and Contractions*, NBER Occasional Paper 103, New York, 1967, Chapter 2, p. 17, footnote 6.

They suggest that preliminary statistics could be considered acceptable if the underlying trend of the series (the trend-cycle component) would not be altered by subsequent revisions (i.e., if the errors are merely random.)

<sup>29</sup> The root mean square errors of unbiased and efficient extrapolations,  $X$ , are computed for Table 7 as

$$\sqrt{M_X} = \sqrt{(1 - r_{A_n A_{0-t-1}}^2) S_{A_n}^2}$$

rather than

$$\sqrt{M_X} = \sqrt{(1 - r_{A_n A_{n-1}}^2) S_{A_n}^2}$$

as they were in Table 1.

The use of  $A_{0-t-1}$  rather than  $A_{n-t-1}$ , however, takes only partial account of the fact that final data would not be available to use in projections of the value of  $A$  in period  $t$ . As a consequence, the error statistic  $\sqrt{M_X}$  that is used in Table 7 would be too small and would provide too severe a standard of accuracy. If, however, the true autoregressive structure were of an order higher than the first,  $\sqrt{M_X}$  would be too high.

It is unlikely, however, that the magnitude of the upward bias is sufficient to offset the downward bias. (Mincer and Zarnowitz find relatively small differences in the accuracy of extrapolations based on first order regressions and those based on higher order regressions—see “The Evaluation of Economic Forecasts,” in Mincer, *Economic Forecasts and Expectations*, pp. 3–46.)

It would, of course, have been preferable to generate a series of extrapolations of the value of  $A$  in period  $t$ , each based on the history of  $A$  as it is known in period  $t-1$ . That is, each extrapolation ( $X_t$ ) would be computed as

$$X_t = a_0 + a_1 A_{0-t-1},$$

where  $a_0$  and  $a_1$  are coefficients estimated from the regression,

$$A_{0-t-1} = a_0 + a_1 A_{0-t-2} + u_{t-1},$$

for the period 1947 I to the current quarter  $t-1$ .

A series of such extrapolations would require a succession of estimation, projection, and re-estimation for each quarter of the 1947–61 period and for each of the variables reviewed. While there is no denying that such a procedure would have yielded more appropriate standards of accuracy for the provisional estimates, the costs of obtaining them, in terms of the enormous amount of computations involved, were deemed too great for the purposes of this study.

TABLE 7. Errors in Naive Model Projections and Successive Estimates of Quarterly Levels and Changes in Gross National Product and Its Components, 1947 II-1961 IV  
(billion dollars)

Line Estimate <sup>a</sup>	Code of Estimate <sup>a</sup>	QUARTERLY LEVELS				QUARTERLY CHANGES <sup>b</sup>				
		Mean Error (1)	Standard Deviation of Error (2)	Root Mean Square Error (3)	Relative Root Mean Square Error <sup>c</sup> $RM_N$ (4)	Mean Error (6)	Standard Deviation of Error (7)	Root Mean Square Error (8)	Relative Root Mean Square Error <sup>c</sup> $RM_N$ (9)	$RM_X$ (10)
<i>GROSS NATIONAL PRODUCT</i>										
1	N	-13.6	9.0	16.4		-5.5	6.1	8.1		
2	A <sub>0</sub>	-8.9	5.6	10.5	.640	1.221	3.2	3.2	.395	.571
3	A <sub>1</sub>	-6.1	4.8	7.7	.470	.895	2.9	2.9	.358	.518
4	A <sub>2</sub>	-5.3	4.2	6.7	.408	.779	2.4	2.4	.296	.428
5	A <sub>3</sub>	-5.0	3.6	6.1	.372	.709	2.0	2.0	.247	.357
<i>PERSONAL CONSUMPTION EXPENDITURES</i>										
6	N	-7.0	4.8	8.4		-3.3	3.0	4.5		
7	A <sub>0</sub>	-4.4	3.3	5.5	.655	1.341	1.4	1.6	.356	.533
8	A <sub>1</sub>	-2.1	2.8	3.5	.417	.854	1.2	1.2	.267	.400
9	A <sub>2</sub>	-1.7	3.0	3.4	.405	.829	1.1	1.1	.244	.367
10	A <sub>3</sub>	-1.5	2.7	3.1	.369	.756	1.0	1.0	.222	.333
<i>CONSUMER DURABLES</i>										
11	N	-2.9	2.4	3.8		-0.5	1.9	2.0		
12	A <sub>0</sub>	-2.6	1.8	3.2	.842	1.333	1.0	1.0	.500	.526
13	A <sub>1</sub>	-1.7	1.8	2.5	.658	1.042	1.0	1.0	.500	.526
14	A <sub>2</sub>	-1.3	1.5	2.0	.625	.833	0.9	0.9	.450	.474
15	A <sub>3</sub>	-1.1	1.4	1.7	.531	.708	1.1	1.1	.550	.579

TABLE 7. (continued)

Line	Code of Estimate <sup>a</sup>	QUARTERLY LEVELS					QUARTERLY CHANGES <sup>b</sup>				
		Mean Error (1)	Standard Deviation of Error (2)	Root Mean Square Error (3)	Relative Root Mean Square Error <sup>c</sup>		Mean Error (6)	Standard Deviation of Error (7)	Root Mean Square Error (8)	Relative Root Mean Square Error <sup>c</sup>	
					$RM_N$ (4)	$RM_X$ (5)				$RM_N$ (9)	$RM_X$ (10)
<b>CONSUMER NONDURABLES</b>											
16	N	2.3	2.8	3.6							
17	A <sub>0</sub>	3.3	2.3	4.0	1.111	1.739	-1.2	1.4	1.8	.556	.714
18	A <sub>1</sub>	3.1	2.0	3.6	1.000	1.565	0.0	0.9	0.9	.500	.643
19	A <sub>2</sub>	2.6	1.8	3.2	.889	1.391	-0.0	0.8	0.8	.444	.571
20	A <sub>3</sub>	2.3	1.7	2.8	.778	1.217	-0.1	0.7	0.7	.389	.500
<b>CONSUMER SERVICES</b>											
21	N	-6.4	1.4	6.5			-1.6	0.7	1.8	.444	1.143
22	A <sub>0</sub>	-5.1	1.4	5.3	.815	2.650	-0.3	0.7	0.8	.333	.857
23	A <sub>1</sub>	-3.5	0.8	3.6	.554	1.800	-0.2	0.6	0.6	.333	.857
24	A <sub>2</sub>	-3.0	1.2	3.2	.492	1.600	-0.1	0.6	0.6	.333	.857
25	A <sub>3</sub>	-2.7	1.4	3.0	.462	1.500	-0.0	0.6	0.6	.333	.857
<b>GROSS PRIVATE DOMESTIC INVESTMENT</b>											
26	N	-4.3	6.5	7.8			-0.8	4.7	4.7	.574	.574
27	A <sub>0</sub>	-3.4	3.5	4.9	.628	.778	0.0	2.7	2.7	.489	.489
28	A <sub>1</sub>	-3.1	2.5	4.0	.513	.635	-0.1	2.3	2.3	.404	.404
29	A <sub>2</sub>	-2.8	2.0	3.5	.449	.556	0.1	1.9	1.9	.340	.340
30	A <sub>3</sub>	-2.8	1.3	3.1	.397	.492	0.0	1.6	1.6	.340	.340



TABLE 7. (continued)

Line Estimate <sup>a</sup>	Code of Estimate <sup>a</sup>	QUARTERLY LEVELS					QUARTERLY CHANGES <sup>b</sup>						
		Mean Error (1)	Standard Deviation of Error (2)	Root Mean Square Error (3)	Relative Root Mean Square Error <sup>c</sup>	RM <sub>N</sub> (4)	RM <sub>X</sub> (5)	Mean Error (6)	Standard Deviation of Error (7)	Root Mean Square Error (8)	Relative Root Mean Square Error <sup>c</sup>	RM <sub>N</sub> (9)	RM <sub>X</sub> (10)
<i>PRODUCERS' DURABLE EQUIPMENT</i>													
31	N	1.6	3.4	3.7			-0.2	1.1	1.1				
32	A <sub>0</sub>	2.2	3.2	3.9	1.054	1.147	0.3	0.9	0.9		.818	.818	
33	A <sub>1</sub>	1.0	2.8	2.9	.784	.853	0.0	0.7	0.7		.636	.636	
34	A <sub>2</sub>	0.7	2.4	2.5	.676	.735	-0.0	0.6	0.6		.545	.545	
35	A <sub>3</sub>	0.6	2.2	2.3	.622	.676	-0.0	0.6	0.6		.545	.545	
<i>NEW CONSTRUCTION</i>													
36	N	-5.1	2.9	5.8			-0.4	1.1	1.2				
37	A <sub>0</sub>	-4.8	2.8	5.5	.948	2.115	-0.1	0.7	0.7		.583	.700	
38	A <sub>1</sub>	-3.9	2.3	4.6	.793	1.769	0.0	0.6	0.6		.500	.600	
39	A <sub>2</sub>	-3.6	2.0	4.2	.724	1.615	0.1	0.5	0.5		.417	.500	
40	A <sub>3</sub>	-3.5	1.9	4.0	.690	1.538	0.1	0.6	0.6		.500	.600	
<i>CHANGE IN BUSINESS INVENTORIES</i>													
41	N	-0.7	5.0	5.0			-0.1	3.9	3.9				
42	A <sub>0</sub>	-0.8	2.7	2.8	.560	.667	-0.2	3.1	3.1		.795	.795	
43	A <sub>1</sub>	-0.3	1.8	1.8	.360	.428	-0.1	2.3	2.3		.590	.590	
44	A <sub>2</sub>	0.0	1.4	1.4	.280	.333	0.0	1.9	1.8		.462	.462	
45	A <sub>3</sub>	0.1	1.1	1.1	.220	.262	0.0	1.5	1.5		.385	.385	

TABLE 7. (continued)

Line	Code of Estimate <sup>a</sup>	QUARTERLY LEVELS					QUARTERLY CHANGES <sup>b</sup>				
		Mean Error (1)	Standard Deviation of Error (2)	Root Mean Square Error (3)	Relative Root Mean Square Error <sup>c</sup>		Mean Error (6)	Standard Deviation of Error (7)	Root Mean Square Error (8)	Relative Root Mean Square Error <sup>c</sup>	
					$RM_N$ (4)	$RM_X$ (5)				$RM_N$ (9)	$RM_X$ (10)
<i>GOVERNMENT EXPENDITURES ON GOODS AND SERVICES</i>											
46	N	0.7	2.2	2.9							
47	A <sub>0</sub>	2.1	2.2	3.0	1.034	1.154	-1.5	2.2	2.6	.500	.867
48	A <sub>1</sub>	2.3	2.2	3.2	1.103	1.231	-0.1	1.3	1.3	.462	.800
49	A <sub>2</sub>	2.3	2.1	3.1	1.069	1.192	-0.0	1.2	1.2	.423	.733
50	A <sub>3</sub>	2.2	2.1	3.0	1.034	1.154	-0.0	1.1	1.1	.385	.667
<i>FEDERAL GOVERNMENT</i>											
51	N	1.3	2.8	3.1			-0.8	2.2	2.3		
52	A <sub>0</sub>	2.0	2.2	3.0	.968	1.154	-0.1	1.1	1.1	.478	.786
53	A <sub>1</sub>	2.0	2.1	2.9	.935	1.115	-0.0	1.2	1.2	.522	.857
54	A <sub>2</sub>	1.9	2.0	2.8	.903	1.077	-0.0	1.1	1.1	.478	.786
55	A <sub>3</sub>	1.8	2.0	2.7	.871	1.038	-0.0	1.0	1.0	.437	.714
<i>STATE AND LOCAL GOVERNMENTS</i>											
56	N	-0.5	0.7	0.9			-0.7	0.4	0.8		
57	A <sub>0</sub>	0.1	0.7	0.7	.778	1.000	-0.0	0.4	0.4	.500	1.000
58	A <sub>1</sub>	0.3	0.4	0.5	.556	.714	-0.0	0.3	0.3	.375	.750
59	A <sub>2</sub>	0.4	0.2	0.4	.444	.571	0.0	0.3	0.3	.375	.750
60	A <sub>3</sub>	0.3	0.2	0.4	.444	.571	0.0	0.3	0.3	.375	.750

TABLE 7. (concluded)

Line Estimate <sup>a</sup>	QUARTERLY LEVELS				QUARTERLY CHANGES <sup>b</sup>					
	Code of Estimate	Mean Error (1)	Standard Deviation of Error (2)	Root Mean Square Error (3)	Relative Root Mean Square Error <sup>c</sup> $RM_N$ (4)	Mean Error (6)	Standard Deviation of Error (7)	Root Mean Square Error (8)	Relative Root Mean Square Error <sup>c</sup> $RM_X$ (9)	$RM_X$ (10)
61	N	-2.7	1.6	3.1						
62	A <sub>0</sub>	-2.6	1.6	3.1	1.000	-0.1	1.9	1.8	.944	1.700
63	A <sub>1</sub>	-2.6	1.4	3.0	.968	-0.2	1.6	1.6	.889	1.600
64	A <sub>2</sub>	-2.5	1.5	2.9	.935	-0.2	1.6	1.6	.889	1.600
65	A <sub>3</sub>	-2.4	1.5	2.8	.903	-0.0	0.8	0.8	.444	.800

NET EXPORTS

<sup>a</sup>Estimates refer to quarter t of year T. The date of publication and notation is:

- Date Published
- Second month of t      N: Naive projection of last known quarterly level ( $A_{0,t}$ )
- Second month of t + 1      A<sub>0</sub>: Provisional estimates
- July, T + 1      A<sub>1</sub>: First July revised estimates
- July, T + 2      A<sub>2</sub>: Second July revised estimates
- July, T + 3      A<sub>3</sub>: Third July revised estimates

<sup>b</sup>The first estimates of quarter-to-quarter change are not simply the change in the provisional estimates of levels,  $A_{0,t} - A_{0,t-1}$ . In some cases  $A_{0,t-1}$  has been revised by the time the estimate of  $A_{0,t}$  is made. For example, the first estimates of change from the first

to second quarter of a year would be  $A_{0,t} - A_{1,t-1}$ . These current basis revisions were discontinued in 1954 because they were so often offset by the first July revisions. The changes used here are the estimates of change and not the change in a given set of level estimates ( $A_{j,t} - A_{j,t-1}$ ).

<sup>c</sup>Relative root mean square roots  $RM_N$  and  $RM_X$  are  $RM_N = \sqrt{M_j} / \sqrt{M_N}$  and  $RM_X = \sqrt{M_j} / \sqrt{M_X}$ ; where  $\sqrt{M_j}$  is the root mean square error of each set of official estimates ( $j = 0, \dots, 3$ ),  $\sqrt{M_N}$  is the root mean square of naive projections, and  $\sqrt{M_X}$  is the root mean square error of unbiased and efficient extrapolations.

$$\sqrt{M_X} \text{ is computed } \sqrt{M_X} = \sqrt{(1 - r_{A_{0,t}, A_{0,t-1}}^2) S_{A_{0,t}}^2}$$

The provisional estimates of quarterly levels are on the whole superior to  $N$ , but their errors exceed those of  $X$  (compare the initial entries in columns 4 and 5 in Table 7). The early data on quarterly changes, however, are substantially more accurate. The errors in levels exceed those in changes in all four major sectors, as well as in all but one of the detailed components. This is true both in terms of the absolute errors (compare the statistics in columns 1–3 with those in columns 6–8, respectively) and in terms of the relative errors (columns 4–5 compared with columns 9–10, respectively). The only exception is in estimates of the change in business inventories.

Although there is considerable bias in the initial estimates of quarterly levels, it appears to be very small in the change estimates.<sup>30</sup> Even so, the bias in the provisional estimates of quarterly changes in expenditures on producers' durable equipment, the change in business inventories, and net exports is greater than that in naive projections of "no change" (column 6).

The early figures are more efficient than naive projections for GNP and most of the components, but there are some exceptions. For example, the first estimates of consumer services (quarterly levels and changes), new construction (levels), and net exports (levels), as well as state and local government expenditures on goods and services (levels and changes) are only about as efficient as  $N$ .

To sum up, errors in the provisional estimates of quarterly changes in GNP and its components are on the average about 60 per cent as large as the errors in naive projections of no change ( $N$ ) and about 90 per cent as large as the errors in unbiased and efficient extrapolations ( $X$ ). Thus, one would have been about 10 per cent more accurate using the early quarterly change data than in relying on very accurate extrapolations ( $X$ ).

The early data for levels are less accurate. We have seen that the provisional estimates were not much more accurate than an average of forecasters' estimates of current annual levels during the 1953–62 period,

<sup>30</sup> The fact that the revisions affect levels considerably more than changes is the reason why errors in absolute rather than in percentage changes are used in Table 7. If, for example, the initial estimate of change were from 100 in quarter  $t - 1$  to 105 in quarter  $t$  and the revised estimate, from 105 in quarter  $t - 1$  to 110 in quarter  $t$ , the change in both sets of estimates, in absolute terms, is 5. In percentage terms, however, the initial estimate of a 5 per cent change would appear to overestimate the revised change of 4.8 per cent.

even though the forecasts are published three to four months earlier than the official figures. Comparisons with typical forecasts of quarterly data are more favorable. The provisional estimates were roughly 15 per cent more accurate than a typical forecaster's estimates of current quarterly levels for 1957 IV–1962 IV. Over the longer period 1947 II–1961 IV, however, errors in the early level data were on the whole larger than the errors in unbiased and efficient extrapolations.