13 Sensitivity of the Forecasting Results to Errors Made in Forecasting the Exogenous Variables

13.1 Introduction

The outside-sample forecasts presented in Chapter 12 cannot be considered to be forecasts that could have been generated *ex ante*, since the actual values of the exogenous variables were used. The purpose of this chapter is to examine how sensitive the results of the model are to errors made in forecasting the exogenous variables. The procedure that was used to examine this sensitivity is discussed in Section 13.2, and the forecasts are examined in Section 13.3. The forecasts in Section 13.3 are close to being forecasts that could have been generated *ex ante*. This chapter concludes with an examination in Section 13.4 of the accuracy of the model with respect to making annual forecasts.

13.2 Forecasting the Exogenous Variables

The Variability of the Exogenous Variables

Before discussing the procedure that was used to forecast the exogenous variables, it will be useful to examine the variability of each of the variables. The exogenous variables in the money GNP sector will be examined first, then the exogenous variables in the price and employment and labor force sectors, and finally the exogenous variables in the monthly housing starts sector. This examination will be quite informal and is meant to be used only to give the reader a rough idea as to the variability of each of the exogenous variables. The more important question is how much forecasting accuracy is lost by having to forecast the exogenous variables ahead of the overall forecast, and this question will be examined in Section 13.3.

In Table 13–1 the quarterly changes in each of the exogenous variables in the money GNP sector are presented from 602 through 694. Because it is the first quarter considered after the steel strike, 602 was chosen as the starting point. The exogenous G_t variable has been broken into four components in the table: federal government nondefense expenditures, federal government defense expenditures, state and local government expenditures, and farm housing investment.

Table 13–1. Quarterly Changes in the Exogenous Variables of the Money GNP Sector for the 602–694 Period.

Quarter	Federal Government Nondefense Expenditures	Federal Government Defense Expenditures	State and Local Government Expenditures	Farm Housing Investment	Exports	$MOOD_t$	$PE2_t$
602	.9	−.6	1.6	0	1.3	−6.0	2.51
603	.7	.2	.7	0	.1	−1.4	.59
604	−.5	1.2	.7	0	.5	−1.4	−.60
611	−.4	1.1	1.7	0	.6	1.0	−2.00
612	1.2	.8	.4	0	−.8	1.2	−1.10
613	.4	0	1.2	0	.7	1.1	.80
614	.3	1.2	1.5	0	.9	1.0	1.30
621	.5	2.2	.4	0	−.2	2.8	.60
622	.1	1.9	.6	0	1.7	−1.8	.10
623	1.1	−1.7	1.0	0	−.3	−3.8	1.10
624	1.5	−.4	.9	0	−.2	3.4	.25
631	.3	.3	1.9	0	−.3	−.2	−.25
632	−.9	−.7	.6	0	2.3	−3.4	.95
633	.3	.5	1.2	0	.1	4.8	1.30
634	.9	−.7	1.1	0	1.8	.7	1.20
641	.4	.2	1.6	0	2.2	2.1	−.40
642	.8	.2	1.8	−.1	−.4	−.9	1.95
643	.1	−.9	1.1	0	1.4	2.1	1.60
644[a]	.1	−.9	1.0	0	.8	−.8	1.84
651[a]	.3	−.3	1.7	0	−3.1	2.1	1.75
652[a]	.4	.6	1.9	0	5.6	.7	1.75
653[b]	1.2	.9	2.4	0	−.5	1.0	1.15
654	.2	2.4	1.9	0	.2	−.6	2.15
661	−.1	2.8	2.0	0	1.7	−2.8	3.75
662	−.3	3.2	2.5	0	.5	−4.0	2.20
663	.0	4.8	2.4	0	1.0	−4.7	2.75
664	−.7	2.3	2.9	1	1.1	−2.8	1.90
671	1.4	4.3	3.4	0	1.0	3.9	−.10
672	.5	2.0	1.7	0	.1	2.7	−1.20
673	.0	1.1	1.9	0	.4	1.6	.55
674	.5	1.6	2.9	0	.4	−3.6	−.15
681	1.2	1.5	4.2	0	1.0	2.1	2.40
682	1.0	1.8	2.3	0	3.0	−2.6	−.75
683	1.0	.9	2.3	−.1	2.7	.5	1.75
684[b]	.4	.5	3.1	0	−2.8	−.8	−.90
691[b]	.1	−.3	3.7	0	−3.0	3.0	6.00
692[b]	−.5	−.5	3.8	0	9.5	−3.5	−.30
693[b]	.8	1.8	1.5	0	.7	−5.2	2.60
694	.2	−1.1	2.2	0	.8	−6.7	−1.35

[a] Excluded from all periods of estimation because of the automobile strike.
[b] Excluded from the import equation because of the dock strikes.

With respect to federal government expenditures, without some knowledge of the proposed federal budget these expenditures do not appear to be particularly easy to forecast. Defense expenditures in particular are subject to rather large fluctuations. Fortunately, during at least certain times, knowledge of the proposed federal budget should aid in forecasting federal government expenditures. The state and local government expenditure series is smoother than the federal series and does not appear to be too difficult to forecast within the accuracy expected of the overall model. Farm housing investment is trivial to forecast within the accuracy expected of the model.

The export series in Table 13–1 does not appear to be too difficult to forecast, aside from the quarters in which there are dock strikes. On the average, exports appear to increase about one billion dollars each quarter. The last two series in Table 13–1, $MOOD_t$ and $PE2_t$, are subject to large fluctuations. Fortunately, observations for $PE2_t$ are available about five months ahead, and proxies for $PE2_t$ are available as much as eleven months ahead. Forecasting $PE2_t$ thus does not pose as much difficulty as is indicated by its large variance in Table 13–1. $MOOD_t$ enters the model with lags of one and two quarters, and so forecasting $MOOD_t$ is really only a problem for three-quarter-ahead forecasts and beyond. Nevertheless, the series does not appear to be particularly easy to forecast, and as mentioned above, the sensitivity of the accuracy of the model to errors made in forecasting variables like $MOOD_t$ will be examined in the next section.

In Table 13–2 the quarterly changes in each of the exogenous variables in the price and employment and labor force sectors are presented from 602 through 694. As expected, the two population variables, P_{1t} and P_{2t}, do not appear to pose any forecasting difficulties. Likewise, real agricultural output YA_t, and real government output, YG_t, appear to be fairly smooth series. The change in government output in current dollars, GG_t, is also fairly constant over time, except for those quarters like 683 and 693, in which large federal government pay increases occurred. The agricultural employment series, MA_t, is not very smooth, and much of the short-run variation is probably due to measurement error. This series, however, is not too important within the context of the overall model. With respect to the two government employment series, MCG_t and AF_t, the former is, as expected, somewhat smoother than the latter. AF_t is, of course, significantly influenced by federal government defense policy, although MCG_t is to some extent as well.

In Table 13–3, $DHF3_t$, $DSF6_t$, and the change in the mortgage rate, ΔRM_t, are presented monthly for the January 1965–December 1969 period. $DHF3_t$ is the three-month moving average of the flow of advances from the Federal Home Loan Bank (FHLB) to Savings and Loan Associations (SLAs), and $DSF6_t$ is the six-month moving average of private deposit flows into SLAs and Mutual Savings Banks.

Table 13–2. Quarterly Changes in the Exogenous Variables of the Price Sector and of the Employment and Labor Force Sector for the 602–694 Period.

Quarter	P_{1t}	P_{2t}	YA_t	MA_t	GG_t	YG_t	MCG_t	AF_t
602	22.3	291.0	1.3	121	1.0	.7	60	−16
603	33.0	338.0	.5	202	1.1	−.1	74	−2
604	48.0	392.0	−.3	−38	.7	.1	25	26
611	46.0	386.0	0	−97	.7	.3	58	0
612	31.0	333.7	−.1	−355	.8	.2	66	−17
613	32.3	347.7	−.3	57	.9	.5	88	18
614	23.7	355.9	.4	−60	1.4	.8	59	189
621	23.3	317.7	−.1	158	1.2	.8	52	153
622	−39.3	480.7	.6	−241	.6	.4	77	1
623	47.0	445.6	−1.2	−96	.4	.2	96	−56
624	26.3	584.0	−.1	−116	.9	−.1	102	−66
631	24.3	543.3	1.4	27	1.1	.2	34	−26
632	22.3	517.7	.2	−53	.7	.5	58	12
633	20.7	493.7	−.6	−43	.8	.4	83	11
634	21.3	491.0	.1	17	1.6	.1	144	−7
641	27.7	484.0	−.5	−145	1.4	.3	43	−8
642	28.0	480.3	.2	−14	1.0	.5	84	14
643	27.7	507.7	.1	42	1.4	.3	62	−1
644†	26.3	506.6	.3	−138	1.0	.3	148	−13
651†	24.3	477.4	1.2	−96	.7	.1	75	−27
652†	23.7	467.3	.2	192	1.1	.6	131	−21
653	−24.0	459.0	−.5	−228	1.9	.7	149	20
654	30.7	491.7	−.2	−124	2.5	.9	148	96
661	29.0	443.4	−.1	−107	2.3	1.0	189	131
662	30.3	448.9	−.9	−52	2.1	1.1	210	121
663	38.3	457.7	−.7	−136	2.8	1.2	158	130
664	53.7	478.3	.5	−8	1.8	1.1	185	150
671	52.3	457.0	1.1	−2	2.3	.6	91	83
672	54.7	466.0	.7	−123	1.8	.5	127	36
673	105.7	536.4	−.1	134	2.2	.7	74	5
674	111.0	494.3	−.2	45	2.8	0	110	13
681	93.0	423.7	.3	23	2.3	.6	132	6
682	93.3	414.6	−1.0	−79	2.5	1.0	111	63
683	93.3	495.4	.4	−140	3.3	.5	72	53
684	73.0	509.0	−.5	−51	1.4	0	124	−49
691	70.0	471.6	.8	44	1.7	.3	95	−55
692	79.0	500.4	0	−2	1.9	.4	87	35
693	92.7	492.6	.4	−216	4.1	.3	19	11
694	70.3	536.4	−1.5	−133	1.8	.4	132	−44

† Excluded from all periods of estimation because of the automobile strike.

Table 13–3. Monthly Values of $DHF3_t$, $DSF6_t$, and ΔRM_t for the January 1965–December 1969 Period.

Month	$DHF3_t$	$DSF6_t$	ΔRM_t	Month	$DHF3_t$	$DSF6_t$	ΔRM_t
1/65	49.0	1281.7	0	7/67	−187.0	1423.7	5
2/65	22.3	1227.3	0	8/67	−89.3	1404.3	0
3/65	−192.7	1236.2	0	9/67	−60.0	1331.2	5
4/65	91.7	1058.5	0	10/67	−35.7	1328.2	0
5/65	125.3	1047.0	0	11/67	11.7	1196.2	0
6/65	279.7	1005.8	0	12/67	88.0	1142.7	10
7/65	191.3	867.8	0	1/68	109.3	1081.2	5
8/65	181.0	864.0	0	2/68	53.3	1076.2	5
9/65	72.0	844.8	0	3/68	−39.0	1107.3	0
10/65	11.0	984.5	0	4/68	34.3	934.2	5
11/65	−15.3	981.7	5	5/68	123.7	992.0	10
12/65	65.0	1009.5	5	6/68	206.7	948.2	25
1/66	24.0	1072.7	10	7/68	147.7	875.2	10
2/66	5.0	1064.7	0	8/68	92.7	822.2	5
3/66	−103.3	1018.0	5	9/68	45.7	774.3	0
4/66	206.0	711.3	10	10/68	15.7	945.8	0
5/66	321.7	630.7	10	11/68	14.3	907.8	−5
6/66	365.3	490.2	5	12/68	77.7	970.3	5
7/66	275.3	249.7	10	1/69	107.3	1062.8	10
8/66	174.0	174.2	5	2/69	86.0	1114.7	15
9/66	130.7	139.5	10	3/69	24.0	1178.0	5
10/66	−31.0	329.7	10	4/69	135.7	949.2	5
11/66	−47.3	372.3	5	5/69	224.3	932.7	10
12/66	−80.0	534.3	0	6/69	360.7	826.2	0
1/67	−303.0	852.8	−5	7/69	429.7	591.0	25
2/67	−428.0	987.0	−5	8/69	524.3	449.2	10
3/67	−586.7	1186.3	−10	9/69	509.0	309.7	10
4/67	−519.3	1294.2	−5	10/69	462.0	329.5	5
5/67	−459.7	1431.0	−5	11/69	419.3	259.5	5
6/67	−291.0	1463.8	5	12/69	449.7	233.3	5

As can be seen in Table 13–3, $\bar{RM}_t$ has generally been increasing throughout the 1965–1969 period, and at times quite substantially. Only in early 1967 did the rate fall to any degree. The fluctuations in the two deposit flow variables are quite large, although the variables to some extent offset one another. When private deposit flows are small, the flow of advances from the FHLB tend to be large, and vice versa. When, for example, private deposit flows began to increase in early 1967, SLAs paid back their borrowings from the FHLB quite rapidly. It is interesting to note, however, that in early 1970 the FHLB in an effort to stimulate the housing sector has been encouraging the SLAs not to pay back their borrowings as their private deposit flows increase. The offsetting relationship between $DHF3_t$ and $DSF6_t$ observed in Table 13–3 may thus be less pronounced in the future.

Of the four major sectors in the model, the monthly housing starts sector relies the most heavily on hard-to-forecast exogenous variables. Values of $DHF3_t$, $DSF6_t$, and RM_t are not available much ahead of the forecast period, and the variables enter the housing starts equations only with a lag of one or two months. It is beyond the scope of this study to attempt to explain $DHF3_t$, $DSF6_t$, and RM_t within the context of the model, and fortunately the results below suggest that the accuracy of the model is not seriously affected by having to forecast these three variables exogenously.

The Forecasts of the Exogenous Variables and the Tests Performed

In order to examine how sensitive the forecasts of the model are to errors made in forecasting the exogenous variables, the following test was performed. Two sets of forecasts were made, one on the assumption that the forecasts would have been made in late January, April, July, and October of each year and the other on the assumption that the forecasts would have been made in the middle of March, June, September, and December. Both sets of forecasts were outside-sample forecasts and the coefficient estimates that were used in Chapter 12 were also used here. The difference between the forecasts in this chapter and those in Chapter 12 is that here the values of all but four of the exogenous variables were not assumed to be known beyond what they would have been in actual practice. The remaining values of the exogenous variables were projected in the manner specified in Table 13–4. From Table 13–4 it can be seen that the remaining values of the variables were essentially projected in a naive manner. Either the variable was assumed to remain unchanged from the last available value or the future changes in the variable were assumed to be the same as some average past change. With respect to the $PE2_t$ variable, data (including the proxies) from the OBE–SEC survey were used as far as they went, and then the changes in $PE2_t$ beyond this were assumed to be the same as the last observed change from the survey.

Notice from Table 13–4 that the four variables for which the actual values continued to be used all pertain, at least in part, to the federal government. As mentioned above, knowledge of the proposed federal budget should aid in forecasting federal government purchases of goods and services. The proposed budget is not always a useful guide, however, since the federal government can (and sometimes does) decide to escalate one of its defense commitments or make some other significant policy change during the middle of the fiscal year. It is beyond the scope of the study to attempt to forecast the policy decisions of government officials, and thus the actual values of

Table 13–4. Assumptions Made in Forecasting the Exogenous Variables.

Actual Values Used
Federal government component of G_t (Federal defense plus nondefense expenditures)
AF_t
YG_t
GG_t

No Change from Last Available Value
$MOOD_t$
YA_t
$DHF3_t$
$DSF6_t$
RM_t

Future Changes Equal to the Average of the Last Four Observed Changes
State and local government component of G_t
MCG_t
MA_t
P_{1t}
P_{2t}

Other Assumptions
EX_t: Change of 1.0 billion dollars each quarter
Farm Housing Investment Component of G_t: Level of .5 billion dollars each quarter
$PE2_t$: Future changes equal to the last observed change

federal government spending and the level of the armed forces have been used for the work in this chapter. Both real and current dollar government output, YG_t, GG_t, are also significantly influenced by federal government policy decisions (such as the effect of federal government pay increases on GG_t), and so the actual values of these two variables have been used for the work here as well. The forecasts in this chapter can thus be considered to be conditional on the actual policy decisions of federal government officials being known.

With respect to the late January, April, July, and October forecasts (to be referred to as the January et al. forecasts), data on all of the variables in the model are available for the previous quarter. At the end of January, for example, the data for the fourth quarter are available. At this time the model can be reestimated using these data, and forecasts for the first, second, third, and fourth quarters of the current year and the first quarter of the next year can be made. At this time, values or proxies for $PE2_t$ are available for the first and second quarters. The value of $MOOD_{t-1}$ is available for the first quarter (and thus values of $MOOD_{t-2}$ are available for the first and second quarters); the value of RM_t is available for January; and values of the deposits

of SLAs and MSBs (including the FHLB advances to SLAs) are available for December.

The other four times when it appears desirable to make forecasts are the middle of March, the middle of June, the middle of September, and the middle of December. These are the times when the figures from the OBE–SEC on plant and equipment investment expectations become available. In March, for example, the value of the one-quarter-ahead expectation of plant and equipment investment, $PE1_t$, is available for the first quarter, and the value of $PE2_t$ is available for the second quarter. Also, proxies for $PE2_t$ are available for the third and fourth quarters. It was seen in Chapter 4 that plant and equipment investment was better explained by the use of $PE1_t$ instead of $PE2_t$, and for the March, June, September, and December forecasts (to be referred to as the March et al. forecasts) the equation that uses $PE1_t$, equation (4.7), can be used for the one-quarter-ahead forecasts. Using these one-quarter-ahead forecasts, equation (4.4) can then be used for the two- through five-quarter-ahead forecasts. The one-quarter-ahead forecasts for the March et al. set of forecasts are, of course, really only forecasts for about one month ahead. With respect to the other exogenous variables, by the middle of March the figures on housing starts for January and February are available; one more value for $MOOD_{t-1}$ (and thus for $MOOD_{t-2}$) is available; values of RM_t are available for February and March; and values of the deposits of SLAs and MSBs are available for January.

Aside from using different values for the exogenous variables, the forecasts presented below were generated in the same manner as was done for forecasts in Chapter 12. In particular, the forecasts were all outside-sample forecasts and were based on the coefficient estimates presented in Tables 12–1 through 12–15. Also, the same adjustments were made here for the 684–693 period with respect to the export and import series as were made above.

13.3 The Forecasting Results

The January et al. Quarterly Forecasts

In Table 13–5 the results of the January et al. forecasts are compared with the results of the outside-sample forecasts of Chapter 12. The mean absolute errors in terms of both levels and changes are presented for 15 endogenous variables. The endogenous variables are the same as those considered in Table 12–16. Likewise, the prediction period is the same as the one con-

sidered in Table 12–16, namely 654–694. At the bottom of Table 13–5 the error measures for GNP_t for the shorter 1968–1969 period are presented.

Looking first at the level errors for GNP_t in Table 13–5, the one- and two-quarter-ahead results are nearly the same, but the gap widens for the three-, four-, and five-quarter-ahead forecasts. The differences between the mean absolute errors for the three- through five-quarter-ahead forecasts are respectively 2.19, 4.02, and 6.21 billion dollars. For the errors in terms of changes, however, the gap between the two sets of forecasts of GNP is fairly constant for the three- through five-quarter-ahead forecasts. The differences are respectively 1.51, 1.36, and 1.45 billion dollars. The same conclusion also tends to hold for the other endogenous variables: the gap between the two sets of forecasting results for most variables widens as the forecast horizon lengthens for the errors in terms of levels, but not for the errors in terms of changes.

In general, for the errors in terms of changes the results of the two sets of forecasts are fairly close. Some accuracy has been lost by having to extrapolate the values of the exogenous variables, but not enough to indicate that the model is of little use unless the actual values of all of the exogenous variables are known.

In order to compare the accuracy of the forecasts generated in this chapter to changes in the forecast horizon, the mean absolute errors for the one- through four-quarter-ahead forecasts were computed for the same prediction period (664–694) that was used for the five-quarter-ahead forecasts in Table 13–5. The results are presented in Table 13–6. At the bottom of the table the error measures for GNP for the 1968–1969 period are also presented.

The errors in terms of levels in Table 13–6 definitely compound as the forecast horizon lengthens. The compounding in Table 13–6 is more pronounced than it was in Table 12–17 for the outside-sample forecasts based on actual values of the exogenous variables. With respect to the errors in terms of changes in Table 13–6, the errors tend to compound for a few of the variables, but in general error compounding does not appear to be a serious problem for the errors in terms of changes.

The quarter by quarter results of the January et al. forecasts are presented in Table 13–7 for eleven variables. The eleven variables are the same as those considered in Table 12–18. The first line for each quarter gives the actual change in each of the variables for that quarter, and the next five lines give, respectively, the one- through five-quarter-ahead forecast of the change in each of the variables for that quarter.

The same conclusions that were made about the forecasts in Table 12–18 can generally be made for the forecasts in Table 13–7, and these conclusions

Table 13–5. Comparisons of Forecasts Based on Actual and Extrapolated Values of the Exogenous Variables. (Both sets of forecasts are outside-sample forecasts. The forecasts based on extrapolated values are January et al. forecasts.)

Variable	One Quarter Ahead (17 observations)		Two Quarters Ahead (16 observations)		Three Quarters Ahead (15 observations)		Four Quarters Ahead (14 observations)		Five Quarters Ahead (13 observations)	
	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values
MAE										
GNP_t	2.47	2.55	3.94	4.22	3.88	6.07	4.67	8.69	6.98	13.19
CD_t	1.46	1.50	1.90	2.12	1.77	2.16	2.41	2.84	2.62	3.82
CN_t	1.62	1.65	2.15	2.25	2.48	2.60	2.77	2.86	3.39	4.05
CS_t	.43	.43	.75	.76	1.13	1.11	1.59	1.56	1.98	1.95
IP_t	1.36	1.35	1.54	2.20	1.75	2.80	2.17	3.85	2.50	4.70
IH_t	.82	.81	1.62	1.69	2.36	2.85	3.05	3.62	3.86	4.19
$V_t - V_{t-1}$	3.13	3.14	3.78	3.65	3.92	3.59	3.64	3.53	3.66	3.57
IMP_t	.73	.75	1.20	1.34	1.66	1.80	1.78	1.92	1.61	1.91
PD_t	.17	.17	.30	.31	.45	.46	.67	.71	.89	.98
$GNPR_t$	2.61	2.54	4.11	4.10	4.05	4.81	4.06	6.09	5.14	8.91
M_t	136	135	184	205	253	265	298	472	374	665
D_t	188	190	228	243	204	236	256	239	245	261
LF_{1t}	52	55	61	82	63	110	65	143	73	182
LF_{2t}	283	281	438	433	588	584	735	729	847	819
UR_t	.0031	.0032	.0055	.0058	.0071	.0076	.0083	.0092	.0094	.0012

MAEΔ										
GNP_t			2.98	3.41	3.18	4.69	2.93	4.29	2.74	4.19
CD_t			1.51	1.62	1.57	1.65	1.37	1.49	1.45	1.54
CN_t			1.47	1.52	1.45	1.52	1.66	1.75	1.89	2.15
CS_t			.46	.45	.49	.48	.47	.47	.48	.50
IP_t			1.25	1.41	1.32	1.74	1.32	1.89	1.39	1.97
IH_t			1.01	1.05	1.13	1.30	1.11	1.33	1.27	1.42
$V_t - V_{t-1}$		s	4.39	4.47	4.83	4.96	4.87	5.07	4.66	4.83
IMP_t		a	.66	.78	.71	.85	.80	.95	.72	.87
PD_t		m	.18	.18	.20	.21	.24	.26	.29	.32
$GNPR_t$		e	2.86	2.63	2.47	3.38	2.31	2.90	1.92	3.00
M_t			102	109	120	168	154	262	161	270
D_t			171	170	175	178	170	178	175	192
LF_{1t}			51	57	53	57	56	59	57	65
LF_{2t}			233	232	241	244	236	248	230	236
UR_t			.0026	.0027	.0020	.0021	.0015	.0021	.0014	.0021
1968–1969 Period Only (8 observations)										
MAE for GNP_t	2.61	2.38	3.20	3.72	2.71	5.07	2.12	5.25	2.88	7.66
MAEΔ for GNP_t	2.67	2.38	2.23	2.89	1.82	3.30	1.75	2.21	1.47	2.53

Table 13–6. Errors Computed for the Same Prediction Period for the Forecasts Based on Extrapolated Values of the Exogenous Variables. (Forecasts are outside-sample forecasts and are January et al. forecasts.)

Variable	Length of Forecast: One Quarter Ahead	Two Quarters Ahead	Three Quarters Ahead	Four Quarters Ahead	Five Quarters Ahead	Number of Observations
MAE						
GNP_t	2.60	4.03	6.01	9.34	13.19	13
CD_t	1.40	2.00	1.97	2.86	3.82	13
CN_t	1.81	2.35	2.66	2.84	4.05	13
CS_t	.44	.69	1.03	1.56	1.95	13
IP_t	1.45	2.30	2.97	3.96	4.70	13
IH_t	.96	1.87	2.98	3.71	4.19	13
$V_t - V_{t-1}$	3.39	3.64	3.44	3.59	3.57	13
IMP_t	.72	1.34	1.76	1.80	1.91	9
PD_t	.17	.32	.51	.73	.98	13
$GNPR_t$	2.38	3.69	4.52	6.39	8.91	13
M_t	118	214	267	487	665	13
D_t	176	216	193	201	261	13
LF_{1t}	64	90	118	149	182	13
LF_{2t}	287	447	592	724	819	13
UR_t	.0027	.0047	.0066	.0087	.0112	13
MAEΔ						
GNP_t	2.60	3.37	4.72	4.18	4.19	13
CD_t	1.40	1.52	1.50	1.54	1.54	13
CN_t	1.81	1.62	1.70	1.84	2.15	13
CS_t	.44	.41	.43	.45	.50	13
IP_t	1.45	1.63	1.94	2.01	1.97	13
IH_t	.96	1.18	1.33	1.40	1.42	13
$V_t - V_{t-1}$	3.39	4.70	4.99	5.10	4.83	13
IMP_t	.72	.78	.87	.91	.87	9
PD_t	.17	.19	.23	.27	.32	13
$GNPR_t$	2.38	2.44	3.27	2.79	3.00	13
M_t	118	113	188	272	270	13
D_t	176	177	179	183	192	13
LF_{1t}	64	65	64	62	65	13
LF_{2t}	287	244	243	244	236	13
UR_t	.0027	.0020	.0017	.0019	.0021	13
1968–1969 Period Only						
MAE for GNP_t	2.38	3.72	5.07	5.25	7.66	8
MAEΔ for GNP_t	2.38	2.89	3.30	2.21	2.53	8

Table 13–7. Actual and Forecasted Changes for Selected Variables of the Model. (Forecasts are outside-sample forecasts, are based on extrapolated values of the exogenous variables, and are January et al. forecasts. Forecasts for UR_t are in terms of levels.)

Quarter	Length of Forecast	GNP_t	$CD_t + CN_t + CS_t$	IP_t	IH_t	$V_t - V_{t-1}$	IMP_t	PD_t	$GNPR_t$	M_t	$LF_{1t} + LF_{2t}$	UR_t
654		18.90	11.10	3.80	.20	.60	1.50	.34	14.10	731	358	.0411
	1	14.82	8.53	1.87	.27	−.49	.76	.74	8.25	566	118	.0370
661		19.50	10.30	2.60	.0	1.60	1.50	.78	12.50	584	345	.0386
	1	18.24	8.57	3.70	.24	.94	.91	.79	11.30	730	203	.0332
	2	15.53	8.64	1.92	.20	.07	.79	.83	8.63	656	250	.0307
662		13.80	4.10	1.50	−1.50	4.90	1.10	1.07	5.90	603	507	.0383
	1	15.50	8.72	2.45	−.48	−.26	.83	.87	8.49	554	202	.0319
	2	16.25	10.09	2.17	−.26	−.83	.81	.89	9.09	813	295	.0261
	3	16.44	9.09	2.15	.22	.12	.84	.92	9.12	543	276	.0260
663		12.60	9.30	2.70	−1.20	−4.30	2.20	.88	5.20	656	576	.0377
	1	10.13	7.76	2.78	−1.15	−6.60	.56	.96	2.61	257	125	.0334
	2	16.92	9.61	2.64	−1.18	−1.14	.91	.99	8.49	659	297	.0257
	3	18.87	9.92	2.45	−.72	.36	.94	1.00	10.16	645	307	.0207
	4	18.30	9.63	2.36	−.73	.38	.94	1.02	9.56	524	291	.0215
664		14.80	3.40	1.20	−2.70	8.00	.60	.88	7.90	290	688	.0369
	1	9.78	6.83	2.09	−2.00	−1.12	.61	1.02	2.70	290	155	.0326
	2	12.25	8.09	2.23	−1.24	−.95	.68	1.06	4.67	355	237	.0293
	3	15.10	9.63	2.60	−.94	−.08	.81	1.11	6.86	476	303	.0212
	4	15.92	10.30	2.36	−.60	.06	.80	1.13	7.48	519	308	.0163
	5	14.76	9.40	2.22	−.78	.27	.75	1.14	6.47	410	287	.0179

Table 13–7 (cont.)

Quarter	Length of Forecast	GNP_t	$CD_t + CN_t + CS_t$	IP_t	IH_t	$V_t - V_{t-1}$	IMP_t	PD_t	$GNPR_t$	M_t	$LF_{1t} + LF_{2t}$	UR_t
671		3.50	6.60	−.90	−.60	−10.90	.50	.60	−1.60	258	358	.0376
	1	7.53	5.77	.52	−.18	−7.21	.46	1.07	−.58	115	66	.0330
	2	15.44	7.75	2.46	−.53	−2.08	.96	1.12	6.18	466	246	.0285
	3	21.28	10.12	2.77	.44	.34	1.18	1.18	10.97	488	279	.0258
	4	22.58	11.27	3.08	.32	.43	1.21	1.24	11.64	582	315	.0170
	5	22.49	11.34	2.81	.38	.48	1.12	1.26	11.46	601	312	.0121
672		9.30	8.60	−.30	1.60	−5.60	−.30	.59	4.00	32	171	.0386
	1	11.40	5.55	.10	2.14	−2.19	.70	1.00	3.57	125	56	.0338
	2	10.92	5.54	1.20	2.05	−3.11	.66	1.15	2.33	116	167	.0311
	3	18.33	9.25	2.63	2.07	−.08	1.15	1.21	8.38	444	273	.0256
	4	21.60	10.68	2.79	2.14	1.58	1.20	1.30	10.71	587	299	.0225
	5	21.80	11.66	3.06	1.64	1.12	1.17	1.38	10.30	637	318	.0130
673		16.90	6.00	.50	3.40	4.40	.60	1.12	7.50	186	752	.0386
	1	18.97	9.15	1.77	1.80	2.87	1.11	1.02	9.84	372	180	.0352
	2	15.06	9.08	1.78	1.59	−1.26	.92	1.05	6.26	311	215	.0311
	3	11.04	6.68	1.19	1.63	−2.28	.67	1.21	1.96	56	197	.0305
	4	17.67	9.53	2.59	1.55	.91	1.10	1.31	7.02	379	275	.0239
	5	18.53	10.66	2.61	1.10	.99	1.03	1.41	7.10	455	278	.0205
674		15.70	6.90	1.50	2.40	1.70	2.10	1.05	5.50	453	571	.0392
	1	14.17	10.02	1.04	.55	−2.24	.80	1.05	4.20	241	172	.0366
	2	18.39	9.39	1.86	.53	2.08	1.08	1.06	7.72	456	263	.0324
	3	17.74	8.68	1.90	.12	2.32	1.09	1.09	7.02	321	269	.0292
	4	12.30	7.14	1.24	−.26	−.58	.75	1.24	1.62	5	217	.0306
	5	16.83	9.74	2.54	−.22	.62	1.05	1.38	4.57	270	269	.0230

681		19.20	18.10	4.10	−.30	−7.90	3.10	.98	9.80	434	106	.0369
	1	17.95	10.84	2.96	−.13	−.89	1.13	1.04	8.38	370	229	.0370
	2	19.54	10.08	1.51	−.28	3.24	1.11	1.06	9.67	394	246	.0343
	3	17.26	9.46	1.75	−.41	1.27	1.01	1.09	7.51	383	279	.0306
	4	16.74	9.24	1.80	−.60	.92	1.02	1.11	6.94	314	288	.0277
	5	13.51	7.69	1.31	−.75	−.01	.82	1.24	3.60	27	234	.0308
682		23.40	9.60	−2.70	1.70	8.30	1.40	1.15	12.50	533	508	.0360
	1	24.72	7.46	.97	.26	11.68	1.85	1.06	14.09	606	348	.0326
	2	17.90	9.28	1.80	−.71	2.45	1.12	1.05	8.41	474	299	.0340
	3	18.03	10.25	1.37	−.43	1.66	1.02	1.07	8.41	403	307	.0318
	4	17.46	9.75	1.73	.02	.68	1.02	1.11	7.66	357	311	.0289
	5	17.94	9.60	1.85	.13	.96	1.10	1.14	7.95	320	320	.0259
683		17.70	14.60	1.70	−.30	−2.70	2.40	1.03	7.00	253	146	.0356
	1	16.96	10.19	3.15	−1.10	.36	1.24	1.08	6.08	412	340	.0334
	2	12.96	10.94	1.62	−1.06	−3.07	.97	1.08	2.75	449	352	.0298
	3	15.03	9.67	1.59	−.46	−.12	.94	1.05	4.68	271	287	.0324
	4	16.81	10.06	1.26	.21	.94	.95	1.08	6.02	308	212	.0302
	5	16.91	9.90	1.68	.38	.54	.99	1.14	5.75	302	308	.0277
684		16.10	5.80	3.40	2.00	3.30	1.30*	1.20	5.70	399	226	.0340
	1	18.77	9.29	.88	.03	5.13	1.46	1.09	8.50	367	323	.0351
	2	15.10	8.99	2.52	−.98	.97	1.11	1.09	5.47	402	310	.0319
	3	14.75	8.94	1.74	−1.00	1.57	1.10	1.08	5.25	228	296	.0295
	4	14.41	9.42	1.52	−.19	.16	.91	1.04	5.22	208	266	.0324
	5	14.28	9.70	1.07	−.29	.21	.81	1.08	4.89	242	284	.0300
691		16.20	11.30	3.80	1.40	−3.90	1.40*	1.40	4.60	733	959	.0336
	1	21.05	12.34	5.75	−.24	−2.25	1.64	1.13	10.07	448	364	.0338
	2	13.82	9.69	1.35	−.36	−.59	1.07	1.12	4.20	359	303	.0347
	3	14.71	9.63	2.31	−.15	−.59	1.08	1.11	5.00	271	300	.0313
	4	14.02	9.79	1.70	.12	−1.03	1.05	1.09	4.54	213	305	.0296
	5	14.21	9.40	1.49	.08	−.18	.89	1.05	4.99	196	280	.0326

Table 13–7 (cont.)

Quarter-	Length of Forecast	GNP_t	$CD_t + CN_t + CS_t$	IP_t	IH_t	$V_t - V_{t-1}$	IMP_t	PD_t	$GNPR_t$	M_t	$LF_{1t} + LF_{2t}$	UR_t
692		16.10	10.80	2.50	−.60	.30	1.40*	1.55	3.60	439	280	.0349
	1	17.99	10.45	1.17	−.22	3.18	1.40	1.22	6.87	388	222	.0325
	2	13.87	9.37	−.29	−.44	3.23	1.08	1.16	3.82	392	351	.0329
	3	12.05	9.14	1.14	−.17	−.12	.94	1.14	2.51	154	299	.0348
	4	14.32	9.56	2.16	.80	.05	1.05	1.13	4.43	194	330	.0307
	5	13.59	9.22	1.67	.84	.18	1.02	1.11	3.97	151	332	.0294
693		18.00	7.00	3.30	−1.30	3.80	1.40*	1.41	3.90	334	688	.0363
	1	22.83	12.31	3.06	−1.12	2.26	1.77	1.34	8.16	348	345	.0343
	2	19.24	11.70	3.20	−1.67	.90	1.49	1.26	5.70	468	285	.0313
	3	13.70	10.08	−.30	−1.24	−.47	1.07	1.18	1.64	113	285	.0337
	4	15.36	9.81	1.21	−.35	−.72	1.19	1.15	3.20	102	289	.0355
	5	17.42	10.29	2.23	−.07	−.16	1.28	1.14	4.91	177	330	.0306
694		9.40	9.60	1.40	.10	−3.00	.70	1.36	−.80	210	417	.0359
	1	7.88	8.89	−.75	−.63	−1.92	.61	1.31	−1.74	−16	152	.0395
	2	15.12	9.96	1.18	−1.18	2.94	1.17	1.36	3.71	340	282	.0338
	3	14.62	10.54	2.85	−2.41	1.67	1.13	1.27	3.76	195	236	.0321
	4	9.27	8.77	−.54	−1.69	.24	.72	1.18	.00	−41	240	.0358
	5	10.80	9.02	.92	−1.47	.07	.84	1.15	1.46	25	262	.0372

* Adjusted value rather than the actual value.

will not be repeated here. The results in the two tables differ primarily in the forecasts for 671 and 672. The last three forecasts of GNP for 671 and 672, for example, are much worse in Table 13–7 than they are in Table 12–18. In Table 13–7 plant and equipment investment was forecast to grow much more in 671 and 672 than it was forecast to grow in Table 12–18, which caused the forecasts of GNP in Table 13–7 to be much larger in 671 and 672. The large plant and equipment investment forecasts in Table 13–7 for 671 and 672 are caused by large (and erroneous) extrapolations of the $PE2_t$ series. Otherwise, the forecasts in Table 12–18 and 13–7 are similar: only a few of the forecasts of GNP in Table 13–7 besides those for 671 and 672 could be considered to be at all misleading. The same problems still occur, of course, with respect to the forecasts of the labor force and thus of the level of the unemployment rate. Likewise, the inflation in 1969 is still somewhat underpredicted.

The March et al. Quarterly Forecasts

In Table 13–8 the results of the March, June, September, and December forecasts are compared with the results of the January, April, July, and October forecasts that have just been presented. The format of Table 13–8 is the same as the format of Table 13–5, aside from the different comparisons being made. The March et al. forecasts differ from the January et al. forecasts in that more data for the March et al. forecasts are available. These data differences were discussed in Section 13.2.

The results for the two sets of forecasts in Table 13–8 are not very different. The one- and two-quarter-ahead forecasts of GNP are actually better for the January et al. set of forecasts. The forecasts of plant and equipment investment and housing investment are better for the March et al. set, but error cancellation has caused the forecasts of GNP to be slightly better for the January et al. set. For the three- through five-quarter-ahead forecasts of the level of GNP, however, the March et al. forecasts are better. For the forecasts of the change in GNP, the two sets of forecasts are about the same. In short, the overall accuracy of the model appears to be only slightly improved by making forecasts about one and one-half months later.

The January et al. Forecasts from the Monthly Housing Starts Equations

In Table 13–9 the outside-sample forecasts of HSQ_t from Chapter 12 are compared with the January et al. forecasts of HSQ_t in this chapter. The format of Table 13–9 is the same as the format of Table 12–19 in Chapter 13.

Table 13–8. Comparisons of the January et al. and March et al. Forecasts.

Variable	One Quarter Ahead (17 observations) Jan.	March	Two Quarters Ahead (16 observations) Jan.	March	Three Quarters Ahead (15 observations) Jan.	March	Four Quarters Ahead (14 observations) Jan.	March	Five Quarters Ahead (13 observations) Jan.	March
MAE										
GNP_t	2.55	2.83	4.22	4.60	6.07	5.48	8.69	8.13	13.19	11.66
CD_t	1.50	1.52	2.12	1.95	2.16	2.13	2.84	2.77	3.82	3.33
CN_t	1.65	1.66	2.25	2.25	2.60	2.52	2.86	2.75	4.05	3.34
CS_t	.43	.43	.76	.77	1.11	1.18	1.56	1.68	1.95	2.08
IP_t	1.35	1.01	2.20	1.66	2.80	2.27	3.85	3.12	4.70	4.21
IH_t	.81	.77	1.69	1.38	2.85	2.59	3.62	3.55	4.19	4.18
$V_t - V_{t-1}$	3.14	3.12	3.65	3.74	3.59	3.75	3.53	3.37	3.57	3.59
IMP_t	.75	.75	1.34	1.27	1.80	1.77	1.92	1.84	1.91	1.71
PD_t	.17	.17	.31	.37	.46	.46	.71	.69	.98	.96
$GNPR_t$	2.54	2.79	4.10	4.35	4.81	4.74	6.09	6.08	8.91	8.15
M_t	135	130	205	146	265	193	472	344	665	549
D_t	190	184	243	251	236	226	239	257	261	228
LF_{1t}	55	55	82	82	110	82	143	143	182	182
LF_{2t}	281	283	433	429	584	582	729	729	819	828
UR_t	.0032	.0032	.0058	.0057	.0076	.0077	.0092	.0092	.0112	.0107

MAEΔ										
GNP_t			3.41	3.28	4.69	4.37	4.29	4.83	4.19	4.25
CD_t			1.62	1.54	1.65	1.68	1.49	1.51	1.54	1.53
CN_t			1.52	1.46	1.52	1.51	1.75	1.76	2.15	2.03
CS_t			.45	.47	.48	.49	.47	.48	.50	.49
IP_t			1.41	1.13	1.74	1.57	1.89	1.89	1.97	2.05
IH_t	s		1.05	1.00	1.30	1.45	1.33	1.29	1.42	1.42
$V_t - V_{t-1}$	a		4.47	4.48	4.96	4.92	5.07	5.02	4.83	4.81
IMP_t	m		.78	.72	.85	.80	.95	.97	.87	.88
PD_t	e		.18	.18	.21	.21	.26	.25	.32	.31
$GNPR_t$			2.63	2.97	3.38	3.29	2.90	3.28	3.00	2.87
M_t			109	79	168	139	262	226	270	281
D_t			170	174	178	174	178	178	192	187
LF_{1t}			57	57	57	57	59	59	65	65
LF_{2t}			232	231	244	239	248	247	236	240
UR_t			.0027	.0028	.0021	.0021	.0021	.0018	.0021	.0020
1968–1969 Period Only (8 observations)										
MAE for GNP_t	2.38	2.54	3.72	4.96	5.07	5.94	5.15	6.79	7.66	7.41
MAEΔ for GNP_t	2.38	2.54	2.89	3.13	3.30	3.27	2.21	3.53	2.53	2.58

Table 13–9. Comparison of Forecasts of HSQ_t Based on Actual and Extrapolated Values of the Exogenous Variables. (Both sets of forecasts are outside-sample forecasts. The forecasts based on extrapolated values are January et al. forecasts. Errors are in thousands of units at annual rates.)

	One Quarter Ahead (17 observations)		Two Quarters Ahead (16 observations)		Three Quarters Ahead (15 observations)		Four Quarters Ahead (14 observations)		Five Quarters Ahead (13 observations)	
Error Measure	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values	Actual Values	Extra-polated Values
MAE	84.6	78.8	138.0	124.1	173.0	171.6	208.3	218.4	278.4	234.0
MAEΔ	84.6	78.8	88.1	93.8	98.8	94.8	109.4	94.8	120.7	101.2

The errors are in the thousands of units at annual rates. The results in Table 13–9 indicate that the January et al. forecasts of HSQ_t are in general slightly better than the outside-sample forecasts of HSQ_t from Chapter 12, which are based on the actual values of the exogenous variables. The reason for this is that the extrapolated values of the mortgage rate, which were used for the January et al. forecasts, were in general smaller than the actual values (the extrapolated values being based on the assumption of no change in the mortgage rate), and this caused the forecasts from the demand equation to be better. The forecasts from the demand equation were better because the large (and erroneous) negative estimates of the coefficient of the mortgage rate in the demand equation (see Table 12–14) were multiplied by smaller values of the mortgage rate. The January et al. forecasts from the demand equation were actually better (compared with the forecast based on the actual values of the exogenous variables) than the results in Table 13–9 indicate. The January et al. forecasts from the supply equation were worse, since extrapolated values of the deposit flow variables had to be used, and this lessened the accuracy of the overall forecasts of HSQ_t.

In order to compare how the accuracy of the January et al. forecasts of HSQ_t varies with the length of the forecast horizon, the mean absolute errors of HSQ_t computed for the same prediction period are presented in Table 13–10. The format of Table 13–10 is the same as the format of Table

Table 13–10. Errors Computed for the Same Prediction Period for the Forecasts of HSQ_t Based on Extrapolated Values of the Exogenous Variable. (Forecasts are outside-sample forecasts and are January et al. forecasts. Errors are in thousands of units at annual rates.)

	Length of Forecast					
Error Measure	One Quarter Ahead	Two Quarters Ahead	Three Quarters Ahead	Four Quarters Ahead	Five Quarters Ahead	No. of Observations
MAE	91.4	140.2	176.9	222.8	234.4	13
MAEΔ	91.4	101.4	95.2	97.6	101.2	13

12–20 in Chapter 12. As was the case in Table 12–20, the level errors in Table 13–10 compound rather substantially as the forecast horizon increases. There is, however, little evidence that the change errors compound.

Finally, the quarter-by-quarter results of the January et al. forecasts of HSQ_t are presented in Table 13–11 for the 654–694 period. The format of Table 13–11 is the same as the format of Table 12–21. There is a tendency

Table 13–11. Actual and Forecasted Levels of HSQ_t. (Forecasts are outside-sample forecasts, are based on extrapolated values of the exogenous variables, and are January et al. forecasts. Figures are in thousands of units at annual rates.)

		Length of Forecast				
Quarter	Actual Value	One Quarter Ahead	Two Quarters Ahead	Three Quarters Ahead	Four Quarters Ahead	Five Quarters Ahead
654	1463	1398				
661	1349	1370	1376			
662	1267	1290	1333	1373		
663	1018	1060	1089	1186	1183	
664	883	874	996	1042	1158	1124
671	1038	925	893	1089	1119	1211
672	1206	1225	1211	1197	1329	1307
673	1316	1224	1208	1178	1159	1258
674	1420	1324	1195	1165	1129	1093
681	1436	1258	1208	1102	1060	1021
682	1434	1370	1292	1266	1201	1200
683	1449	1300	1216	1216	1188	1143
684	1548	1415	1272	1206	1225	1191
691	1604	1464	1360	1294	1221	1224
692	1507	1525	1456	1403	1369	1328
693	1341	1380	1308	1227	1233	1222
694	1290	1430	1313	1155	1141	1132

in Table 13–11, as there was in Table 12–21, for the model to underpredict the level of housing starts and for the size of the underprediction to increase as the forecast horizon increases. This is somewhat less pronounced in Table 13–11 than it was in Table 12–21, however, which is due in large part to the use of smaller values for the mortgage rate.

Conclusion

The forecasts presented in this chapter are close to being forecasts that could have been made *ex ante*. There are essentially only four reasons why the forecasts cannot be considered to be completely *ex ante* forecasts:

1. The actual values of AF_t, YG_t, GG_t, and the federal government component of G_t were used for the forecasts.
2. For the estimates of the production function parameter α_t, two of the interpolation peaks (in Figure 9–1) occurred within the 654–694 period;

for the estimates of the potential agricultural output and potential agricultural employment series (in Chapter 10), interpolation peaks occurred within the 654–694 period; and for the construction of the series on the potential number of hours worked per private nonfarm worker, the HP_t regression in (10.2) was estimated through 694.

3. The data used in this study are based on 1969 revisions.
4. The model was specified and experimented with in 1968 and 1969 and the final version was chosen in early 1970.

The first two of these points have been discussed above. With respect to the first point, it is beyond the scope of this study to attempt to forecast federal government policy changes that are not reflected in the proposed federal budget. The second point is a very minor one, since the forecasting results would be little changed if slightly different interpolation procedures had been used to construct the estimates of α_t and of the potential agricultural output and employment series and if a different sample period for the HP_t regression had been used. The third point is more significant. The national income account figures are revised every July for three years back, and many times these revisions are fairly large. An attempt could have been made in this study to consider prerevised as well as revised data, but the extra work involved in doing this would have been considerable and would have complicated the presentation of the results. The extra information that could have been gained from considering the prerevised data did not appear to warrant the cost involved, and thus only the revised data were used. In general, the conclusions reached in this study should not be too sensitive to the use of revised data.

The fourth point is an important one. Had the model been specified and worked on in 1964 and 1965 and had the final version been chosen in 1965 (before the 654–694 prediction period), the model undoubtedly would not have been the same as the one chosen in early 1970. In other words, information from the 654–694 period was used in choosing the final specification of the model. Little can be done about this problem, however, since it is very hard for one to behave as if he does not know something that he actually knows. Consequently, the results in this chapter may be atypical of what the model can actually achieve, since information from the 654–694 period was used in the specification of the model. It should perhaps be pointed out, however, that the money GNP sector of the model (which was the first sector developed) was developed in early 1968, and except for a change in the inventory investment equation, it has remained unchanged to the present.

The four points listed above all indicate that the forecasting results achieved in this chapter may be better than the results that can actually be achieved in practice. There are, however, two reasons for arguing that the

model may be able to do better in actual practice than the results in this chapter indicate. The first is that one may be able to do better in forecasting the exogenous variables than merely extrapolating past levels or changes. To the extent that one can do better than these naive extrapolations, the forecasting results of the model should be closer to results achieved in Chapter 12 than to the results achieved in this chapter. Secondly, as can be seen from the results in Chapter 12, the coefficient estimates of many of the equations of the model have been more stable in 1968 and 1969 than they were previously, and if the estimates continue to be as stable in the future, the forecasting results of the model should be closer to the within-sample results. Also, the future forecasting results of the model should be improved to the extent that the demand equation for housing starts and the equation explaining the labor force participation of secondary workers become more stable than they were throughout the 654–694 period.

The major conclusions of this study will be discussed in Chapter 15, but it should be noted here that no constant terms adjustments have been made for any of the forecasts. The conclusion that Evans, Haitovsky, and Treyz reached that econometric models cannot forecast well without constant term adjustments does not appear to be true for the present model.

13.4 Annual Forecasting Results

This study is primarily concerned with quarterly forecasting results, but in this section the annual implications of the quarterly results will be briefly discussed. Implicit in any one-, two-, three-, and four-quarter-ahead set of forecasts is an annual forecast, and in Tables 13–12 and 13–13 the annual forecasts that are implicit in the above quarterly forecasts are presented. In both tables the first line for each quarter gives the actual annual change in each of eleven variables, the second line gives the forecasted annual change in each variable based on the one-, two-, three-, and four-quarter-ahead set of forecasts, and the third line gives the forecasted annual change in each variable based on the two-, three-, four-, and five-quarter-ahead set of forecasts. Table 13–12 presents the forecasts from Chapter 12, which are outside-sample forecasts and are based on actual values of the exogenous variables; and Table 13–13 presents the January et al. forecasts from this chapter, which are outside-sample forecasts and are based on extrapolated values of the exogenous variables. The eleven variables considered in the tables are the same as those considered in Tables 11–6, 12–18, and 13–7 for the quarterly forecasts. As in the other tables, the forecasts for UR_t in Tables 13–12 and 13–13 are in terms of levels rather than changes.

The annual change in a variable (say, GNP) for a given quarter (say, 663) is defined as the average level of GNP for 654, 661, 662, and 663 (i.e.,

$[GNP_{654} + GNP_{661} + GNP_{662} + GNP_{663}]/4)$ minus the average level of GNP for 644, 651, 652, and 653. The forecasted annual change for GNP for the year ending in 663 is then defined as the average of the one-quarter-ahead forecast of the level of GNP for 654, the two-quarter-ahead forecast of the level of GNP for 661, the three-quarter-ahead forecast of the level of GNP for 662, and the four-quarter-ahead forecast of the level of GNP for 663 minus the average level of GNP for 644, 651, 652, and 653. In other words, for the 663 annual forecast of GNP, the equation estimates through 653 were used to forecast the levels of GNP for 654, 661, 662, and 663, and then the forecasted annual change was taken to be the average of these four levels minus the average level of GNP for 644, 651, 652, and 653.

The second forecasted annual change in a variable (say, GNP) for a given quarter (say, 664) is defined as follows. The forecasted *level* of GNP for the year ending in 664 is defined as the average of the two-quarter-ahead forecast of the level of GNP for 661, the three-quarter-ahead forecast of the level for GNP for 662, the four-qarter-ahead forecast of the level for GNP for 663, and the five-quarter-ahead forecast of the level of GNP for 664. The forecasted annual *change* in GNP for the year ending in 664 is then defined to be this forecasted level of GNP minus the average of the one-quarter-ahead forecast of the level of GNP for 654 and the actual levels of GNP for 653, 652, and 651. The horizon for the second set of annual forecasts in Tables 13–12 and 13–13 is thus one quarter longer than the horizon for the first set.

Looking at the GNP results in the two tables, relatively large errors were made for the years ending in 671, 672, 673, and 674 because of the large error made in forecasting 671. The largest error made in Table 13–12 was 12.39 billion dollars for the second forecast for the year ending in 672, and the largest error made in Table 13–13 was 18.48 billion dollars for the same forecast. The GNP forecasts for the years ending in 681 through 694 in Table 13–12 are all quite good. Only one forecast (the first forecast for the year ending in 694) is even off by as much as 4 billion dollars. The GNP forecasts for the years ending in 681 through 694 in Table 13–13 are also fairly good, although the second forecast for the year ending in 691 is off by 9.78 billion dollars. For the GNP forecasts for the years ending in the fourth quarter (i.e., for the years ending in 664, 674, 684, and 694), the mean absolute errors are 2.69 and 3.74 billion dollars respectively for the first and second forecasts in Table 13–12 and 3.40 and 5.99 billion dollars respectively for the first and second forecasts in Table 13–13.

The other results in Tables 13–12 and 13–13 are as expected from the quarterly results above. In particular, the model has consistently underpredicted the level of the unemployment rate throughout the period and has slightly underpredicted the rate of inflation in 1969.

Table 13–12. Actual and Forecasted Annual Changes for Selected Variables of the Model. (Forecasts are outside-sample forecasts and are based on actual values of the exogenous variables. Forecasts for UR_t are in terms of levels.)

Year Ending in	GNP_t	$CD_t + CN_t + CS_t$	IP_t	IH_t	$V_t - V_{t-1}$	IMP_t	PD_t	$GNPR_t$	M_t	$LF_{1t} + LF_{2t}$	UR_t
663	66.00	36.27	11.47	−.70	3.12	5.60	2.22	44.48	2488	1595	.0389
	62.09	34.65	10.85	−.31	−.52	3.90	2.63	38.75	2377	1138	.0284
664	64.95	33.42	10.27	−2.20	5.17	5.77	2.73	40.32	2420	1725	.0379
	68.48	37.27	12.62	−1.04	.05	4.37	2.74	43.39	2847	1249	.0228
	63.26	34.28	10.99	−1.30	−.90	3.75	3.12	36.69	2381	1099	.0231
671	59.45	29.81	8.47	−3.73	4.50	5.12	3.13	32.80	2257	1876	.0376
	66.98	37.36	10.68	−2.26	−.27	4.05	3.28	38.01	2381	1291	.0239
	68.02	37.31	11.58	−2.32	−.54	3.56	3.36	39.13	2754	1226	.0178
672	52.60	28.31	6.45	−4.20	−.52	4.77	3.27	25.53	1938	1956	.0377
	55.16	30.54	8.18	−4.14	−3.15	3.63	3.91	24.28	1687	1222	.0287
	64.99	36.76	9.24	−3.04	−1.49	3.84	3.90	32.98	2177	1229	.0208
673	47.53	25.76	3.92	−3.15	−2.25	3.55	3.29	20.77	1486	2002	.0379
	52.85	30.59	6.39	−3.20	−3.25	4.55	4.16	20.54	1739	1388	.0282
	54.62	31.06	6.62	−3.40	−3.29	3.30	4.31	21.25	1407	1193	.0266
674	43.70	25.99	2.12	−.10	−7.40	2.93	3.23	16.53	1185	1936	.0385
	44.58	24.44	3.75	−.99	−5.47	3.27	4.18	12.23	823	1319	.0332
	53.63	31.72	4.87	−1.28	−3.70	4.12	4.43	18.69	1456	1280	.0268

681	47.80	30.05	2.45	3.18	−8.67	3.20	3.30	18.18	1009	1804	.0383
	46.00	27.84	2.92	1.52	−7.05	3.23	3.67	15.33	859	1234	.0330
	45.49	26.64	3.43	1.28	−6.81	2.97	4.38	11.12	488	1123	.0329
682	56.55	33.21	2.62	5.70	−3.85	4.25	3.64	23.82	1102	1839	.0377
	58.04	33.82	3.88	2.51	−2.44	2.85	3.55	25.55	1148	1255	.0317
	53.54	30.83	3.76	2.54	−3.69	3.34	3.89	19.91	883	1156	.0314
683	64.42	39.37	3.65	6.15	−2.98	6.15	3.89	28.07	1328	1680	.0369
	64.01	35.91	4.54	3.17	−.96	3.03	3.93	27.51	1178	1392	.0333
	65.52	36.73	5.30	2.50	.15	3.50	3.86	29.18	1355	1216	.0300
684	72.18	34.38	5.07	5.22	−.13	7.48†	4.14	32.97	1501	1463	.0356
	69.99	36.74	6.31	2.40	3.72	4.78	4.15	31.13	1586	1504	.0336
	71.93	38.27	6.20	1.39	4.21	3.70	4.18	32.58	1438	1311	.0318
691	75.25	44.92	5.57	4.65	2.97	7.73†	4.41	33.72	1704	1523	.0348
	75.27	41.52	8.09	.48	5.99	7.18	4.24	34.65	1897	1317	.0315
	71.60	38.57	7.32	−.26	4.49	4.94	4.28	31.37	1696	1346	.0326
692	72.98	45.27	7.17	3.47	.60	7.55†	4.63	30.13	1759	1442	.0345
	72.19	42.71	7.29	−.61	3.63	6.13	4.35	30.96	1720	1293	.0334
	70.51	41.70	8.37	−1.46	2.95	6.34	4.30	29.87	1775	1185	.0310
693	70.57	41.70	9.28	2.93	1.62	6.68†	4.97	25.87	1817	1648	.0347
	74.31	45.39	7.62	.19	4.92	6.73	4.40	31.99	1516	1189	.0337
	69.08	41.43	8.42	−1.61	3.25	5.32	4.41	27.65	1546	1203	.0334
694	66.40	39.35	10.40	2.10	.67	5.85†	5.31	19.95	1841	1987	.0352
	70.55	41.58	10.20	.68	3.57	5.94	4.60	27.15	1445	1214	.0337
	69.47	42.15	9.04	−.35	4.28	5.80	4.51	26.78	1380	1205	.0342

† Based on adjusted values.

Table 13–13. Actual and Forecasted Annual Changes for Selected Variables of the Model. (Forecasts are outside-sample forecasts and are based on extrapolated values of the exogenous variables. Forecasts for UR_t are in terms of levels.)

Year Ending in	GNP_t	$CD_t + CN_t + CS_t$	IP_t	IH_t	$V_t - V_{t-1}$	IMP_t	PD_t	$GNPR_t$	M_t	$LF_{1t} + LF_{2t}$	UR_t
663	66.00	36.27	11.47	−.70	3.12	5.60	2.22	44.48	2488	1595	.0389
	61.69	35.04	9.28	.49	−.33	3.88	2.62	38.43	2314	1097	.0288
664	64.95	33.42	10.27	−2.20	5.17	5.77	2.73	40.32	2420	1725	.0379
	68.94	38.22	12.04	−.27	.57	4.39	2.72	43.89	2775	1195	.0240
	62.74	35.24	8.72	.06	−.35	3.72	3.10	36.31	2287	1034	.0240
671	59.45	29.81	8.47	−3.73	4.50	5.12	3.13	32.80	2257	1876	.0376
	69.30	38.93	11.08	−1.58	.50	4.18	3.28	40.65	2384	1159	.0240
	70.97	39.59	11.29	−.65	.65	3.71	3.33	41.86	2769	1155	.0188
672	52.60	28.31	6.45	−4.20	−.52	4.77	3.27	25.53	1938	1956	.0377
	60.18	32.56	9.91	−2.40	−2.12	3.91	3.94	28.48	1841	1159	.0277
	71.08	39.84	10.98	−1.63	.05	4.17	3.91	38.17	2356	1176	.0192
673	47.53	25.76	3.92	−3.15	−2.25	3.55	3.29	20.55	1486	2002	.0379
	56.17	31.24	9.32	−2.62	−2.87	4.76	4.18	23.25	1896	1316	.0277
	63.02	34.13	9.83	−1.18	−1.75	3.76	4.39	28.06	1769	1098	.0245
674	43.70	25.99	2.12	−.10	−7.40	2.93	3.33	16.53	1185	1936	.0385
	45.17	23.27	4.95	−.89	−5.75	3.30	4.22	12.55	928	1274	.0313
	59.31	32.67	9.66	−.73	−3.29	4.47	4.50	23.21	1752	1187	.0253

681	47.80	30.05	2.45	3.18	−8.67	3.20	3.30	18.88	1009	1804	.0383
	48.92	27.99	3.43	1.14	−6.99	3.41	3.72	17.57	1100	1181	.0304
	44.93	24.38	4.70	1.17	−7.60	2.94	4.45	10.32	563	1018	.0307
682	56.55	33.21	2.62	5.70	−3.85	4.25	3.64	23.82	1102	1839	.0377
	58.18	33.97	4.10	2.22	−2.41	2.86	3.59	25.47	1221	1073	.0318
	55.22	30.93	4.49	2.04	−3.91	3.45	3.98	20.84	1084	1035	.0285
683	64.42	39.37	3.65	6.15	−2.98	6.15	3.89	28.07	1328	1680	.0369
	60.24	35.37	3.17	3.28	−.96	2.81	3.92	24.39	1035	1327	.0332
	64.04	36.63	5.41	2.32	.14	3.41	3.92	27.60	1357	1014	.0299
684	72.18	34.18	5.07	5.22	−.13	7.48†	4.14	32.97	1501	1463	.0356
	65.04	35.32	6.78	2.97	3.00	4.47	4.11	27.20	1353	1511	.0339
	66.44	37.89	4.39	1.95	4.13	3.39	4.16	28.11	1193	1251	.0316
691	75.25	44.92	5.57	4.65	2.97	7.73†	4.41	33.72	1704	1523	.0348
	71.79	41.11	7.44	.81	5.92	6.92	4.22	31.89	1708	1390	.0304
	65.47	36.68	7.21	.83	3.68	4.55	4.21	26.68	1380	1363	.0328
692	72.98	45.27	7.17	3.47	.60	7.55†	4.63	30.13	1759	1442	.0345
	70.29	42.12	7.13	.01	3.50	6.00	4.35	29.45	1628	1381	.0318
	66.49	41.21	7.35	−.90	2.86	6.04	4.26	26.80	1549	1267	.0296
693	70.57	41.70	9.28	2.97	1.62	6.68†	4.97	25.87	1817	1648	.0347
	68.78	43.86	3.72	.14	4.60	6.30	4.37	27.66	1304	1161	.0350
	66.87	40.54	7.92	−.76	2.95	5.16	4.40	25.93	1431	1318	.0311
694	66.40	39.35	10.40	2.10	.67	5.85†	5.31	19.95	1841	1987	.0352
	67.40	40.66	7.97	.16	3.19	5.69	4.59	24.65	1347	1199	.0340
	62.02	40.38	3.88	−.73	3.55	5.22	4.45	21.05	1067	1179	.0356

† Based on adjusted values.