9

Testing the MC Model

9.1 Introduction

This chapter is concerned with testing the overall MC model. It is the counterpart of Chapter 8 for the US model. There are, however, many fewer tests in this chapter than there are in Chapter 8. The main problem here is the short length of many of the sample periods. Many of these periods do not begin until the 1970s, which effectively rules out, for example, the successive reestimation that was done in Sections 8.6, 8.7, and 8.8 for the US model. Therefore, the main testing of the MC model must rely on within sample predictions, although some outside sample results are reported in this chapter.

The size of the MC model is discussed in Section 9.2, and the solution of the model is explained. Section 9.3 then presents the model to which the MC model is to be compared. This model, called ARMC, replaces each of the stochastic equations of the ROW model with a fourth order autoregressive equation for the quarterly countries and a second order autoregressive equation for the annual countries. The within sample test results are discussed in Section 9.4, and the outside sample test results are discussed in Section 9.5.

9.2 The Size and Solution of the MC model

The US model, which is part of the MC model, includes 30 stochastic equations plus one more when it is imbedded in the MC model. This additional equation is discussed below. There are 32 countries in the ROW model and up to 15 stochastic equations per country. If each country had all 15 equations, there would be a total of 480 (32×15) stochastic equations in the ROW model. Because of data limitations, however, not all countries have all equations, and there are in fact 315 stochastic equations in the ROW model. Given the 31 stochastic equations in the US model, there are thus 346 stochastic equations in the MC model. There are a total of 1541 unrestricted coefficients in these equations, counting the autoregressive coefficients of the error terms. In addition, as discussed in Section 6.16, there are 1299 estimated trade share equations. Not counting the trade share coefficient estimates, all the coefficient estimates for the US model are presented in Tables 5.1–5.30, and all the coefficient estimates for the ROW model are presented in Tables 6.1a–6.15a. These are the estimates that were used for the within sample results below.

Table B.1 shows that there are in the ROW model 19 variables determined by identities, 4 variables determined when the countries are linked together, and 22 exogenous variables per country. Counting these variables, various transformations of the variables that are needed for the estimation, and the US variables (but not the trade shares), there are about 4000 variables in the MC model.

The way in which the US model is imbedded in the MC model is explained in Table B.5. The two key variables that are exogenous in the US model but become endogenous in the overall MC model are exports, EX, and the price of imports, PIM. EX depends on $X85\$_{US}$, which is determined in Table B.4. PIM depends on PM_{US}, which depends on PMP_{US}, which is also determined in Table B.4.

Feeding into Table B.4 from the US model are PX_{US} and $M85\$A_{US}$. PX_{US} is determined is the same way that PX is determined for the other countries, namely by equation 11. In the US case $\log PX_{US} - \log PW\$_{US}$ is regressed on $\log GDPD - \log PW\$_{US}$. The equation, which is numbered 132 is:

$$\log PX_{US} - \log PW\$_{US} = \lambda(\log GDPD - \log PW\$_{US}) \qquad (132)$$

This equation is estimated under the assumption of a second order autoregressive error for the 1962:1–1992:3 period. The estimate of λ is .956 with a t-statistic of 24.26. The estimates (t-statistics) of the two autoregressive coefficients are 1.50 (19.17) and $-.51$ (-6.55), respectively. The standard error is .0125. Given the predicted value of PX_{US} from equation 132, PEX is determined by the identity listed in Table B.5: $PEX = DEL3 \cdot PX_{US}$. This identity replaces identity 32 in Table A.3 in the US model.

$M85\$A_{US}$, which, as just noted, feeds into Table B.4, depends on M_{US}, which depends on IM. This is shown in Table B.5. IM is determined by equation 27 in the US model. Equation 27 is thus the key equation that determines the U.S. import value that feeds into Table B.4.

The main exogenous variables in the overall MC model are the government spending variables (G). In other words, fiscal policy is exogenous. Monetary policy is not exogenous because of the use of the interest rate and exchange rate reaction functions.

Because some of the countries are annual, the overall MC model is solved a year at a time. A solution period must begin in the first quarter of the year. In the following discussion, assume that year 1 is the first year to be solved. The overall MC model is solved as follows:

1. Given values of $X85\$$, PMP, and $PW\$$ for all four quarters of year 1 for each quarterly country and for year 1 for each annual country, all the stochastic equations and identities are solved. For the annual countries "solved" means that the equations are passed through k_1 times for year 1, where k_1 is determined by experimentation (as discussed below). For the quarterly countries "solved" means that quarter 1 of year 1 is passed through k_1 times, then quarter 2 k_1 times, then quarter 3 k_1 times, and then quarter 4 k_1 times. The solution for the quarterly countries for the four quarters of year 1 is a dynamic simulation in the sense that the predicted values of the endogenous variables from previous quarters are used, when relevant, in the solution for the current quarter.

2. Given from the solution in step 1 values of E, PX, and $M85\$A$ for each country, the calculations in Table B.4 can be performed. Since all the calculations in Table B.4 are quarterly, the annual values of E, PX, and $M85\$A$ from the annual countries have to be converted to quarterly values first. This is done in the manner discussed at the bottom of Table B.4. The procedure in effect takes the distribution of the annual values into the quarterly values to be exogenous. The second task is to compute $PX\$$ using equation L-1. Given the values of $PX\$$, the third task is to compute the values of α_{ij} from the trade share equations—see equation 6.13 in Section 6.16. This solution is also dynamic in the sense that the predicted value of α_{ij} for the previous quarter feeds into the solution for the current quarter. (Remember that the lagged value of α_{ij} is an explanatory variable in the trade share equations.) The fourth task is to compute $X85\$$, PMP, and $PW\$$ for each country using equations L-2, L-3, and L-4. Finally, for the annual countries the quarterly values of these three variables are then converted to annual values by summing in the case of $X85\$$ and averaging in the case of PMP and $PW\$$.

3. Given the new values of $X85\$$, PMP, and $PW\$$ from step 2, repeat step 1 and then step 2. Keep repeating steps 1 and 2 until they have been done k_2 times. At the end of this, declare that the solution for year 1 has been obtained.

4. Repeat steps 1, 2, and 3 for year 2. If the solution is meant to be dynamic, use the predicted values for year 1 for the annual countries and the predicted values for the four quarters of year 1 for the quarterly countries, when relevant, in the solution for year 2. Continue then to year 3, and so on.

I have found that going beyond $k_1 = 4$ and $k_2 = 7$ leads to very little change in the final solution values, and these are the values of k_1 and k_2 that have been used for the results in this chapter and in Chapter 12.

Stochastic Simulation of the MC Model in the Future

Although no stochastic simulation experiments using the MC model were performed for the present work, it should be possible in future work, with a few adjustments, to do so. Since the MC model has 346 stochastic equations and 1541 unrestricted coefficients, the covariance matrix of the error terms is 346×346 and the covariance matrix of the coefficient estimates is 1541×1541. Some of the problems that arise in dealing with these matrices are the following. First, some of the equations are estimated using quarterly data and some using annual data. Second, even if the periodicity of the data were the same, there are not enough observations to estimate the covariance matrix of the error terms unconstrained. Third, the estimation periods generally differ across countries. The best way to handle these problems is probably to take the covariance matrices to be block diagonal, one block per country. In some cases one may also want to take the covariance matrix of the coefficient estimates within a country to be block diagonal, one block per equation.

The computer time needed to solve the MC model once is still large enough to make stochastic simulation costly in time. Even using the block diagonal matrices just discussed, stochastic simulation would not be routine using, say, 486 computers. This computer restriction should, however, be eased considerably with the next generation of chips, and so in a few years it should be possible to perform the same type of calculations for the MC model as were performed in Chapters 8 and 11 for the US model.

9.3 The ARMC Model

In order to decide how good or bad the MC model predicts the data, one needs a basis of comparison. Two VAR models and an AC model were used for this purpose for the US model. A model that has some similarities to the AC model was used as the basis of comparison for the MC model. This model will be called the "ARMC" model. It is simple to describe. Each of the stochastic equations for the quarterly countries (except the US) is replaced with an autoregressive equation in which the left hand side variable is regressed on a constant term, a linear time trend, and the first four lagged values of the variable. For the annual countries only the first two lagged values are used.[1] The MC and ARMC models differ only in this treatment of the stochastic equations. The US model is the same for both models; all the identities are the same;[2] and the trade share calculations are the same.

The ARMC is like the AC model in that the components of GDP are regressed on their lagged values and the GDP identity is used. It differs from the AC model in that 1) regressions are not performed for components that are not determined by stochastic equations in the MC model, 2) regressions are performed for all the variables determined by stochastic equations, not just the components, and 3) all the identities are used, not just the GDP identity.

Each equation of the ARMC model was estimated over the same sample period as was used for the corresponding equation for the MC model. The model is solved in the same way as the MC model.

[1]With the following five exceptions, the left hand side variable for the ARMC model for each equation is the same as that for the MC model. The exceptions are 1) equation 4, where the left hand side variable is $V1$ rather than Y, 2) equation 8, with RB rather than $RB - RS_{-2}$, 3) equation 9, with $\log E$ rather than $\log(E/E_{-1})$, 4) equation 11, with $\log PX$ rather than $\log PX - \log(PW\$ \cdot E)$, and 5) equation 12, with $\log W$ rather than the left hand side variable used to account for the coefficient restriction. Also, because $V1$ is used for the left hand side variable for equation 4, the identity I-4 is changed from $V1 = Y - X$ to $Y = X + V1$.

[2]With the exception noted in the previous footnote.

9.4 Within Sample RMSEs

Given the data availability, the longest period[3] over which the MC model could be solved was 1972–1990. A series of two year (eight quarter) ahead predictions were run over the period. The first prediction began in 1972, the second one in 1973, and so on through 1990. For each endogenous variable this results in 19 one year ahead forecasts and 18 two year ahead forecasts for the annual countries. For the quarterly countries there were 19 one through four quarter ahead forecasts and 18 five through eight quarter ahead forecasts.[4] Given the forecast values, root mean squared errors (RMSEs) were computed. The same forecasts were made using the ARMC model, and RMSEs were computed.

The results from this work are presented in Table 9.1. Presented in the table for each of 17 variables for each country is the ratio of the MC RMSE to the ARMC RMSE. For the quarterly countries ratios are presented for the one quarter ahead, four quarter ahead, and eight quarter ahead RMSEs, and for the annual countries ratios are presented for the one year ahead and two year ahead RMSEs. A ratio less than one means that the MC model is more accurate, and a ratio greater than one means that the ARMC model is more accurate.

Presented at the top of Table 9.1 for each variable is a weighted average of all the results. The weight used for a country is the ratio of its GDP in 1985 in U.S. dollars to the total for all the countries.[5] The first row, labelled I, is the weighted average of the four quarter ahead results for the quarterly countries and the one year ahead results for the annual countries. The second row, labelled II, is the weighted average of the eight quarter ahead results for the quarterly countries and the two year ahead results for the annual countries. These summary results were obtained by taking weighted averages of the individual RMSEs and then computing the ratio of the weighted averages, rather than by taking weighted averages of the individual ratios. The following discussion will concentrate on the weighted averages.

Consider first the results for the exchange rate in Table 9.1. On average

[3]In order to use the complete 1972–1990 period, the following countries were dropped in the solution of the model for the following periods: NE: 1972–1976; FI: 1972–1976; NO: 1972–1973; and MA: 1987–1990. Data on some of the variables did not exist for these countries for the respective periods.

[4]Remember that each prediction period begins in the first quarter of the year for the quarterly countries. This is contrary to the case for the US model in Chapter 8, where a new prediction period began each quarter.

[5]GDP in U.S. dollars is $(PY \cdot Y)/E$.

the MC model does not do quite as well as the ARMC model. For the one year ahead results the weighted average ratio is 1.05, and for the two year ahead results it is 1.17. It is well known that structural exchange rate equations have a hard time beating autoregressive equations, and the results in Table 9.1 are examples of this. On average, however, the results are only slightly worse for the structural model. Also, as will be seen in the next section, the outside sample exchange rate results favor MC over ARMC.

Other variables for which the ARMC model is more accurate than the MC model are the price of exports (PX) and the price of imports (PM). The results are mixed for GDP (Y), exports ($X85\$$), and the wage rate (W). For the remaining variables—the price deflator (PY), the interest rate (RS), imports (M), consumption (C), investment (I), the balance of payments (S), and the unemployment rate (UR)—the MC model is more accurate than the ARMC model. On average the result seem reasonably good for the MC model. The model appears to have explanatory power beyond that contained in the lagged values and the time trend.

The results for the United States are presented in Table 9.2. The RMSEs in the rows labelled "MC" are from the same MC solutions used for the results in Table 9.1. The RMSEs in the rows labelled "US" are from the solutions for the US model alone. The same 19 prediction periods were used for the US model alone as were used for the MC model. For the US model alone exports (EX) and the price of imports (PIM) are exogenous.

The results in Table 9.2 show how the accuracy of the US model changes when it is imbedded in the MC model. For real GDP, the RMSE increases between 7 and 27 percent when the US model is imbedded in the MC model. For the GDP deflator the increases (after the first quarter) are between 18 and 66 percent. There is very little change for the unemployment rate and the bill rate. Much of the increase for the GDP deflator is due to the effect of errors made in predicting the price of imports. The RMSE for the price of imports ranges from 2.69 percent for the one quarter ahead forecast to 8.11 percent for the eight quarter ahead forecast. Similarly, much of the increase for real GDP is due to the effect of errors made in predicting exports. The RMSE for exports ranges from 2.29 percent for the one quarter ahead forecast to 6.16 percent for the eight quarter ahead forecast.

Table 9.1
Ratios of Within Sample RMSEs 1972-1990: AC/ARMC

		Y	PY	RS	E	M	C	I	$V1/Y$	$X85\$$
I	All	.95	.93	.80	1.05	.75	.95	.90	1.08	.94
II	All	1.11	.79	.96	1.17	.75	1.00	.90	1.12	1.04
1	CA	.87	1.20	.96	1.02	.68	.80	.96	1.19	.99
4	CA	1.06	1.18	.93	1.06	.57	.88	1.06	1.04	1.04
8	CA	1.08	.93	.82	1.11	.49	.83	1.08	.97	1.10
1	JA	.91	1.16	1.25	1.00	.78	1.01	.97	1.10	.97
4	JA	1.02	1.02	.69	1.12	.66	.88	.92	.94	.95
8	JA	1.37	.66	.98	1.37	.62	1.10	1.05	.89	1.09
1	AU	.99	1.05	.75	1.03	.82	1.10	–	1.26	1.02
4	AU	1.24	.67	1.11	1.08	.93	1.48	–	1.16	.83
8	AU	1.41	.83	1.35	1.14	1.07	1.54	–	1.36	.96
1	FR	.61	.90	.99	.98	.62	1.14	1.20	1.20	.77
4	FR	.86	.82	.74	1.00	.83	1.21	.92	.99	.83
8	FR	1.20	1.07	.99	1.03	.88	1.41	.91	1.02	1.00
1	GE	.73	.85	.80	1.03	.92	1.11	1.16	1.08	.86
4	GE	.85	.75	.94	1.09	.68	.74	.95	.93	.87
8	GE	.85	.62	.99	1.14	.66	.68	.82	.97	1.00
1	IT	.57	.80	.84	.95	.67	.92	1.12	1.00	1.08
4	IT	1.26	.72	.64	1.02	.91	1.11	.87	1.34	.95
8	IT	1.71	.75	.95	1.00	1.01	1.38	1.12	1.52	1.05
1	NE	.90	1.06	.75	1.01	1.03	1.19	–	1.71	.78
4	NE	.93	.77	.98	1.08	.96	1.02	–	1.02	.81
8	NE	.84	.87	1.03	1.08	.96	.83	–	.98	1.13
1	ST	1.19	.96	.81	1.02	1.09	1.00	–	–	.85
4	ST	1.48	1.11	1.18	1.04	1.15	1.01	–	–	.88
8	ST	1.83	1.41	1.20	1.13	1.31	.95	–	–	.99
1	UK	.89	1.23	.90	.95	1.01	.85	.91	.89	1.02
4	UK	.81	.95	.87	1.01	.68	.76	.76	.91	1.03
8	UK	.79	.65	.86	1.13	.89	.85	.67	.94	1.03
1	FI	.81	.97	.90	.95	.83	.93	–	1.44	1.06
4	FI	.91	.72	1.02	1.06	.76	.89	–	1.00	1.19
8	FI	1.17	.77	1.11	1.12	.82	1.02	–	1.21	2.03
1	AS	.84	.80	1.01	1.07	.80	.96	–	1.01	.96
4	AS	.98	.97	.86	1.10	.71	1.10	–	.84	.76
8	AS	1.27	.78	.90	1.23	.74	1.42	–	.84	.95
1	SO	.99	1.11	1.05	1.06	.76	.91	1.08	–	1.18
4	SO	.86	1.33	1.19	.95	.65	.84	.97	–	.84
8	SO	1.03	1.61	1.41	.96	.82	.95	.95	–	.75
1	KO	.79	.97	1.01	1.02	.98	1.18	–	.87	.95
4	KO	.82	.98	.98	1.13	.92	.93	–	1.18	.93
8	KO	.85	.82	.97	1.18	.92	.93	–	.94	.97
1	BE	.54	.94	.62	.79	.59	.76	.69	.88	.70
2	BE	.48	.94	.73	1.11	.80	.71	.55	.90	.78
1	DE	1.05	.87	.94	.78	.93	1.33	1.01	.97	.80
2	DE	1.08	.63	1.05	1.04	1.16	1.42	.91	.95	1.27
1	NO	1.08	1.05	.88	.74	.65	1.31	–	–	.88
2	NO	1.37	1.24	.81	1.08	.69	1.23	–	–	.92
1	SW	.47	.84	.87	.84	.67	.89	.81	1.70	.69
2	SW	.58	.96	1.05	1.10	.89	.90	.87	1.59	.91
1	GR	.87	.87	–	.82	.86	1.05	1.11	.66	.97
2	GR	.89	.88	–	1.07	.93	.98	1.08	.68	.96
1	IR	.88	.82	.74	.74	1.06	1.07	1.07	1.08	.94
2	IR	.96	.69	.86	1.11	1.33	1.04	1.22	1.16	.98
1	PO	1.66	1.22	1.06	.90	.90	.76	–	–	.85
2	PO	1.86	1.42	1.11	1.13	.97	.78	–	–	1.10
1	SP	1.12	.68	–	.83	.57	.95	–	.64	.84
2	SP	1.41	.63	–	1.06	.49	.83	–	.62	1.25
1	NZ	.82	.97	1.09	1.54	.42	1.22	–	–	.90
2	NZ	1.02	.96	1.30	1.65	.57	.87	–	–	1.28

Table 9.1 (continued)

		PX	PM	S	W	J	$L1$	$L2$	UR
I	All	1.02	1.05	.87	1.07	.89	1.05	.94	.92
II	All	1.07	1.14	.76	.97	.92	1.23	.96	.89
1	CA	1.17	.98	.78	1.31	1.03	.95	–	1.03
4	CA	1.11	1.04	.67	1.25	.84	1.03	–	.84
8	CA	1.01	1.04	.50	1.18	.85	1.13	–	.86
1	JA	1.06	1.13	.97	1.18	.88	1.15	.95	.81
4	JA	1.08	1.23	1.12	1.22	1.19	1.24	1.01	1.19
8	JA	1.29	1.54	.99	1.04	1.63	1.86	1.02	1.49
1	AU	1.00	1.13	1.00	1.57	1.08	1.02	.98	1.04
4	AU	.95	1.19	.91	1.51	.96	1.03	1.00	1.34
8	AU	1.03	1.09	.62	1.65	1.05	1.05	1.01	1.10
1	FR	1.03	1.02	.69	.93	–	–	–	–
4	FR	.98	.89	.82	1.06	–	–	–	–
8	FR	.92	.87	1.00	1.06	–	–	–	–
1	GE	1.09	1.19	.89	1.09	1.04	1.07	–	1.13
4	GE	1.12	1.12	.90	.75	.88	.90	–	.88
8	GE	1.06	1.18	.92	.69	.80	.93	–	.69
1	IT	.97	1.06	.80	1.06	1.23	1.13	1.17	.90
4	IT	.78	.84	.63	.71	.88	.99	.96	.81
8	IT	.82	.76	.69	.73	1.24	1.08	1.28	.94
1	NE	1.35	1.01	1.10	.97	–	–	–	–
4	NE	1.28	.97	.91	.63	–	–	–	–
8	NE	1.38	.96	1.27	.67	–	–	–	–
1	ST	.98	1.13	1.17	–	1.02	.88	.91	1.62
4	ST	1.03	1.14	1.34	–	1.05	.93	.92	1.46
8	ST	1.15	1.10	1.40	–	.85	1.00	.97	.98
1	UK	.95	1.02	.91	1.24	.83	1.04	–	1.16
4	UK	.79	1.03	1.02	.78	.55	1.03	–	.78
8	UK	.70	1.16	.84	.63	.56	1.02	–	.75
1	FI	1.49	.95	.84	1.15	.65	.86	1.00	.81
4	FI	1.61	.88	.98	1.18	.76	.80	.89	.66
8	FI	1.46	.76	.87	1.04	.57	1.04	.91	.45
1	AS	1.07	1.03	.95	–	.81	1.03	.98	1.16
4	AS	1.27	1.09	1.07	–	.54	.97	.91	.53
8	AS	1.38	1.14	1.09	–	.46	.89	.86	.46
1	SO	1.05	.92	.65	–	–	–	–	–
4	SO	1.15	.74	.50	–	–	–	–	–
8	SO	1.31	.71	.36	–	–	–	–	–
1	KO	1.05	.96	.91	1.95	–	–	–	–
4	KO	.96	1.04	1.11	2.32	–	–	–	–
8	KO	1.03	1.15	.97	1.72	–	–	–	–
1	BE	.91	.61	.45	.88	.87	.78	.57	.81
2	BE	.94	.93	.62	.78	.65	.85	.61	.58
1	DE	.75	.71	.70	.90	.84	1.00	1.04	.85
2	DE	.87	.91	.68	.91	.89	1.01	1.08	.88
1	NO	1.08	.94	.94	1.35	1.69	1.40	–	1.46
2	NO	1.15	1.04	.91	1.56	1.73	1.74	–	1.56
1	SW	1.01	.88	.83	1.20	.95	1.11	1.15	.75
2	SW	1.02	1.10	.95	1.13	.98	1.34	1.26	.66
1	GR	1.04	.77	.85	.97	–	–	–	–
2	GR	1.06	.83	.84	1.09	–	–	–	–
1	IR	.87	.69	.61	1.00	.98	–	–	.96
2	IR	.87	.81	.48	1.15	1.03	–	–	1.01
1	PO	1.12	.93	1.06	–	–	–	–	–
2	PO	1.27	1.11	1.03	–	–	–	–	–
1	SP	.83	.72	.58	1.23	.77	.93	.70	1.13
2	SP	.87	.97	.46	1.27	.58	.86	.49	.99
1	NZ	1.03	1.23	.82	1.03	–	–	–	–
2	NZ	1.00	1.20	.74	1.04	–	–	–	–

Table 9.1 (continued)

		Y	PY	RS	E	M	C	I	$V1/Y$	$X85\$$	PX	PM	S
1	SA	.82	–	–	–	1.23	.91	.83	1.60	.98	–	1.03	.97
2	SA	.95	–	–	–	1.15	1.00	.61	1.47	.89	–	1.02	.75
1	VE	.83	–	.74	–	.84	.97	–	1.04	1.02	–	1.02	1.08
2	VE	.92	–	.66	–	.76	.99	–	1.13	1.02	–	1.00	.89
1	CO	1.22	1.13	–	–	.56	1.33	–	1.12	1.07	1.08	1.03	.91
2	CO	1.61	1.30	–	–	.62	1.61	–	1.30	1.18	1.13	.99	.58
1	JO	1.10	1.30	–	1.21	.65	.86	–	.96	1.07	1.34	1.16	.79
2	JO	1.18	1.54	–	1.30	.59	.87	–	.97	1.06	1.61	1.12	.73
1	SY	1.04	1.08	–	–	.94	1.01	–	–	1.23	1.14	1.02	.91
2	SY	1.20	1.30	–	–	.77	.75	–	–	1.44	1.29	1.04	.92
1	ID	1.00	–	–	1.08	.97	1.10	–	–	.87	1.00	.94	.99
2	ID	.91	–	–	1.16	.89	.89	–	–	.93	1.31	.82	1.03
1	MA	.71	.90	–	–	.74	.75	–	–	.76	.79	1.05	1.00
2	MA	.69	1.26	–	–	1.21	.69	–	–	.75	.74	1.05	1.00
1	PA	.89	.49	.73	–	1.11	1.04	–	.85	.83	1.14	1.01	.99
2	PA	1.07	.59	.86	–	1.03	1.09	–	1.45	.77	1.28	.98	1.14
1	PH	1.17	1.13	1.13	1.24	.80	1.13	.92	.98	1.06	1.28	1.26	1.65
2	PH	.96	1.15	1.36	1.34	.63	.95	.65	.94	1.27	1.41	1.30	1.49
1	TH	.76	1.40	–	–	.55	.95	–	1.00	1.05	1.05	1.02	.45
2	TH	.95	1.24	–	–	.43	.90	–	1.04	1.12	1.03	1.08	.32

Variables W, J, $L1$, $L2$, and UR are not part of the model for countries SA–TH.
Each number is the ratio of the MC RMSE and the ARMC RMSE.

9.5 Outside Sample RMSEs

As noted at the beginning of this chapter, short sample periods for many countries limit the amount of outside sample work that can be done. The outside sample results in this section are thus very preliminary.

The outside sample results were obtained as follows. First, each of the non US stochastic equations of the MC and ARMC models was estimated through 1986.4 for the quarterly countries and 1986 for the annual countries. These coefficient estimates were then used to predict 1987, 1988, 1989, and 1990. This gave for the annual countries 4 one year ahead forecasts and 3 two year ahead forecast. For the quarterly countries there were 4 one through four quarter ahead forecasts and 3 five through eight quarter ahead forecasts. RMSEs were computed for these forecasts, and the results are presented in Table 9.3. The same weighting scheme was used in Table 9.3 as was used in Table 9.1. When comparing Tables 9.1 and 9.3 remember that, for example, the one year ahead results in Table 9.3 are based on only 4 observations compared to 19 in Table 9.1 and in this sense are less reliable. The following discussion of Table 9.3 will concentrate on the weighted results.

The results in Tables 9.1 and 9.3 differ in that some variables for which the MC model does better in Table 9.1 do worse in Table 9.3 and vice versa. For example, the MC model does much better for the exchange rate in Table 9.3.

Table 9.2
US RMSEs: US Alone Versus US in MC Model

	1	2	3	4	6	8
			$GDPR$: Real GDP			
Alone	.46	.98	1.04	1.36	1.52	1.52
MC	.54	1.05	1.14	1.46	1.93	1.72
MC÷Alone	1.16	1.07	1.09	1.07	1.27	1.13
			$GDPD$: GDP Deflator			
Alone	.45	.48	.68	.75	.99	1.15
MC	.44	.57	.82	.96	1.50	1.92
MC÷Alone	.98	1.18	1.20	1.28	1.52	1.66
			UR: Unemployment Rate			
Alone	.22	.41	.45	.54	.76	.77
MC	.22	.39	.38	.52	.85	.77
MC÷Alone	1.01	.95	.86	.95	1.12	1.00
			RS: Bill Rate			
Alone	.50	1.16	1.75	1.33	1.62	1.75
MC	.52	1.13	1.72	1.38	1.71	1,82
MC÷Alone	1.04	.98	.99	1.03	1.05	1.04
			PIM: Import Price Deflator			
MC	2.69	4.14	5.09	5.44	7.66	8.11
			EX: Exports			
MC	2.29	3.20	3.64	4.47	5.17	6.16

Errors are in percentage points.

The ratio is .57 for both the one year ahead and two year ahead results. From the results in Table 9.3 one would conclude that structural exchange rate equations dominate autoregressive ones. On the other hand, the MC model does worse for the interest rate, where the ratios are 1.52 and 1.61. The other variables for which the MC model does worse are consumption, employment, and the unemployment rate. It does better, sometimes considerably better, for the other variables. Overall, the MC model appears to do somewhat better relative to the ARMC model in Table 9.3 than in Table 9.1. This suggests that the ARMC equations may be somewhat more subject to within sample data mining problems than are the MC equations. Again, however, these results are based on only 3 or 4 observations, and so they are very tentative.

This completes the discussion of the RMSE results. One can get from Tables 9.1 and 9.3 an idea of the accuracy of the model for the individual countries, and this is left to the reader. When more data become available in the future, it will be interesting to put the MC model through more tests. In

Table 9.3
Ratios of Outside Sample RMSEs 1987-1990: MC/ARMC

		Y	PY	RS	E	M	C	I	$V1/Y$	$X85\$$
I	All	.93	1.10	1.52	.57	.86	1.47	.98	.80	.80
II	All	.88	.80	1.61	.57	.81	1.31	.85	.82	.60
1	CA	.43	.89	1.14	.61	.95	1.57	.56	1.02	1.01
4	CA	1.06	.46	1.13	.35	1.79	.29	.74	.85	.48
8	CA	1.01	.41	1.36	.51	.69	.38	.58	.97	.61
1	JA	.69	2.56	5.01	.84	1.21	.52	1.27	3.32	.91
4	JA	1.50	2.82	3.39	.68	.27	1.17	1.29	.27	1.55
8	JA	1.71	2.55	3.36	.73	.56	1.81	1.24	.62	.59
1	AU	1.20	.43	1.14	.95	.80	1.86	–	1.06	.81
4	AU	1.52	.72	2.27	.90	.72	4.53	–	5.18	.54
8	AU	1.06	.80	3.20	.94	1.00	3.70	–	11.21	.43
1	FR	.31	.64	.59	.85	1.15	1.30	.29	.68	.85
4	FR	.17	.95	.37	.67	1.02	2.29	.24	.30	.49
8	FR	.21	.79	.47	.69	.72	2.06	.23	.54	.24
1	GE	.72	.71	2.96	.93	1.69	1.76	.84	1.72	.96
4	GE	.50	.54	3.10	.89	.55	2.28	.42	.64	.73
8	GE	.25	.38	2.51	.90	.49	3.95	.16	.74	.57
1	IT	.52	2.98	.44	.56	.93	2.20	.77	1.89	1.02
4	IT	.95	2.05	.36	.28	.64	1.73	.34	1.00	1.09
8	IT	1.45	1.06	.41	.22	.45	1.70	.30	.94	1.54
1	NE	1.08	.47	.59	.69	.62	1.01	–	2.11	1.74
4	NE	.83	.44	.47	.35	.99	.67	–	.80	.64
8	NE	.33	.20	.57	.27	.81	.55	–	.95	.32
1	ST	1.43	1.31	1.10	.86	1.63	1.94	–	–	.87
4	ST	2.26	1.94	1.41	.98	2.72	1.75	–	–	.74
8	ST	2.30	3.78	1.17	1.33	1.70	.69	–	–	.56
1	UK	1.64	.94	1.35	.66	1.60	2.29	1.67	2.22	.99
4	UK	1.71	.49	2.60	.57	1.97	2.12	1.89	.83	1.07
8	UK	1.33	.30	4.96	.48	1.70	1.52	1.54	.83	1.15
1	FI	.83	2.52	.29	.59	1.15	.86	–	3.90	1.12
4	FI	3.13	2.11	.51	.32	1.53	1.21	–	1.99	2.07
8	FI	2.36	3.56	.50	.26	1.51	1.22	–	1.31	.33
1	AS	1.11	1.04	.61	.55	.61	1.03	–	1.17	.77
4	AS	.71	.73	.76	.55	.53	1.46	–	.72	.58
8	AS	.74	.40	.47	.48	.58	1.67	–	.67	.70
1	SO	.75	1.52	2.49	.28	1.92	.70	.36	–	.60
4	SO	.27	2.11	2.02	.22	1.42	1.52	1.00	–	.29
8	SO	.57	2.46	5.03	.23	1.50	2.32	.43	–	.20
1	KO	.75	2.64	1.06	.57	3.76	2.99	–	1.20	.88
4	KO	.38	4.88	.50	.51	8.98	4.44	–	1.64	.73
8	KO	.60	3.39	.22	.63	15.10	2.18	–	1.05	.62
1	BE	.40	.58	.30	.50	2.71	1.48	.92	.24	.49
2	BE	.20	.69	.45	.60	1.84	.97	.82	.25	.23
1	DE	1.13	.24	2.15	.60	.81	4.09	3.28	1.79	.61
2	DE	.98	.24	2.52	.99	1.31	9.27	3.26	1.66	.38
1	NO	1.39	.89	.30	.64	2.04	.69	–	–	1.07
2	NO	1.21	.69	.22	.96	4.19	.51	–	–	.95
1	SW	.18	.11	.50	.46	.80	1.25	.74	2.24	.57
2	SW	.16	.18	.90	.51	.97	.88	.64	1.45	.38
1	GR	1.64	1.05	–	.85	.66	1.10	5.96	.82	.94
2	GR	1.88	.53	–	.91	.88	.79	6.18	.89	.55
1	IR	2.42	.52	.36	.25	1.19	4.84	3.38	2.35	1.58
2	IR	3.38	.43	.44	.28	2.15	4.94	4.48	1.11	2.02
1	PO	7.13	.64	.06	.54	1.19	4.65	–	–	.93
2	PO	8.48	.58	.05	.63	.62	5.11	–	–	.86
1	SP	.49	.79	–	.46	.49	.33	–	.60	.73
2	SP	1.59	.70	–	.71	.42	.17	–	.30	.51
1	NZ	1.10	.27	1.15	1.15	.90	3.66	–	–	.50
2	NZ	1.01	.21	1.42	1.44	.96	4.59	–	–	.50

Table 9.3 (continued)

		PX	PM	S	W	J	$L1$	$L2$	UR
I	All	.65	.55	.58	.65	1.37	1.09	.85	1.39
II	All	.50	.47	.38	.50	1.27	1.39	.82	1.33
1	CA	.94	.44	.69	1.33	.69	1.57	–	1.65
4	CA	.51	.26	.48	1.01	1.12	3.06	–	1.50
8	CA	.42	.45	.14	.88	.97	2.55	–	1.31
1	JA	1.21	1.00	.75	1.09	.96	.48	1.08	1.17
4	JA	1.59	.69	.42	.42	1.70	1.10	1.44	1.59
8	JA	1.60	.66	.18	.32	1.92	2.77	1.52	1.44
1	AU	.67	.77	.61	1.52	.67	1.64	1.47	.88
4	AU	.42	1.09	2.45	3.10	1.61	1.11	2.30	6.97
8	AU	.23	.92	1.75	2.78	.82	.61	3.30	4.98
1	FR	.53	.57	.61	.94	–	–	–	–
4	FR	.21	.73	.60	.69	–	–	–	–
8	FR	.13	.59	.75	.41	–	–	–	–
1	GE	.71	.66	1.16	1.92	1.23	1.07	–	1.61
4	GE	.51	1.50	1.42	.09	1.22	.81	–	1.37
8	GE	.38	1.62	1.23	.13	.57	.68	–	.65
1	IT	.53	.92	1.88	.31	.87	1.00	1.29	.80
4	IT	.17	.20	.21	.23	.61	.99	.28	.41
8	IT	.14	.11	.16	.19	.14	1.16	.25	.11
1	NE	.60	.47	.29	.73	–	–	–	–
4	NE	.29	.19	.09	.16	–	–	–	–
8	NE	.39	.12	.07	.05	–	–	–	–
1	ST	.77	.74	1.34	–	3.82	2.43	5.53	3.46
4	ST	1.01	1.13	1.85	–	4.64	3.50	7.31	1.29
8	ST	1.14	1.40	1.81	–	3.25	4.00	4.70	2.27
1	UK	.93	.42	1.19	1.09	2.25	.82	–	2.21
4	UK	.58	.66	1.43	.57	2.19	.51	–	2.82
8	UK	.42	.37	1.10	.43	2.24	.32	–	2.88
1	FI	1.31	.34	.40	.85	1.60	.87	1.70	.43
4	FI	.67	.23	.15	3.08	.69	.60	1.31	.98
8	FI	.37	.18	.09	5.06	.78	.72	1.17	.73
1	AS	.81	1.13	.60	–	.63	1.02	.89	.78
4	AS	.82	.75	.77	–	.65	1.02	1.06	.84
8	AS	.69	.39	1.92	–	.34	.95	1.03	1.52
1	SO	1.79	.18	.25	–	–	–	–	–
4	SO	2.03	.14	.06	–	–	–	–	–
8	SO	2.54	.14	.15	–	–	–	–	–
1	KO	.56	.52	1.86	4.32	–	–	–	–
4	KO	.32	.53	10.31	3.56	–	–	–	–
8	KO	.34	.68	7.53	3.12	–	–	–	–
1	BE	.33	.31	.46	1.10	2.14	.92	.73	2.05
2	BE	.16	.23	.13	1.97	1.71	.66	.58	1.60
1	DE	.56	.51	.93	.77	1.10	.92	.85	1.34
2	DE	.53	.76	.50	1.06	1.23	.88	.78	1.32
1	NO	1.15	.99	1.13	3.94	.76	1.79	–	.47
2	NO	1.16	.91	1.51	4.65	.65	1.77	–	.41
1	SW	.48	.54	.52	1.05	.77	1.49	1.85	.49
2	SW	.34	.43	.51	.46	.96	2.18	2.84	.15
1	GR	1.69	.41	.78	1.41	–	–	–	–
2	GR	2.17	.19	.42	1.88	–	–	–	–
1	IR	.81	.39	.43	2.06	2.21	–	–	2.16
2	IR	.92	.21	.16	1.52	4.93	–	–	4.85
1	PO	1.69	.83	1.95	–	–	–	–	–
2	PO	1.39	.93	1.46	–	–	–	–	–
1	SP	.33	.40	.18	.75	.67	1.15	.49	.96
2	SP	.31	.61	.07	.74	.33	1.14	.35	2.77
1	NZ	1.94	1.29	1.88	.57	–	–	–	–
2	NZ	2.48	2.94	2.00	.53	–	–	–	–

Table 9.3 (continued)

		Y	PY	RS	E	M	C	I	$V1/Y$	$X85\$$	PX	PM	S
1	SA	.59	–	–	–	.81	.39	.75	1.03	1.10	–	.74	1.06
2	SA	.48	–	–	–	.25	.26	.59	.42	1.41	–	.78	1.43
1	VE	.54	–	1.22	–	.95	.81	–	2.05	1.10	–	.70	1.31
2	VE	.39	–	1.20	–	.76	.97	–	2.77	1.09	–	.70	1.17
1	CO	1.65	.74	–	–	.52	1.32	–	1.13	1.13	1.37	.77	1.04
2	CO	2.78	.89	–	–	.39	1.63	–	1.23	1.10	2.59	.74	.99
1	JO	2.63	1.04	–	1.12	.31	1.15	–	1.37	.96	1.04	1.01	1.33
2	JO	2.46	.99	–	1.16	.20	.85	–	1.68	.98	1.01	1.07	2.56
1	SY	1.20	1.60	–	–	1.00	2.45	–	–	1.14	7.75	.77	2.83
2	SY	1.11	1.50	–	–	1.32	10.02	–	–	1.55	6.28	.93	2.17
1	ID	1.20	–	–	.69	1.29	1.18	–	–	.68	.68	.63	.87
2	ID	.71	–	–	.66	1.18	.79	–	–	.68	.74	.68	.75
1	MA	1.36	–	–	–	–	–	–	–	.68	–	.89	.14
2	MA	–	–	–	–	–	–	–	–	.58	–	–	–
1	PA	.90	.57	2.51	–	.77	.78	–	4.91	.89	1.07	.79	.95
2	PA	2.85	.50	3.99	–	1.02	1.62	–	3.31	.59	.96	.93	1.29
1	PH	.82	5.58	2.58	1.59	1.04	.72	.62	.94	1.01	3.09	1.04	1.73
2	PH	.71	8.52	3.09	1.97	.66	3.85	.59	.79	.86	1.86	1.13	1.26
1	TH	3.41	1.01	–	–	.67	1.54	–	4.53	.72	.42	.54	.37
2	TH	2.84	.96	–	–	.50	1.43	–	4.48	.75	.25	.60	.17

Variables W, J, $L1$, $L2$, and UR are not part of the model for countries SA–TH.
Each number is the ratio of the MC RMSE and the ARMC RMSE.

particular, it will be interesting to see if the ARMC forecasts contain information not in the MC forecasts, which if true would suggest that the MC model has not handled all the lags right. Other testing techniques will also become available when stochastic simulation of the MC model becomes practical. The possible future use of stochastic simulation of the MC model is discussed in Section 9.2.