9 Evaluating Static and Dynamic Properties

9.1 Introduction

A useful way of examining the properties of a model is to consider how the predicted values of the endogenous variables change when one or more exogenous variables are changed. This exercise is usually called multiplier analysis, although the use of the word "multiplier" is somewhat misleading. The output that one looks at from this exercise does not have to be the change in the endogenous variable *divided by* the change in the exogenous variable; it can merely be, for example, the change or percentage change in the endogenous variable itself. Indeed, if more than one exogenous variable has been changed, there is no obvious thing to divide the change in the endogenous variable by. The form of the output that is examined depends on the nature of the problem, and thus the word "multiplier" should be interpreted in a very general way.

The procedure that is usually used to compute multipliers is discussed in Section 9.2. It is based on the use of deterministic simulations. An alternative procedure, which is based on the use of stochastic simulations, is discussed in Section 9.3. The main advantage of using stochastic simulations is that it also allows standard errors of the multipliers to be estimated. Given the obvious importance of knowing how much confidence to place in the results from any given policy experiment in a model, the ability to estimate standard errors is a significant advantage. Results for the US model are discussed in Section 9.4, and results for the MC model are discussed in Section 9.5.

9.2 Use of Deterministic Simulations

Let x_t^a denote a "base" set of exogenous variable values for period t, and let x_t^b denote an alternative set. In most applications the base values are the actual values, although this is not always true. If, for example, the prediction period is beyond the end of the data, the base values must be guessed values. Assume that the prediction period begins in period t and is of length T. Given (1) the initial conditions as of the beginning of period t, (2) the coefficient

estimates, (3) a set of exogenous variable values for the entire period, and (4) values of the error terms for the entire period (usually zero), the predicted values of the endogenous variables can be computed using the Gauss-Seidel technique. Let $\hat{y}^a_{itk}$ denote the k-period-ahead predicted value of endogenous variable i from the simulation that uses x^a_{t+k-1} ($k = 1, 2, \ldots, T$) for the exogenous variable values, and let $\hat{y}^b_{itk}$ denote the predicted value from the simulation that uses x^b_{t+k-1} ($k = 1, 2, \ldots, T$). The difference between the two predicted values, denoted $\hat{\delta}_{itk}$, is an estimate of the effect on the endogenous variable of changing the exogenous variables:

$$\hat{\delta}_{itk} = \hat{y}^b_{itk} - \hat{y}^a_{itk}. \tag{9.1}$$

If only one exogenous variable is changed, then $\hat{\delta}_{itk}$ is sometimes divided by this change when results are presented. If, say, the exogenous variable is a government spending variable and the change is 5 billion dollars, $\hat{\delta}_{itk}$ would be divided by 5. This procedure is generally followed only if the particular endogenous variable is in the same units as the exogenous variable. For example, if the endogenous variable is GNP in billions of dollars and the exogenous variable is government spending in billions of dollars, then $\hat{\delta}_{itk}$ divided by the change in government spending is an estimate of how much GNP changes for a one-billion-dollar change in government spending.

$\hat{\delta}_{itk}$ is sometimes simply divided by $\hat{y}^a_{itk}$, which converts the change into a percentage change. This percentage change may then be divided by something else, where the something else is problem-specific. Examples of this procedure are presented in Sections 9.4 and 9.5.

The error terms are generally set equal to their expected values for the simulations, where the expected values are almost always zero. For linear models it makes no difference what values are used as long as the same values are used for both simulations. For nonlinear models the choice does make a difference, and in this case the choice of zero values has some problems associated with it. Consider, for example, a model in which inflation responds in a very nonlinear way to the difference between actual output and some high activity level of output: inflation accelerates as output approaches the high activity level. Consider now a period in which output is close to the high activity level, and consider an experiment in which government spending is increased. This experiment should be quite inflationary, but this will not necessarily be the case if the model is predicting a much lower level of output than actually existed. In other words, if the model is predicting that output is not close to the high activity level when in fact it is, the inflationary consequences of the policy change will not be predicted very well.

There is an easy answer to this problem if the simulation period is within the period for which data exist, which is simply to use the actual (historical) values of the error terms rather than the zero values. By "actual" in this case is meant the values of the estimated residuals that result from the estimation of the equations. If these values are used and if the actual values of the exogenous variables are used, the simulation will result in a perfect fit. As the Gauss-Seidel technique passes through the model, each stochastic equation results in a perfect fit. The identities also fit perfectly, and therefore one pass through the equations will simply give back the actual values. (This assumes that the actual values are used as starting values. If this is not the case, the technique will require more iterations to converge to the actual values.) This solution will be called the "perfect tracking" solution. Once the residuals are added to the equations, they are never changed. The same set of values is used for all experiments.

If the actual values of the error terms are used, the problem regarding the response of inflation to output does not exist. The model predicts the actual data before any policy change is made. Note that this procedure is also not inconsistent with the statistical assumptions of the model, since the error terms are assumed to be uncorrelated with the exogenous and lagged endogenous variables. This procedure cannot be followed if the simulation period is beyond the end of the data. In this case no historical residuals are available, and therefore other values, such as zero, must be used.

The use of the actual values of the error terms has the advantage that only one simulation needs to be performed per policy experiment. $\hat{y}_{itk}^a$ is simply the actual value of the variable, and thus a simulation is only needed to get $\hat{y}_{itk}^b$.

9.3 Use of Stochastic Simulations

For nonlinear models $\hat{\delta}_{itk}$ in (9.1) is not an unbiased estimate of the change because the predicted values are not equal to the expected values. This does not, however, seem to be an important problem in practice (see Section 7.3), and so if one were only interested in estimates of the changes, it seems unlikely that stochastic simulation would be needed. The main reason for using stochastic simulation is to compute standard errors of $\hat{\delta}_{itk}$, that is, to estimate the uncertainty attached to the policy effects. The following is a discussion of a procedure that can be used to estimate standard errors of multipliers.

Since multipliers for nonlinear models are a function of the error terms, the treatment of the error terms must be considered. From the discussion in

Section 9.2, the best possibility seems to be to use the actual values of the error terms for all the simulations, where the base run is then simply the perfect tracking solution. The other main possibility is to use zero values for the error terms. Both possibilities will be considered in the description of the procedure.

There are two sources of uncertainty of policy effects in models: one is from the coefficient estimates, and the other is from the possible misspecification of the model. Unlike the procedure in Chapter 8, the present procedure does not account for the possible misspecification of the model. The estimated standard errors are based on the assumption that the model is correctly specified. This is a serious limitation, but the question of how to handle misspecification effects is still open.

The uncertainty from the coefficient estimates is estimated by drawing alternative sets of coefficients from an estimated distribution. As in Chapter 7, let $N(\hat{\alpha}, \hat{V})$ be the distribution of the coefficient estimates, and let α^* be a draw from this distribution. The steps of the procedure for the case in which the actual values of the error terms are used are the following.

1. Draw α^*, and for this draw compute the values of the error terms in the stochastic equations over the prediction period. Let u^* denote these values.
2. Given α^*, u^*, and the base set of exogenous variable values (x^a_{t+k-1}, $k = 1, 2, \ldots, T$), solve the model. Let $\tilde{y}^{aj}_{itk}$ denote the k-period-ahead predicted value of variable i from this solution. If the exogenous variable values are the actual values, this solution does not have to be performed because it is merely the perfect tracking solution.
3. Given α^*, u^*, and the alternative set of exogenous variable values (x^b_{t+k-1}, $k = 1, 2, \ldots, T$), solve the model. Let $\tilde{y}^{bj}_{itk}$ be the k-period-ahead predicted value of variable i from this solution.
4. Compute

$$\tilde{\delta}^j_{itk} = \tilde{y}^{bj}_{itk} - \tilde{y}^{aj}_{itk}. \tag{9.2}$$

5. Repeat steps 1 through 4 J times, where J is the desired number of trials.
6. Given the values from the J trials, compute the mean ($\tilde{\bar{\delta}}_{itk}$) and variance ($\tilde{s}^2_{itk}$) of $\tilde{\delta}_{itk}$:

$$\tilde{\bar{\delta}}_{itk} = \frac{1}{J}\sum_{j=1}^{J} \tilde{\delta}^j_{itk}, \tag{9.3}$$

$$\tilde{s}^2_{itk} = \frac{1}{J}\sum_{j=1}^{J} (\tilde{\delta}^j_{itk} - \tilde{\bar{\delta}}_{itk})^2. \tag{9.4}$$

If zero values of the error terms are used instead of the actual values, step 1 merely consists of drawing α^*. In this case the solution in step 2 must always be performed because there is no perfect tracking solution. Otherwise the steps are the same.

It is important to understand the computation of u^* in step 1. These errors are computed using the actual values of all the variables in the stochastic equations. For $\hat{\alpha}$, the actual vector of coefficient estimates, these errors are simply the residuals from the estimated equations (assuming that the prediction period is within the estimation period). For α^* they are the residuals that would exist if the coefficient estimates had been α^* rather than $\hat{\alpha}$. It is necessary to compute new values of the error terms for each draw to have each base run be the perfect tracking solution.

One final point should be made about this procedure. Consider first the case in which zero values of the error terms are used, where the zero values are the expected values. In this case, for linear models $\tilde{\delta}_{itk}^j$ in (9.2) is the difference between two expected values. For nonlinear models there is the usual problem that the predicted values of the endogenous variables are not the expected values. The bias in the nonlinear case could be corrected by computing both $\tilde{y}_{itk}^{bj}$ and $\tilde{y}_{itk}^{aj}$ using stochastic simulation. In other words, two stochastic simulations could be performed for each pass through steps 1–4, one in step 2 and one in step 3. This procedure is expensive, because it means that two stochastic simulations are being performed within the overall stochastic simulation represented by steps 1–4. Given that the bias in the nonlinear case seems small, these simulations are not likely to be necessary in most applications.

In the case in which u^* is used, stochastic simulation in steps 2 and 3 could also be performed. The errors in u^* would be treated as exogenous variables, and the errors that are drawn for the stochastic simulation would simply be added to the stochastic equations *inclusive* of the errors in u^*. The predicted values computed by the stochastic simulation would be expected values conditional on u^*. In step 2 the predicted values would not be equal to the actual values even if the actual values of the exogenous variables were used, and therefore the solution in step 2 would always have to be performed. Again, however, these stochastic simulations are not likely to be needed.

9.4 Properties of the US Model

The rest of this chapter consists of a discussion of the properties of the US and MC models. The US model is discussed in this section, and the MC model is

discussed in Section 9.5. This material provides both an example of the application of the deterministic and stochastic simulation techniques that were discussed in Sections 9.2 and 9.3 and a detailed description of the properties of the models. For purposes of understanding the US and MC models, this section and the next are the most important in the book.

9.4.1 General Remarks about the Properties

Because the theoretical model was used to guide the specification of the econometric model, the qualitative properties of the two models are similar. The properties of the theoretical model were examined by changing various variables from a position of equilibrium. Although this is an artificial starting point in the sense that the model never returns to equilibrium once it is shocked, it is useful for learning about the properties of the model. In particular, it is easy to see how disequilibrium can occur as a result of expectation errors and how multiplier reactions can take place. This artificial environment cannot be set up for the econometric model, and the experiments must be performed over an actual sample period.

The first quarter of the prediction period that is used for the results below, 1977I, was not a high activity quarter. The unemployment rate was 7.5 percent; the labor constraint variable Z was considerably below 0; and the demand pressure variable ZZ was considerably above 0. (Remember that slack times correspond to negative values of Z and positive values of ZZ: see Eqs. 97 and 98 in Table A-5.) This means that an expansionary policy action beginning in this quarter is likely to increase real output and employment. The main way in which this comes about is as follows (all equation numbers refer to Table A-5 in Appendix A).

1. The level of sales of the firm sector *(X)* is increased, say by an increase in government purchases of goods.
2. The firm sector responds by increasing production *(Y)*: Eq. 11.
3. The increase in Y leads to an increase in plant and equipment investment *(IK_f)*, jobs *(J_f)*, and hours per job *(H_f)*: Eqs. 12, 13, and 14.
4. The increase in J_f and H_f leads to an increase in JJ and JJ^* and then to an increase in the labor constraint variable Z: Eqs. 95, 96, and 97.
5. The increase in Z leads to an increase in consumption: Eqs. 1, 2, and 3.
6. The increase in plant and equipment investment and consumption increases sales (Eq. 60), which leads to a further increase in production, and so on.

If the labor constraint variable is close to 0 and thus not very binding, the expansionary effects in step 5 do not take place since Z will be changed very little. Also, considerable inflation will result from any attempt at expansion because the demand pressure variable will be small. (Values of the labor constraint variable close to zero almost always correspond to small values of the demand pressure variable.) In this situation the price level responds faster initially than does the wage rate, and thus the real wage falls. The fall in the real wage then has a negative effect on consumption and housing investment.

One of the key variables in the econometric model, as in the theoretical model, is the short-term interest rate. The interest rate has important effects on consumption and housing investment, which in turn have important effects on production, plant and equipment investment, and employment as outlined in the steps above. If the interest rate reaction function is part of the model, the interest rate will rise as an expansion takes place (the Fed "leans against the wind"), which means that the expansion will not be as strong as it would be if, say, the interest rate remained unchanged.

Four of the most important equations in the model are the three consumption equations and the housing investment equation. If these are affected by a policy change, this will affect sales, which then affects the economy in the manner outlined above. The explanatory variables in these four equations have been discussed extensively in Chapter 4; they include the price level, the after-tax wage rate, the after-tax interest rate (either short-term or long-term), nonlabor income, the initial value of wealth, and the labor constraint variable. Nonlabor income and the initial value of wealth are the variables through which transfer payments and dividends affect the economy. If, say, transfer payments are increased, this increases nonlabor income, which increases demand. An increase in nonlabor income also increases wealth to the extent that not all of the income is spent in the current quarter. The increase in wealth then has a positive effect on demand in the next quarter.

The link between output and the unemployment rate is not very tight in the model. When output increases by a certain percentage, the number of jobs increases by less than this percentage (Eq. 13). How much the number of jobs increases depends in part on the amount of excess labor on hand, which varies considerably over time. When the number of jobs increases, the number of people holding two jobs increases (Eq. 8), which means that the number of new people employed increases by less than the number of new jobs (Eq. 85). How much the number of people holding two jobs increases depends in part on the value of the labor constraint variable, which also varies considerably over time. Finally, when the number of jobs increases, the number of people

in the labor force increases (Eqs. 6 and 7), which means that the unemployment rate falls less than it otherwise would for the given increase in the number of new people employed (Eqs. 86 and 87). How much the number of people in the labor force increases also depends on the value of the labor constraint variable. Because of these three leakages, the unemployment rate will drop less than the percentage change in output. Because the various responses vary depending on factors such as the amount of excess labor on hand and the value of the labor constraint variable, it seems quite unlikely that the relationship between output and the unemployment rate will be stable over time. The model thus does not obey Okun's law.

There are a number of variables other than the demand pressure variable that affect the price level (Eq. 10), and thus one would also not expect a stable relationship between, say, the rate of inflation and the demand pressure variable when they are simply plotted together on a graph. A stable relationship is even less likely to exist between the rate of inflation and the unemployment rate because of the many factors that affect the labor force variables and thus the unemployment rate. An important variable in the price equation is the price of imports, which has a positive effect on prices.

Productivity defined as output per paid-for worker hour (Y/J_fH_f) is procyclical. When Y changes by a certain percentage, J_fH_f changes by less than this percentage in the immediate quarter. The buffer for this is the amount of excess labor held: as output falls, excess labor builds up, and vice versa. Other things being equal, excess labor is gradually eliminated because it has a negative effect on the demand for employment and hours. Similar considerations apply to the amount of excess capital held. Excess capital is gradually eliminated because it has a negative effect on investment.

9.4.2 Estimated Effects for Eight Policy Actions

Construction of Tables 9-1 and 9-2

The procedure in Section 9.3 was used to estimate the uncertainty of eight policy actions for the US model. The 2SLS estimates were used for these results. The period for the policy actions was 1977I–1980IV (16 quarters). The eight policy variables that were changed (one at a time) are (1) C_g, government purchases of goods, (2) d_{1g}, the personal income tax rate, (3) d_{2g}, the profit tax rate, (4) d_{3g}, the indirect business tax rate, (5) d_{4g}, the employee social security tax rate, (6) d_{5g}, the employer social security tax rate, (7) J_g, the

employment of the government, and (8) TR_{gh}, the level of transfer payments from the government to the household sector. All these variables are federal government variables.

The change in C_g from its actual value for each quarter was taken to be .25 percent of real GNP, *GNPR*. (*GNPR* is at an annual rate, whereas C_g is at a quarterly rate, and therefore the amount by which C_g was changed each period is .000625 · *GNPR*.) C_g was changed for each of the 16 quarters, not just the first, and the amount by which it was changed varied because *GNPR* varied. Remember that the change is from the actual value for the quarter; it is not the change from quarter to quarter. The results for this experiment are presented first in Table 9-1 for each endogenous variable. The effects on five endogenous variables are presented in the table: real GNP, the GNP deflator, the unemployment rate, the bill rate, and the money supply. The values in the 0 rows are the estimated effects from a deterministic simulation; the values in the a rows are the estimated effects from a stochastic simulation; and the values in the b rows are the estimated standard errors computed from the stochastic simulation. The actual values of the error terms were used for both simulations, and therefore the base run for both simulations was the perfect tracking solution. The number of trials for each experiment was 50.

The units of the results in Table 9-1 are as follows. For real GNP, the GNP deflator, and the money supply, the numbers in the 0 rows are $(1/.0025)(\hat{\delta}_{itk}/\hat{y}^a_{itk})$, where from (9.1) $\hat{\delta}_{itk} = \hat{y}^b_{itk} - \hat{y}^a_{itk}$. The $\hat{y}^a_{itk}$ values are the actual values because the base run is the perfect tracking solution. These numbers are the percentage changes in the variables divided by .0025. Since C_g was changed by .25 percent of real GNP, each number can be interpreted as the percentage change in the variable (in percentage points) that results from an exogenous change in real GNP of 1.0 percent. For the bill rate, which is in units of percentage points (1.0 percent = 1.0), the numbers in the 0 rows are simply $\hat{\delta}_{itk}$. For the unemployment rate, which is in units of percent (1.0 percent = .01), the numbers are $100 \cdot \hat{\delta}_{itk}$.

The numbers in the a rows are $(1/.0025)(\tilde{\tilde{\delta}}_{itk}/y^a_{itk})$ for real GNP, the GNP deflator, and the money supply, where $\tilde{\tilde{\delta}}_{itk}$ is defined in (9.3) and the y^a_{itk} values are the actual values. For the bill rate the numbers are $\tilde{\tilde{\delta}}_{itk}$, and for the unemployment rate the numbers are $100 \cdot \tilde{\tilde{\delta}}_{itk}$. The numbers in the b rows are $\tilde{s}_{itk}$ for the bill rate, where $\tilde{s}_{itk}$ is the square root of $\tilde{s}^2_{itk}$, which is defined in (9.4). For the unemployment rate the numbers are $100 \cdot \tilde{s}_{itk}$. For real GNP, the GNP deflator, and the money supply, the b-row numbers are the estimated standard errors of the a-row numbers. In other words, the b-row

TABLE 9-1. Estimated policy effects for the US model for five variables and eight experiments

Policy variable changed		1977 I	1977 II	1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II	1979 III	1979 IV	1980 I	1980 II	1980 III	1980 IV	Sum[c]
GNPR: Real GNP																		
C_g	0	1.10	1.31	1.32	1.28	1.20	1.10	1.01	.93	.86	.80	.75	.71	.69	.66	.64	.64	13.4
	a	1.09	1.30	1.32	1.28	1.20	1.10	1.01	.93	.85	.79	.74	.70	.68	.65	.64	.63	13.4
	b	.07	.07	.09	.10	.11	.12	.12	.13	.13	.14	.14	.14	.14	.14	.13	.13	1.5
d_{1g}	0	.23	.47	.63	.75	.80	.81	.81	.78	.76	.74	.71	.69	.68	.70	.71	.72	10.0
	a	.23	.46	.62	.73	.79	.79	.79	.77	.75	.73	.70	.69	.68	.70	.71	.71	9.8
	b	.06	.09	.11	.12	.13	.14	.14	.14	.14	.14	.14	.13	.13	.13	.13	.13	1.7
d_{2g}	0	-.00	.03	.09	.14	.17	.19	.20	.20	.20	.20	.20	.21	.22	.26	.30	.32	2.7
	a	.00	.03	.09	.13	.16	.18	.19	.20	.20	.20	.20	.20	.22	.26	.30	.33	2.6
	b	.00	.02	.05	.07	.09	.10	.11	.11	.12	.13	.13	.13	.14	.15	.16	.17	1.5
d_{3g}	0	.20	.40	.54	.62	.66	.66	.66	.64	.62	.60	.58	.57	.57	.59	.59	.60	8.2
	a	.20	.39	.52	.60	.64	.64	.63	.61	.60	.58	.56	.55	.55	.57	.58	.59	8.0
	b	.04	.07	.09	.09	.10	.10	.10	.10	.10	.10	.10	.10	.11	.11	.11	.12	1.3
d_{4g}	0	.40	.81	1.09	1.26	1.35	1.35	1.35	1.31	1.27	1.23	1.18	1.16	1.16	1.21	1.23	1.25	16.8
	a	.40	.80	1.07	1.25	1.34	1.34	1.34	1.30	1.26	1.23	1.18	1.17	1.17	1.23	1.24	1.26	16.8
	b	.09	.14	.17	.19	.20	.21	.22	.22	.21	.21	.21	.20	.20	.20	.20	.20	2.6
d_{5g}	0	.01	.04	.10	.15	.19	.22	.24	.26	.28	.29	.30	.31	.32	.34	.35	.36	3.4
	a	.01	.04	.10	.15	.19	.22	.24	.26	.27	.29	.29	.31	.32	.34	.35	.36	3.4
	b	.00	.01	.03	.04	.06	.06	.07	.07	.07	.08	.08	.08	.08	.09	.09	.09	.9
J_g	0	1.31	1.38	1.35	1.19	1.10	1.00	.96	.80	.76	.69	.69	.61	.69	.73	.68	.68	13.1
	a	1.31	1.37	1.34	1.18	1.09	.99	.94	.78	.74	.67	.67	.58	.65	.70	.64	.64	12.7
	b	.05	.09	.12	.15	.18	.20	.22	.23	.25	.27	.27	.27	.27	.28	.28	.27	2.9
TR_{gh}	0	.16	.32	.44	.53	.58	.59	.60	.60	.60	.59	.57	.57	.56	.57	.57	.56	7.6
	a	.16	.32	.43	.50	.54	.56	.56	.56	.55	.54	.52	.52	.51	.52	.51	.50	7.1
	b	.07	.12	.16	.19	.21	.22	.23	.23	.23	.24	.23	.24	.24	.25	.26	.27	2.9
GNPD: GNP deflator																		
C_g	0	.04	.18	.27	.33	.40	.46	.54	.57	.61	.63	.67	.71	.77	.80	.80	.85	
	a	.03	.17	.26	.32	.38	.45	.52	.54	.59	.60	.64	.68	.73	.76	.76	.81	
	b	.03	.02	.04	.05	.07	.08	.10	.11	.12	.13	.13	.14	.15	.15	.16	.16	
d_{1g}	0	-.01	.01	.05	.09	.12	.18	.23	.26	.30	.34	.37	.38	.41	.43	.45	.46	
	a	-.01	.01	.05	.09	.12	.17	.22	.25	.28	.32	.35	.36	.39	.41	.43	.44	
	b	.01	.01	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.10	.11	.12	.12	
d_{2g}	0	-.00	-.00	.00	.01	.02	.04	.05	.06	.07	.09	.10	.10	.11	.13	.15	.16	
	a	-.00	-.00	.00	.01	.02	.03	.05	.06	.07	.08	.09	.10	.10	.11	.13	.15	
	b	.00	.00	.00	.01	.01	.02	.03	.03	.04	.05	.06	.06	.07	.08	.09	.10	
d_{3g}	0	-1.03	-1.03	-1.00	-.95	-.94	-.88	-.86	-.81	-.79	-.74	-.73	-.73	-.73	-.72	-.68	-.70	
	a	-1.03	-1.03	-1.00	-.96	-.94	-.89	-.87	-.83	-.81	-.77	-.75	-.75	-.76	-.75	-.71	-.74	
	b	.01	.01	.01	.02	.03	.04	.05	.05	.06	.07	.07	.08	.08	.09	.10	.10	
d_{4g}	0	-.02	.02	.09	.16	.22	.32	.40	.46	.51	.58	.63	.65	.69	.72	.76	.78	
	a	-.02	.02	.08	.16	.21	.30	.38	.44	.49	.55	.61	.62	.66	.70	.74	.76	
	b	.01	.01	.02	.04	.05	.07	.09	.10	.12	.13	.14	.15	.16	.17	.18	.19	
d_{5g}	0	-.06	-.12	-.17	-.21	-.24	-.27	-.30	-.32	-.34	-.35	-.37	-.39	-.41	-.42	-.43	-.44	
	a	-.06	-.12	-.17	-.21	-.24	-.28	-.31	-.33	-.35	-.37	-.38	-.40	-.42	-.44	-.44	-.46	
	b	.01	.02	.03	.03	.04	.04	.05	.05	.05	.06	.06	.06	.07	.07	.07	.08	
J_g	0	-.12	-.04	.06	.21	.30	.34	.36	.44	.45	.44	.41	.53	.50	.47	.50	.61	
	a	-.15	-.05	.05	.19	.27	.31	.32	.40	.40	.39	.35	.47	.43	.39	.41	.51	
	b	.01	.03	.05	.08	.09	.11	.13	.15	.17	.18	.20	.21	.23	.25	.26	.28	
TR_{gh}	0	-.00	.01	.04	.08	.11	.15	.19	.23	.26	.30	.34	.36	.39	.42	.45	.47	
	a	-.01	.01	.04	.07	.09	.14	.17	.20	.23	.27	.30	.31	.34	.36	.39	.40	
	b	.01	.01	.02	.03	.04	.06	.07	.09	.10	.11	.13	.13	.14	.15	.17	.18	

(continued)

TABLE 9-1 (continued)

Policy variable changed		1977 I	1977 II	1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II	1979 III	1979 IV	1980 I	1980 II	1980 III	1980 IV
100·UR:	Unemployment rate (percentage points)																
C_g	0	-.05	-.10	-.11	-.11	-.11	-.10	-.09	-.09	-.08	-.08	-.08	-.07	-.07	-.07	-.07	-.07
	a	-.05	-.09	-.11	-.11	-.11	-.10	-.09	-.09	-.08	-.08	-.08	-.07	-.07	-.07	-.07	-.07
	b	.01	.01	.01	.01	.02	.02	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02
d_{1g}	0	.02	.02	.02	.02	.03	.03	.04	.04	.05	.05	.05	.06	.06	.06	.06	.06
	a	.02	.02	.02	.02	.03	.03	.04	.04	.05	.05	.05	.06	.06	.06	.06	.07
	b	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
d_{2g}	0	-.00	-.00	-.01	-.02	-.02	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.04
	a	.00	-.00	-.01	-.02	-.02	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.04	-.04
	b	.00	.00	.01	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
d_{3g}	0	.00	-.00	-.01	-.02	-.02	-.02	-.02	-.02	-.02	-.01	-.01	-.01	-.01	-.01	-.01	-.02
	a	.00	-.00	-.01	-.02	-.02	-.02	-.02	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01	-.01
	b	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02
d_{4g}	0	.02	.03	.03	.03	.04	.04	.05	.06	.07	.08	.09	.09	.10	.10	.10	.10
	a	.02	.03	.03	.03	.03	.04	.05	.06	.07	.08	.09	.09	.10	.10	.10	.11
	b	.01	.02	.02	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
d_{5g}	0	.00	-.00	-.01	-.01	-.02	-.02	-.02	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03
	a	.00	-.00	-.01	-.01	-.02	-.02	-.02	-.02	-.03	-.03	-.03	-.03	-.03	-.03	-.03	-.03
	b	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
J_g	0	-.40	-.36	-.33	-.26	-.24	-.23	-.24	-.20	-.20	-.20	-.22	-.19	-.22	-.23	-.20	-.20
	a	-.40	-.36	-.33	-.27	-.24	-.23	-.24	-.20	-.20	-.20	-.22	-.19	-.22	-.23	-.21	-.20
	b	.01	.01	.02	.02	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03	.03	.03
TR_{gh}	0	-.01	-.03	-.04	-.06	-.07	-.07	-.08	-.08	-.09	-.09	-.09	-.09	-.09	-.10	-.10	-.10
	a	-.01	-.03	-.04	-.06	-.06	-.07	-.07	-.08	-.08	-.08	-.09	-.09	-.09	-.09	-.09	-.10
	b	.00	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
RS:	Bill rate (percentage points)																
C_g	0	.08	.10	.12	.13	.13	.14	.14	.14	.14	.13	.13	.13	.12	.12	.12	.12
	a	.08	.10	.12	.13	.13	.13	.14	.14	.13	.13	.13	.13	.12	.12	.12	.12
	b	.02	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
d_{1g}	0	.02	.03	.05	.06	.07	.08	.09	.09	.10	.10	.10	.10	.09	.09	.10	.10
	a	.02	.03	.05	.06	.07	.08	.09	.09	.09	.10	.10	.10	.09	.09	.10	.10
	b	.01	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
d_{2g}	0	.00	-.00	.00	.00	.00	.00	.01	.01	.01	.01	-.00	-.01	-.03	-.04	-.04	-.04
	a	-.00	-.00	.00	.00	.00	.01	.01	.01	.01	.01	.00	-.01	-.03	-.04	-.04	-.04
	b	.00	.00	.01	.01	.01	.01	.01	.02	.02	.02	.02	.02	.03	.03	.03	.03
d_{3g}	0	.01	.01	.03	.04	.06	.06	.07	.08	.08	.08	.09	.09	.09	.09	.09	.10
	a	.01	.01	.03	.04	.05	.06	.07	.07	.08	.08	.09	.09	.09	.09	.09	.10
	b	.01	.02	.01	.01	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02
d_{4g}	0	.03	.06	.08	.10	.12	.13	.14	.15	.15	.16	.16	.16	.16	.16	.17	.17
	a	.03	.06	.08	.10	.12	.13	.14	.15	.15	.16	.16	.16	.16	.16	.17	.17
	b	.01	.02	.02	.02	.03	.03	.03	.03	.03	.04	.04	.03	.03	.03	.03	.03
d_{5g}	0	-.00	-.01	-.01	-.00	-.00	.00	.00	.01	.01	.01	.01	.01	.02	.02	.02	.02
	a	-.00	-.01	-.01	-.00	-.00	.00	.00	.01	.01	.01	.01	.02	.02	.02	.02	.02
	b	.00	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.02	.02
J_g	0	.13	.18	.21	.22	.24	.25	.26	.26	.26	.26	.26	.25	.26	.26	.26	.26
	a	.13	.17	.20	.22	.23	.24	.25	.25	.26	.25	.26	.24	.25	.25	.25	.25
	b	.03	.04	.04	.05	.05	.06	.06	.06	.06	.07	.06	.06	.06	.07	.07	.07
TR_{gh}	0	.01	.02	.04	.05	.05	.06	.07	.07	.08	.08	.08	.09	.09	.09	.09	.10
	a	.01	.02	.04	.04	.05	.06	.06	.07	.07	.08	.08	.08	.08	.09	.09	.09
	b	.01	.01	.02	.02	.02	.03	.03	.03	.03	.04	.04	.04	.04	.04	.04	.04

(continued)

TABLE 9-1 (continued)

Policy variable changed		1977 I	1977 II	1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II	1979 III	1979 IV	1980 I	1980 II	1980 III	1980 IV
M1:	Money supply																
C_g	0	-.13	-.10	-.06	-.04	-.02	-.01	-.00	.00	-.01	-.01	-.01	-.02	-.02	-.03	-.02	-.03
	a	-.13	-.10	-.07	-.05	-.03	-.02	-.02	-.01	-.03	-.03	-.03	-.04	-.05	-.05	-.05	-.05
	b	.04	.08	.12	.16	.19	.21	.24	.26	.28	.29	.30	.31	.32	.32	.33	.33
d_{1g}	0	-.03	-.05	-.07	-.08	-.09	-.09	-.10	-.12	-.14	-.16	-.17	-.20	-.22	-.22	-.22	-.25
	a	-.03	-.05	-.07	-.08	-.09	-.10	-.11	-.12	-.14	-.16	-.18	-.20	-.22	-.22	-.22	-.25
	b	.01	.03	.05	.07	.09	.12	.14	.16	.18	.20	.21	.22	.24	.24	.26	.27
d_{2g}	0	-.10	-.18	-.28	-.38	-.47	-.55	-.67	-.76	-.89	-.95	-1.05	-1.20	-1.33	-1.43	-1.50	-1.68
	a	-.10	-.19	-.28	-.40	-.48	-.57	-.69	-.78	-.92	-.98	-1.08	-1.24	-1.38	-1.48	-1.55	-1.74
	b	.03	.05	.07	.10	.12	.15	.17	.20	.23	.25	.27	.30	.33	.36	.37	.42
d_{3g}	0	-.65	-.56	-.48	-.40	-.36	-.32	-.29	-.26	-.25	-.23	-.23	-.23	-.24	-.24	-.21	-.23
	a	-.65	-.56	-.49	-.40	-.37	-.32	-.30	-.26	-.25	-.23	-.23	-.22	-.24	-.23	-.21	-.23
	b	.03	.05	.07	.09	.11	.13	.15	.16	.18	.19	.20	.21	.22	.22	.23	.24
d_{4g}	0	-.13	-.23	-.31	-.35	-.40	-.43	-.46	-.49	-.53	-.57	-.59	-.62	-.64	-.66	-.68	-.71
	a	-.13	-.24	-.32	-.37	-.42	-.45	-.48	-.52	-.55	-.59	-.61	-.64	-.66	-.68	-.70	-.73
	b	.03	.06	.09	.11	.14	.17	.20	.22	.25	.27	.29	.31	.32	.33	.35	.37
d_{5g}	0	-.04	-.08	-.11	-.13	-.15	-.17	-.19	-.21	-.22	-.24	-.26	-.27	-.29	-.30	-.32	-.34
	a	-.04	-.08	-.11	-.14	-.15	-.17	-.19	-.21	-.23	-.25	-.26	-.28	-.29	-.31	-.33	-.35
	b	.01	.02	.02	.03	.04	.04	.05	.06	.07	.08	.08	.09	.10	.10	.11	.12
J_g	0	-.04	-.04	-.06	-.11	-.15	-.22	-.30	-.35	-.44	-.49	-.55	-.60	-.64	-.68	-.71	-.72
	a	-.04	-.05	-.07	-.12	-.17	-.24	-.32	-.38	-.47	-.51	-.58	-.64	-.68	-.72	-.75	-.77
	b	.07	.14	.21	.27	.33	.38	.43	.48	.53	.57	.60	.63	.65	.67	.70	.71
TR_{gh}	0	-.01	-.01	-.01	-.00	.01	.02	.03	.04	.04	.05	.06	.06	.07	.07	.08	.09
	a	-.01	-.01	-.01	-.00	.00	.01	.02	.03	.03	.04	.05	.04	.05	.05	.06	.06
	b	.01	.02	.03	.05	.06	.08	.10	.11	.13	.15	.16	.17	.18	.19	.20	.21

Notes: 0 = Estimated effects from deterministic simulations.
a = Estimated effects from stochastic simulations.
b = Estimated standard errors of the a-row values.
c. Sum of the changes (at quarterly rates) over the 16 quarters, in billions of 1972 dollars.
• See discussion in text for an explanation of the units of the variables.

numbers are estimated standard errors of $\tilde{\delta}^j_{itk}/\tilde{y}^{aj}_{itk}$, where $\tilde{\delta}^j_{itk}$ is defined in (9.2) and the $\tilde{y}^{aj}_{itk}$ values are the actual values. The formulas are

$$\tilde{\bar{\delta}}^*_{itk} = \frac{1}{J}\sum_{j=1}^{J}\frac{\tilde{\delta}^j_{itk}}{\tilde{y}^{aj}_{itk}}, \tag{9.6}$$

$$\tilde{s}^{*2}_{itk} = \frac{1}{J}\sum_{j=1}^{J}\left(\frac{\tilde{\delta}^j_{itk}}{\tilde{y}^{aj}_{itk}} - \tilde{\bar{\delta}}^*_{itk}\right)^2. \tag{9.7}$$

The b-row numbers are the square roots of $\tilde{s}^{*2}_{itk}$. Because of the nonlinearities involved, $\tilde{s}^*_{itk}$ does not equal $\tilde{s}_{itk}/\tilde{y}^a_{itk}$, and thus the latter would not be appropriate to use for the b-row values.

The changes for the other policy variables in Table 9-1 were made to be comparable to the change in C_g with respect to the initial injection of funds

into the system. Consider, for example, the change in d_{1g}. The aim is to change d_{1g} so that the change in personal income taxes in real terms is equal to the change in C_g. From Eq. 47 in Table A-5, the variable for personal income taxes, T_{hg}, is equal to $[d_{1g} + (\gamma_g YT)/POP]YT$, where YT is taxable income. Let ΔC_g denote the change in C_g for a given quarter. The aim is to change d_{1g} in such a way that the change in T_{hg} is equal to $P_g \Delta C_g$, where P_g is the price deflator for C_g. The change in d_{1g} for the given quarter is thus $(P_g \Delta C_g)/YT$. The values that were used for P_g and YT for these calculations are the actual values, not the predicted values. The predicted values are, of course, affected by the change in d_{1g}. All this procedure does is to change d_{1g} by an amount that would lead personal income taxes to change by $P_g \Delta C_g$ if nothing else happened.

The changes in the other policy variables are similarly done. For d_{2g} the relevant tax variable is T_{fg}, corporate profit taxes, and the relevant equation in Table A-5 is 49. The other matchings are as follows: d_{3g} to IBT_g and Eq. 51, d_{4g} to SI_{hg} and Eq. 53, d_{5g} to SI_{fg} and Eq. 55, J_g to $W_g J_g H_g$ (no separate equation), and T_{gh} to itself (no separate equation).

In order to understand some of the properties of the model, it is necessary to present results for other than just the five endogenous variables in Table 9-1. Results for eighteen other variables for the C_g experiment are presented in Table 9-2. The results are in percentage terms (like the results for real GNP in Table 9-1) except for RB, S_r, and S_g. The units for S_r and S_g are billions of current dollars. The units for RB are the same as those for RS in Table 9-1.

The results in Table 9-1 are based on 6,400 solutions of the model (6,400 = 50 trials × 8 experiments × 16 quarters). As discussed in Section 7.5.1, each solution of the model takes about .2 seconds on the IBM 4341 and about 1.5 seconds on the VAX. The total time for the 6,400 solutions was thus about 21 minutes on the IBM 4341 and 2.7 hours on the VAX.

The rest of this section consists of a discussion of the results in Tables 9-1 and 9-2. Each experiment will be discussed first without regard to the estimated standard errors, and then the standard errors will be discussed.

The C_g Experiment

The increase in government purchases of goods led to an increase in real GNP, the GNP deflator, and the bill rate and to a decrease in the unemployment rate and the money supply (Table 9-1). The reasons for the increase in output were discussed in Section 9.4.1, and they will not be repeated here. The GNP deflator rose because of the effects of the increase in real GNP on the

demand pressure variable. The Fed responded (through Eq. 30, the interest rate reaction function) to the output and inflation increase by raising the bill rate, and this is the reason for the higher values of the bill rate. The money supply fell because of the rise in the interest rate. An increase in output and prices has a positive effect on the demand for money, but this positive effect was outweighed by the negative interest rate effect. In general, the changes in the money supply were quite small.

More detailed results from this experiment are presented in Table 9-2. Either immediately or after a few quarters, two of the three consumption variables and housing investment become lower. This change is due to the increase in the interest rates: the negative effects from the interest rates are larger than the positive effects from the labor constraint variable. The decrease in consumption and housing investment is the main reason that real GNP rose by less than the change in C_g after 8 quarters (Table 9-1).

The wage rate *(*W_f*)* rose less than the GNP deflator, and a decrease in the real wage has a negative effect on consumption and housing investment. It also has a negative effect on the two labor force variables $L2$ and $L3$. This negative effect on $L2$ and $L3$ was, however, more than offset by the positive effect from the labor constraint variable: $L2$ and $L3$ both rose.

Plant and equipment investment was higher because of the higher output, as was the number of jobs. The percentage increase in the number of jobs was less than the percentage increase in real output, as expected from the discussion in Section 9.4.1. The demand for money of the firm sector fell as a result of the bill rate increase. The demand for money of the household sector fell for the first three quarters and rose thereafter. The bond rate *(RB)* rose; this occurred because of the bill rate increase. This is the term structure equation 23 in operation. Although it is not shown in Table 9-2, the mortgage rate *(RM)* also rose, for similar reasons. The demand for imports rose because of the increase in output and because of the increase in the domestic price level relative to the price of imports.

The last four variables in Table 9-2 are determined by identities. They are interesting summary variables to consider. The level of profits rose because of the expansion and because of the fall in the real wage. The savings of the foreign sector *(*S_r*)*, which is the negative of the balance of payments on current account, rose because of the increase in the demand for imports. By the end of the period, however, the change in S_r was essentially zero. S_r is negatively affected by the increase in the price of exports that results from the expansion, and by the end of the period this negative effect roughly offset the positive effect from the increase in imports. The level of savings of the federal

TABLE 9-2. Estimated policy effects for the US model for eighteen variables and one experiment

	1977				1978				1979				1980			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
CS: Consumption of services																
a	-.04	-.07	-.11	-.15	-.19	-.23	-.28	-.32	-.36	-.40	-.43	-.46	-.49	-.52	-.54	-.56
b	.02	.04	.05	.07	.08	.10	.11	.12	.14	.15	.16	.18	.19	.20	.22	.23
CN: Consumption of nondurables																
a	.04	.12	.19	.23	.25	.26	.26	.25	.25	.25	.24	.24	.25	.27	.27	.28
b	.04	.07	.10	.12	.13	.14	.15	.15	.15	.16	.16	.16	.16	.17	.17	.17
CD: Consumption of durables																
a	.10	.16	.12	-.04	-.26	-.46	-.67	-.85	-1.03	-1.19	-1.27	-1.37	-1.44	-1.66	-1.63	-1.58
b	.08	.19	.27	.32	.38	.39	.42	.44	.47	.51	.51	.53	.54	.61	.58	.55
IH_h: Housing investment																
a	.00	-.10	-.39	-.86	-1.37	-1.85	-2.31	-2.76	-3.15	-3.49	-3.74	-3.94	-4.21	-5.04	-5.03	-4.38
b	.00	.10	.23	.37	.49	.59	.69	.80	.91	1.01	1.10	1.18	1.28	1.56	1.58	1.39
L1: Labor force of males 25-54																
a	.00	-.00	.00	.00	.00	.00	.00	-.00	-.00	-.01	-.01	-.01	-.02	-.02	-.02	-.02
b	.00	.00	.00	.00	.00	.00	.01	.01	.01	.01	.01	.01	.01	.02	.02	.02
L2: Labor force of females 25-54																
a	.03	.07	.12	.16	.19	.22	.25	.26	.28	.29	.30	.30	.30	.31	.31	.31
b	.01	.03	.04	.06	.07	.08	.09	.10	.10	.11	.11	.11	.12	.12	.13	.13
L3: Labor force of all others 16 and over																
a	.08	.17	.26	.34	.41	.45	.47	.48	.47	.47	.45	.43	.41	.38	.35	.33
b	.02	.03	.05	.06	.07	.07	.08	.08	.08	.09	.09	.09	.10	.10	.11	.11
M_h: Demand for money, h																
a	-.18	-.11	-.04	.01	.06	.11	.15	.17	.19	.21	.22	.24	.26	.28	.31	.32
b	.05	.11	.16	.20	.24	.28	.31	.34	.36	.38	.39	.41	.42	.43	.43	.44
IK_f: Plant and equipment investment																
a	1.46	2.00	2.58	3.01	3.12	2.90	2.72	2.50	2.28	2.11	1.87	1.72	1.54	1.48	1.33	1.21
b	.25	.34	.37	.38	.42	.41	.42	.43	.43	.44	.43	.44	.43	.45	.44	.42
J_f: Number of jobs in the firm sector																
a	.34	.68	.88	.97	1.01	1.01	1.00	.97	.94	.91	.88	.85	.83	.81	.79	.78
b	.06	.08	.09	.10	.11	.12	.12	.13	.13	.14	.14	.14	.14	.14	.14	.14
W_f: Wage rate																
a	.01	.07	.14	.20	.26	.31	.35	.39	.42	.45	.48	.50	.52	.54	.55	.56
b	.01	.03	.05	.08	.10	.12	.13	.15	.16	.17	.18	.19	.20	.21	.22	.23
M_f: Demand for money, f																
a	-.10	-.13	-.17	-.23	-.29	-.37	-.44	-.51	-.60	-.68	-.76	-.83	-.88	-.94	-1.00	-1.04
b	.05	.11	.17	.21	.26	.30	.33	.37	.41	.45	.48	.52	.54	.57	.60	.63
RB: Bond rate (percentage points)																
a	.02	.03	.04	.06	.07	.08	.09	.10	.10	.11	.11	.12	.12	.12	.12	.13
b	.01	.01	.01	.01	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03
IM: Imports																
a	.42	.69	.91	1.01	1.02	1.02	1.00	.96	.93	.86	.82	.77	.74	.76	.78	.74
b	.10	.18	.25	.30	.34	.38	.42	.45	.50	.52	.56	.58	.60	.66	.72	.69
Π_f: Profits																
a	7.98	8.33	7.23	6.11	5.37	4.47	4.39	3.77	3.68	3.44	3.67	4.21	4.69	6.33	5.88	6.91
b	.89	.58	.71	.81	.91	.89	.97	1.01	1.09	1.18	1.28	1.40	1.59	1.84	1.78	1.85
S_r: Savings of the foreign sector (billions of current dollars)																
a	.05	.07	.09	.09	.09	.08	.07	.06	.05	.04	.03	.02	.01	.00	-.00	-.01
b	.01	.02	.03	.04	.04	.05	.06	.07	.08	.09	.10	.11	.12	.13	.13	.14
S_g: Savings of the federal government (billions of current dollars)																
a	-.89	-.86	-.89	-.92	-1.01	-1.07	-1.16	-1.21	-1.29	-1.34	-1.43	-1.51	-1.64	-1.72	-1.75	-1.88
b	.03	.03	.03	.04	.04	.05	.06	.06	.07	.08	.09	.09	.10	.10	.11	.11
SR: Savings rate																
a	5.29	7.10	7.36	8.35	8.51	10.74	10.75	11.43	11.08	11.01	12.07	14.48	13.57	12.48	11.99	13.52
b	.83	.92	1.09	1.31	1.41	1.81	1.89	2.09	2.13	2.21	2.54	3.17	3.07	2.98	3.04	3.46

Notes: a = Estimated effects from stochastic simulation.
b = Estimated standard errors of the a-row values.
• This experiment is the C_g experiment in Table 9-1.
• Unless otherwise noted, the changes are in percentage points. See discussion in text.

government fell, primarily as a result of the increase in C_g. The deficits are smaller than they otherwise would be because taxes increased as a result of the expansion. The savings rate was higher in all quarters. The increase in the interest rate is the primary reason for the higher savings rate.

The Other Experiments

Given an understanding of the C_g experiment, the other experiments in Table 9-1 are fairly easy to follow. A useful way of comparing the expansionary effects across experiments is to compute the sums of the real GNP changes over the 16 quarters of the prediction period. This has been done in the last column in Table 9-1. The sums are in billions of 1972 dollars rather than in percentage terms.

All the experiments led to an increase in real GNP. The main channels are the following.

1. The decrease in d_{1g}, the personal income tax parameter, increases after-tax nonlabor income (Eq. 88). It also decreases the marginal personal income tax rate (Eq. 90), which in turn increases the after-tax wage rate (Eq. 126) and the after-tax interest rates (Eqs. 127 and 128). The increase in after-tax nonlabor income and the after-tax wage rate has a positive effect on consumption and housing investment, and the increase in the after-tax interest rates has a negative effect. The net effect is positive, and therefore the experiment is expansionary. It is initially less expansionary than the C_g experiment, but by the end of the period it becomes more so. The unemployment rate is higher for this experiment even though output is higher. The decrease in d_{1g} raises the after-tax wage rate *(WA)*, which has a positive effect on the labor force variables $L2$ and $L3$ and thus on the unemployment rate. This effect was large enough to offset the negative effect on the unemployment rate from the increase in employment.

2. The decrease in d_{2g}, the profit tax rate, increases after-tax profits, which increases dividends, which increases nonlabor income of the household sector, which in turn increases consumption and housing investment.

3. The decrease in d_{3g}, the indirect business tax rate, decreases the price deflators for consumption (Eqs. 35, 36, and 37), which has a positive effect on consumption. The GNP deflator is lower in this case because indirect business tax rates are included in it. The unemployment rate is essentially unchanged even though output is higher because there was a positive labor force response to the increase in the real wage.

4. The decrease in d_{4g}, the employee social security tax rate, is similar to the

decrease in d_{1g} in that it increases after-tax nonlabor income, the after-tax wage rate, and the after-tax interest rates. The unemployment rate also is higher in this case because of the increase in the after-tax wage rate.

5. The decrease in d_{5g}, the employer social security tax rate, lowers the cost of labor in the firm sector, which has a negative effect on the price level (Eq. 10). This leads to a rise in the real wage, which stimulates consumption and housing investment. Also, the lower tax rate means that profits are higher (Eq. 67), which leads to an increase in dividends and thus in nonlabor income of the household sector, which stimulates consumption and housing investment.

6. The increase in J_g, the number of jobs of the government, lessens the labor constraint on the household sector and thus leads to an increase in consumption.

7. The increase in TR_{gh}, the level of transfer payments to the household sector, increases nonlabor income, which stimulates consumption and housing investment. The increase in TR_{gh} has a negative effect on the labor force variable $L1$ and thus on the unemployment rate. The unemployment rate thus fell more than it otherwise would have as a result of the increase in transfer payments. This is contrary to the case of the decrease in d_{1g}, where the unemployment rate actually rose.

To summarize the results for the eight experiments, although all are expansionary with respect to real output changes, they differ regarding the effects on variables like the GNP deflator and the unemployment rate. The GNP deflator is lower for the d_{3g} and d_{5g} experiments, and the unemployment rate is higher for the d_{1g} and d_{4g} experiments. There is essentially no change in the unemployment rate for the d_{3g} experiment, where the various effects on it roughly cancel each other out. These results thus reinforce the conclusion stated earlier that the relationships between real output and the unemployment rate and between real output and the inflation rate are not likely to be stable.

The Estimated Standard Errors

The estimated standard errors in Tables 9-1 and 9-2 in general seem fairly small. This conclusion is consistent with the results in Table 8-2, which show that the contribution of the uncertainty of the coefficient estimates to the total uncertainty of the forecast is in general relatively small. If the only concern is with uncertainty from the coefficient estimates, which is true for the standard errors of the multipliers, a fairly high degree of confidence can be placed on

the results. Consider, for example, the eight-quarter-ahead prediction of the five variables in Table 9-1 for the C_g experiment. The estimated means and standard errors for the five variables are as follows: .93 and .13 for real GNP, .54 and .11 for the GNP deflator, −.09 and .01 for the unemployment rate, .14 and .03 for the bill rate, and −.01 and .26 for the money supply. Only for the money supply are the results not precise. In the more detailed results in Table 9-2, the only main imprecise results are for the two demand-for-money variables (M_h and M_f). The results for the last four summary variables in the table are even fairly good.

The results are thus encouraging regarding the accuracy of the properties of the model, provided the model is correctly specified. The assumption of correct specification is the key restriction in the present exercise. It was seen in Section 8.5, for example, that misspecification contributes substantially to the total variance of the forecast error for the US model, and therefore it should be taken into account in the estimation of the standard errors of multipliers. It is an open question as to how this can be done, and until it is done, the present estimates of the standard errors must be interpreted as merely lower bounds.

9.4.3 Estimated Effects of a Change in Import Prices

One of the significant economic events of the 1970s was the large change in import prices that occurred for most countries. It is thus of interest to examine the effects of import prices on the endogenous variables. The relevant exogenous variable in the model is *PIM*, the price deflator for imports. For the results in Table 9-3, *PIM* was increased by 10 percent in the first quarter of the period (1977I). For the other quarters of the prediction period it was not changed from its historical values. The same stochastic simulation procedure was followed here as was followed for the results in Table 9-1. The number of trials was 50.

The results in Table 9-3 show that the increase in import prices is contractionary with respect to real output and inflationary with respect to the GNP deflator. *PIM* is an explanatory variable in the price equation, and this is the reason for the increase in domestic prices. The real wage fell as a result of the increase in prices, and this led to a fall in consumption and housing investment. The fall in the real wage also had a negative effect on the labor force, and this is the main reason the unemployment rate fell in the first quarter and rose very little in the other quarters even though output fell. The Fed responded to the initial change in prices by increasing the bill rate, which is another reason for the fall in consumption and housing investment. After

TABLE 9-3. Estimated effects of a change in the import price deflator (PIM) for the US model

	1977				1978				1979				1980				Sum[c]
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
GNPR: Real GNP																	
a	-.95	-.78	-.65	-.54	-.44	-.34	-.28	-.22	-.17	-.13	-.10	-.08	-.06	-.05	-.04	-.04	-4.3
b	.20	.22	.19	.17	.16	.14	.12	.10	.09	.09	.08	.07	.07	.07	.07	.07	1.1
GNPD: GNP deflator																	
a	1.76	.94	.83	.75	.68	.61	.56	.51	.47	.43	.41	.37	.34	.32	.31	.29	
b	.17	.14	.12	.11	.09	.08	.08	.08	.07	.07	.07	.07	.07	.07	.06	.06	
100·UR: Unemployment rate (percentage points)																	
a	-.01	.03	.03	.03	.02	.02	.01	.01	.01	.01	.01	.01	.00	.00	.00	.00	
b	.02	.02	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	
RS: Bill rate (percentage points)																	
a	.44	.04	-.07	-.06	-.05	-.05	-.05	-.04	-.04	-.04	-.03	-.03	-.03	-.02	-.02	-.02	
b	.23	.08	.03	.02	.02	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01	
M1: Money supply																	
a	3.07	-.28	-.16	-.06	-.00	.05	.09	.12	.15	.16	.18	.19	.19	.19	.20	.19	
b	.40	.29	.22	.18	.16	.14	.14	.13	.13	.13	.12	.12	.11	.11	.11	.10	

Notes: a = Estimated effects from a stochastic simulation.
b = Estimated standard errors of the a-row values.
c = Sum of the changes (at quarterly rates) over the 16 quarters, in billions of 1972 dollars.
• PIM was increased by 10 percent for 1977 I. For the other quarters it was kept unchanged from its historical values.
• The changes for GNPR, GNPD, and M1 are in percentage points.

three quarters, however, the bill rate was lower. The lower values are due primarily to the lower values of real output. (The change in real output is an explanatory variable in the interest rate reaction function.)

This experiment is the best example in the model of a situation in which real GNP and the rate of inflation are negatively correlated. The estimated standard errors are again fairly small except for those for the money supply.

9.4.4 Sensitivity of Fiscal Policy Effects to Assumptions about Monetary Policy

The various assumptions that one can make about monetary policy have been discussed in Section 4.1.10, and the reader should review this material before reading this section. The results in Table 9-4 are for the C_g experiment in Table 9-1 under five assumptions about monetary policy. The row 1 experiment is the same as that in Table 9-1. In this case the Fed is assumed to behave according to the interest rate reaction function. Note that the values of $-A_g$ are positive in row 1 in Table 9-4: the Fed issued securities in response to the increase in purchases of goods of the government. ($-A_g$ will be called the "amount of government securities outstanding.")

TABLE 9-4. Estimated policy effects for the US model under alternative assumptions about monetary policy

	1977				1978				1979				1980				Sum[a]
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
GNPR:	Real GNP																
1	1.10	1.31	1.32	1.28	1.20	1.10	1.01	.93	.86	.80	.75	.71	.69	.66	.64	.64	13.4
2	1.14	1.42	1.52	1.58	1.59	1.57	1.56	1.53	1.52	1.50	1.47	1.45	1.43	1.41	1.37	1.34	21.1
3	1.15	1.38	1.38	1.32	1.21	1.10	1.00	.91	.84	.78	.74	.71	.69	.67	.66	.66	13.6
4	1.15	1.42	1.48	1.48	1.41	1.31	1.22	1.13	1.05	.98	.92	.88	.84	.81	.78	.77	15.8
5	1.69	2.64	3.15	3.28	3.18	2.97	2.79	2.62	2.52	2.48	2.43	2.41	2.39	2.40	2.34	2.27	37.4
GNPD:	GNP deflator																
1	.04	.18	.27	.33	.40	.46	.54	.57	.61	.63	.67	.71	.77	.80	.80	.85	
2	.04	.18	.28	.36	.44	.54	.66	.72	.80	.87	.97	1.02	1.12	1.20	1.24	1.32	
3	.04	.18	.28	.35	.42	.48	.56	.58	.62	.64	.68	.72	.77	.81	.81	.86	
4	.04	.18	.29	.36	.44	.52	.61	.65	.71	.74	.78	.83	.89	.94	.93	.99	
5	.02	.21	.44	.66	.83	1.06	1.25	1.36	1.48	1.58	1.71	1.80	1.93	2.04	2.12	2.21	
RS:	Bill rate (percentage points)																
1	.08	.10	.12	.13	.13	.14	.14	.14	.14	.13	.13	.13	.12	.12	.12	.12	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	-.02	.12	.14	.15	.15	.15	.14	.14	.13	.13	.12	.12	.12	.12	.12	.12	
4	-.02	.03	.07	.09	.10	.11	.12	.11	.11	.11	.11	.11	.10	.10	.10	.10	
5	-1.08	-.74	-.30	.05	.00	.01	-.06	-.08	-.16	-.19	-.18	-.21	-.19	-.17	-.16	-.16	
M1:	Money supply																
1	-.13	-.10	-.06	-.04	-.02	-.01	-.00	.00	-.01	-.01	-.01	-.02	-.02	-.03	-.02	-.03	
2	-.03	.13	.29	.46	.61	.76	.89	1.01	1.12	1.20	1.29	1.36	1.42	1.47	1.53	1.55	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	-.00	.11	.19	.25	.29	.32	.34	.35	.35	.36	.36	.35	.35	.35	.35	.35	
5	1.36	2.35	2.76	2.72	2.75	2.81	2.95	3.05	3.29	3.46	3.64	3.83	3.97	4.04	4.17	4.21	
CUR:	Currency (billions of current dollars)																
1	.00	.02	.04	.06	.07	.08	.09	.10	.10	.10	.11	.11	.11	.11	.11	.11	
2	.02	.06	.11	.16	.21	.26	.31	.35	.40	.44	.49	.52	.56	.60	.63	.67	
3	.03	.04	.06	.07	.08	.09	.10	.10	.10	.11	.11	.11	.11	.12	.12	.12	
4	.03	.06	.09	.12	.14	.16	.18	.19	.20	.21	.22	.23	.23	.24	.24	.25	
5	.25	.46	.61	.66	.74	.80	.88	.95	1.04	1.14	1.23	1.30	1.39	1.47	1.54	1.61	
BR-BD:	Nonborrowed reserves (billions of current dollars)																
1	-.03	-.03	-.03	-.04	-.04	-.04	-.04	-.04	-.05	-.04	-.04	-.05	-.05	-.05	-.05	-.05	
2	-.01	.01	.02	.04	.05	.07	.08	.10	.11	.12	.13	.14	.15	.17	.16	.16	
3	.00	-.03	-.03	-.04	-.04	-.04	-.04	-.05	-.04	-.04	-.04	-.04	-.05	-.05	-.04	-.04	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	.34	.38	.31	.27	.27	.28	.30	.34	.39	.40	.42	.47	.49	.54	.51	.49	
S_{g_1}:	Savings of the federal government (billions of current dollars)																
1	-.88	-.85	-.88	-.92	-1.00	-1.06	-1.15	-1.21	-1.28	-1.33	-1.43	-1.50	-1.63	-1.71	-1.75	-1.87	
2	-.86	-.80	-.79	-.77	-.80	-.80	-.82	-.81	-.83	-.82	-.85	-.88	-.92	-.94	-.91	-.97	
3	-.86	-.82	-.86	-.90	-.99	-1.06	-1.15	-1.21	-1.29	-1.33	-1.42	-1.50	-1.62	-1.70	-1.73	-1.86	
4	-.86	-.80	-.82	-.83	-.91	-.96	-1.04	-1.08	-1.16	-1.20	-1.29	-1.36	-1.48	-1.56	-1.59	-1.71	
5	-.59	-.25	-.08	-.01	-.08	-.07	-.11	-.11	-.13	-.11	-.12	-.12	-.11	-.12	-.04	-.05	
$-A_{g_1}$:	Amount of federal government securities outstanding (billions of current dollars)																
1	.91	1.74	2.60	3.51	4.50	5.56	6.70	7.91	9.20	10.52	11.95	13.45	15.08	16.79	18.53	20.40	
2	.85	1.59	2.31	3.01	3.75	4.48	5.23	5.98	6.75	7.52	8.32	9.15	10.02	10.91	11.80	12.74	
3	.83	1.67	2.51	3.41	4.39	5.45	6.59	7.80	9.08	10.41	11.83	13.32	14.94	16.64	18.36	20.22	
4	.83	1.60	2.38	3.19	4.08	5.01	6.03	7.10	8.25	9.44	10.72	12.08	13.55	15.11	16.69	18.39	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes: a. Sum of the changes (at quarterly rates) over the 16 quarters, in billions of 1972 dollars.
1. Interest rate reaction function.
2. Bill rate exogenous.
3. Money supply exogenous.
4. Nonborrowed reserves exogenous.
5. A_g exogenous.

- The changes for GNPR, GNPD, and M1 are in percentage points.
- This experiment is the G_g experiment in Table 9-1. The values are estimated effects from deterministic simulations.

In examining the results in Table 9-4 it will be useful to keep in mind the government budget constraint, Eq. 77 in Table A-5:

$$77. \qquad 0 = S_g - \Delta A_g - \Delta M_g + \Delta CUR + \Delta(BR - BO) - \Delta Q - DIS_g.$$

This equation states that any decrease in S_g that results from the increase in C_g must result in a change in at least one of the other RHS variables. Since M_g, Q, and DIS_g are exogenous, the other variables are A_g, currency *(CUR)*, and nonborrowed reserves *(BR − BO)*. Subject to rounding error, the values presented in Table 9-4 meet this identity. For example, the first-quarter values for the row 1 experiment are −.88 for S_g, .91 for $-\Delta A_g$, .00 for ΔCUR, and −.03 for $\Delta(BR - BO)$, which sum to zero. The second-quarter values are −.85 for S_g, 1.74 − .91 = .83 for $-\Delta A_g$, .02 − .00 = .02 for ΔCUR, and −.03 − (.03) = .00 for $\Delta(BR - BO)$, which also sum to zero.

For the other four experiments in Table 9-4 the interest rate reaction function was dropped. For the row 2 experiment the bill rate was kept unchanged from its historical values. This experiment is considerably more expansionary than the first, since the bill rate does not rise to choke off some of the increase in demand. The increase in the GNP deflator is larger because of the larger increase in output. The sum of the GNP changes across the 16 quarters is 21.1 in this case versus 13.4 in the first case. The money supply rose rather than fell because there was no negative effect from a higher interest rate. The increase in the amount of government securities outstanding was less, since less was needed to meet the lower bill rate target.

There is an unusual, but not important, feature of the results for the second experiment that needs to be explained before going further. The question is why the money supply falls in the first quarter for the second experiment (the change in $M1$ is −.03). In the first quarter real GNP and the GNP deflator are higher and the bill rate is unchanged, so there appears to be no reason for the money supply to fall. The reason is that the price deflator P_h that is used in the demand-for-money equation of the household sector (Eq. 9) actually falls in the first quarter, which then results in a fall in the demand for money. P_h is a weighted price deflator, and it falls because of a change in weights caused by the change in C_g. It can be seen from Eq. 34 in Table A-5 that P_h is a function of another deflator *(PD)* and the average indirect business tax rate. When C_g increases, the average tax rate falls, and this is the reason for the initial fall in P_h. This feature of the results is not of any quantitative importance.

For the row 3 experiment the money supply, $M1$, was kept unchanged from its historical values. This experiment is slightly more expansionary than the first experiment because in that experiment the money supply fell. The money supply fell in the first experiment because the bill rate rose (the rise in

RS in the first quarter was .08). In the third experiment the bill rate needs to rise less because the money supply is unchanged. The bill rate actually fell in the first quarter for the third experiment (the change in *RS* was −.02), which is due to the feature of the results discussed in the previous paragraph: with the bill rate unchanged the money supply initially falls, and thus the bill rate must fall to prevent the fall in the money supply. Were it not for this feature, the bill rate would have increased in the first quarter for the third experiment, but by less than the increase for the first experiment. The third experiment is not as expansionary as the second experiment, where the bill rate did not change, because some increase in the bill rate (after the first quarter) was needed to choke off the increase in the demand for money that would otherwise have occurred as a result of the increase in income and prices.

For the row 4 experiment the level of nonborrowed reserves, $BR - BO$, was kept unchanged from its historical values. This experiment is more expansionary than the first experiment. In the first experiment nonborrowed reserves decreased, which was caused by both an increase in borrowing (because of the higher bill rate) and a decrease in reserves (because of a lower level of demand deposits). The increase in the bill rate thus choked off all of the increase in nonborrowed reserves that would otherwise have taken place as a result of the expansion *and then some.* For the fourth experiment, where the increase in nonborrowed reserves is constrained to be zero, the "and then some" does not take place. The increase in the bill rate is thus smaller in the fourth experiment because less is choked off. The fourth experiment is, on the other hand, less expansionary than the second experiment, because some increase in the bill rate was needed. The fourth experiment is more expansionary than the third experiment because less of an increase in the bill rate was needed to choke off nonborrowed reserves than was needed to choke off the money supply. The increase in the bill rate in the fourth experiment has two effects, one in decreasing the demand for money and thus bank reserves and the other in increasing borrowing. Both of these result in a drop in nonborrowed reserves. The effect on bank borrowing is not relevant for the third experiment, and therefore the interest rate increase in the third experiment must be larger.

In the row 5 experiment the amount of government securities outstanding, $-A_g$, was kept unchanged from its historical values. This means that the entire deficit of the government is financed by changes in currency and nonborrowed reserves. This requires a large change in the money supply, which requires a large initial fall in the bill rate. This experiment is thus quite expansionary, since it corresponds to both an increase in government pur-

TABLE 9-5. Estimated effects of an exogenous change in the bill rate

	1977				1978				1979				1980				Sum[c]
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
GNPR: Real GNP																	
a	-.12	-.31	-.51	-.71	-.89	-1.02	-1.15	-1.24	-1.33	-1.41	-1.44	-1.48	-1.50	-1.54	-1.54	-1.51	-64.6
b	.03	.06	.09	.12	.15	.18	.20	.22	.25	.28	.30	.32	.35	.38	.41	.43	13.2
GNPD: GNP deflator																	
a	.01	-.00	-.03	-.08	-.11	-.19	-.26	-.33	-.40	-.49	-.60	-.62	-.70	-.78	-.87	-.92	
b	.00	.00	.01	.02	.03	.05	.06	.08	.10	.12	.14	.16	.18	.20	.23	.25	
100·UR: Unemployment rate (percentage points)																	
a	.02	.08	.14	.21	.28	.34	.38	.42	.46	.48	.50	.51	.52	.52	.51	.51	
b	.01	.02	.03	.04	.06	.07	.08	.09	.11	.12	.12	.13	.14	.15	.15	.16	
M1: Money supply																	
a	-.32	-.61	-.89	-1.14	-1.38	-1.62	-1.85	-2.05	-2.26	-2.42	-2.60	-2.76	-2.90	-3.01	-3.16	-3.26	
b	.06	.11	.15	.19	.22	.26	.29	.32	.35	.38	.41	.44	.47	.50	.54	.58	

Notes: a = Estimated effects from a stochastic simulation.
b = Estimated standard errors of the a-row values.
c. Sum of the changes (at quarterly rates) over the 16 quarters, in billions of 1972 dollars.
· The change in the bill rate was 1.0 percentage points for each quarter.
· The changes for GNPR, GNPD, and M1 are in percentage points.

chases of goods and an initial decrease in the bill rate. The change in real GNP over the 16 quarters was 37.4, which is almost double the next largest change. The change in the GNP deflator by the end of the period is also almost double the next largest change. After the first quarter the government deficit ($-S_g$) is small, which is primarily a result of the increased tax collections caused by the more expansionary economy.

It is clear from the results in Table 9-4 that fiscal policy effects are quite sensitive to what is assumed about monetary policy. Monetary policy, in other words, is very important. To give one more example of this, an experiment was run in which the bill rate was raised by one percentage point for all quarters. (The interest rate reaction function is dropped for this experiment.) The results are presented in Table 9-5. This sustained rise in the bill rate of one percentage point led by the end of the period to a decrease in real GNP of 1.51 percent and an increase in the unemployment rate of .51 percentage points. The money supply was 3.26 percent lower, and the GNP deflator was .92 percent lower. This experiment clearly shows the importance of the bill rate in the model.

One last feature of the results in this section that should be emphasized is that the policy of keeping the money supply unchanged is almost the same as the policy implied by the use of the interest rate reaction function. In other words, for all practical purposes the first and third experiments in Table 9-4 are identical.

TABLE 9-6. Estimated policy effects for the US model under alternative sets of coefficient estimates

	1977				1978				1979				1980				Sum[a]
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
GNPR: Real GNP																	
2SLS	1.10	1.31	1.32	1.28	1.20	1.10	1.01	.93	.86	.80	.75	.71	.69	.66	.64	.64	13.41
3SLS	1.12	1.32	1.32	1.28	1.19	1.09	1.00	.93	.86	.81	.76	.73	.70	.67	.65	.64	13.49
FIML	1.97	1.58	1.42	1.30	1.15	1.06	.99	.94	.90	.87	.85	.83	.81	.74	.75	.75	15.08
2SLAD q = 0.5	1.14	1.37	1.38	1.35	1.27	1.17	1.08	1.00	.91	.84	.78	.73	.69	.66	.64	.63	13.98
OLS	1.11	1.35	1.38	1.34	1.25	1.15	1.05	.96	.88	.81	.76	.72	.69	.67	.65	.65	13.76
GNPD: GNP deflator (percent)																	
2SLS	.04	.18	.27	.33	.40	.46	.54	.57	.61	.63	.67	.71	.77	.80	.80	.85	
3SLS	.04	.19	.30	.37	.44	.52	.60	.63	.69	.71	.76	.80	.86	.90	.90	.95	
FIML	.26	.25	.34	.39	.47	.51	.58	.60	.65	.66	.70	.74	.80	.84	.83	.89	
2SLAD q = 0.5	.05	.17	.26	.32	.39	.45	.53	.55	.60	.62	.66	.70	.75	.79	.78	.83	
OLS	.03	.17	.27	.33	.40	.47	.55	.57	.62	.63	.67	.71	.76	.80	.79	.85	

Notes: a. Sum of the changes (at quarterly rates) over the 16 quarters, in billions of 1972 dollars.
- This experiment is the C_g experiment in Table 9-1. The values are estimated effects from deterministic simulations.
- The changes are in percentage points.

9.4.5 Sensitivity of Policy Effects to Alternative Sets of Coefficient Estimates

The last issue examined in this chapter regarding the US model is the sensitivity of policy effects to the different sets of coefficient estimates. The C_g experiment was run for five sets of estimates; the results are presented in Table 9-6. The five estimators are 2SLS, 3SLS, FIML, 2SLAD for $q = 0.5$, and OLS. The 2SLS results are the same as those in Table 9-1. The procedure followed for the results for the other estimators is the same as that followed for the 2SLS results.

The main difference in the results in Table 9-6 concerns the FIML estimator: the initial increases in real GNP and the GNP deflator are larger for FIML than they are for the other estimators. This is again due to the fact that the FIML estimates of the lagged dependent variable coefficients are in general smaller than the estimates for the other estimators. In other words, the lagged adjustment behavior of the model that is due to the presence of the lagged endogenous variables is less pronounced for the FIML estimates because the coefficients of the lagged endogenous variables are generally smaller.

Aside from this difference for the FIML estimator, the results in Table 9-6 are very close to each other. The properties of the model are clearly not very sensitive to the choice of estimator, including the OLS estimator. This conclusion complements the conclusion in Section 8.5.5 that the overall fit of

the model is not very sensitive to the choice of estimator. It is of interest for future research to see if this conclusion holds for other models and for later versions of the US model.

9.5 Properties of the MC Model

9.5.1 General Remarks

As was the case for the US model, it is possible to get some idea of the properties of the MC model without performing simulation experiments. In the following discussion, a variable is said to have a "direct" effect on another variable if it appears on the RHS of the equation (either a stochastic equation or a definition) explaining the other variable. Most endogenous variables have at least an indirect effect on the other endogenous variables—either contemporaneously or with a lag of one quarter. As a result, it is difficult to explain the properties of the model in a very systematic way. This discussion is designed to try to give a general idea of the properties without going into every possible indirect effect. It should also be kept in mind that not all of the effects operate for all countries. All interest rates referred to are short-term rates unless otherwise noted.

Summary of the Stochastic Equations of the Model

For reference purposes it will be useful to provide a summary of the stochastic equations per country. The signs in parentheses in the following list are the expected signs of the coefficient estimates.

Equation number	*Dependent variable*	*Explanatory variables*
1	Merchandise imports	Short-term or long-term interest rate (−), GNP deflator (+), import price index (−), real GNP (+), lagged net foreign assets (+), lagged dependent variable (+)
2	Consumption	Short-term or long-term interest rate (−), real GNP (+), lagged net foreign assets (+), lagged dependent variable (+)
3	Change in investment	Changes in real GNP—current, lagged once, lagged twice, lagged three times—(+), lagged level of investment (−)
4	Real GNP	Final sales (+), lagged stock of inventories (−), lagged dependent variable (+)
5	GNP deflator	Import price index (+), demand pressure variable (−), lagged dependent variable (+)

6	Nominal money supply	Short-term interest rate (−), nominal GNP (+), lagged dependent variable (+)
7a,7b	Short-term interest rate	Lagged rate of inflation (+), lagged rate of growth of the money supply (+), demand pressure variable (−), change in net foreign assets (−), lagged rate of change in the import price index—four countries only—(+), exchange rate—three countries only—(+), lagged dependent variable (+)
8	Long-term interest rate	Short-term interest rates—current, lagged once, lagged twice—(+ or −), lagged dependent variable (+)
9b	Exchange rate	GNP deflator (+), short-term interest rate (−), demand pressure variable (−), lagged change in net foreign assets (−)—all relative to the respective U.S. variables—lagged dependent variable (+)
10b	Forward rate	Exchange rate (+), short-term interest rate relative to the U.S. short-term interest rate (+)
11	Export price index	GNP deflator (+), world price index (+), exchange rate (+)

Trade Effects among Countries

There is a standard trade multiplier effect in the model. An autonomous increase in GNP in country i increases the demand for imports, which increases the exports of other countries and thus their GNP and demand for imports, which then increases the exports of country i and thus its GNP. In short, exports affect imports and vice versa.

Price Effects among Countries

There is also a price multiplier effect in the model. An autonomous increase in country i's domestic price level increases its export prices, which increases the import prices of other countries, which increases their domestic prices, including their export prices, which then increases country i's import prices and thus its domestic and export prices. In short, export prices affect import prices and vice versa.

Direct Interest Rate Effects among Countries

The U.S. short-term interest rate appears as an explanatory variable in the interest rate reaction functions of a number of countries. The U.S. rate is more important in the fixed exchange rate period than it is in the flexible rate period, but even in the flexible rate period it has an effect on some countries.

This means that an increase in the U.S. interest rate directly increases other countries' rates. The German interest rate appears as an explanatory variable in the interest rate reaction functions of a few other European countries, and thus an increase in the German interest rate also directly increases other countries' rates.

Direct Exchange Rate Effects among Countries

The German exchange rate appears as an explanatory variable in the exchange rate equations of the other European countries. The German exchange rate thus directly affects other exchange rates. All exchange rates are relative to the U.S. dollar, and therefore each explanatory variable in the exchange rate equations (other than the lagged dependent variable and the German exchange rate) is the particular variable of the country relative to the same variable for the United States. This means that the following U.S. variables appear as explanatory variables in the exchange rate equations: the GNP deflator, the short-term interest rate, the demand pressure variable, and the change in net foreign assets.

Direct Effects within a Country

The short-term interest rate directly affects the long-term rate in the term structure equation (Eq. 8). The short-term or long-term rate has a direct negative effect on imports and consumption (Eqs. 1 and 2). The short-term rate has a direct negative effect on the demand for money and the exchange rate (Eqs. 6 and 9b). (The reader should remember that an increase in the exchange rate is a depreciation of the country's currency.)

The asset variable, which is the sum of past values of the balance of payments and a measure of the net asset position of the country vis-à-vis the rest of the world, has a direct positive effect on imports and consumption (Eqs. 1 and 2) and a direct negative effect on the short-term interest rate and the exchange rate (Eqs. 7b and 9b).

The exchange rate has a direct positive effect on the local currency price of exports (Eq. 11) and on the local currency price of imports (the equations in Table B-4 involved in linking export and import prices). It also has a direct negative effect on the dollar price of exports (because the coefficient estimate of the exchange rate in Eq. 11, which is in log form, is less than one). It has a direct positive effect on the short-term interest rate for nine countries (Eq. 7b).

The price of imports has a direct negative effect on imports (Eq. 1), a direct

positive effect on the GNP deflator (Eq. 5), a direct negative effect on the asset variable (Eqs. 17 and 18), and a direct positive effect on the short-term interest rate (Eq. 7b). The price of exports has a direct positive effect on the asset variable (Eqs. 17 and 18). The GNP deflator has direct positive effects on imports, the demand for money, the short-term interest rate, the exchange rate, and the price of exports (Eqs. 1, 6, 7a, 7b, 9b, and 11).

The level of imports has a direct negative effect on final sales and the asset variable, and the level of exports has a direct positive effect on these two variables (Eqs. 16, 17, and 18). The level of final sales has a direct positive effect on GNP (Eq. 4). Any deviation of GNP from final sales in a period is absorbed by a change in inventories (Eq. 12). The stock of inventories has a direct negative effect on GNP (Eq. 4). GNP has a direct positive effect on imports, consumption, investment, the GNP deflator, the demand for money, the short-term interest rate, and the exchange rate.

The money variable $M1_i^*$ does not play a very important role in the model. It is only a potential explanatory variable in the two interest rate reaction functions, Eqs. 7a and 7b. It appears in 3 of the 23 estimates of Eq. 7a (Table 4-7) and in 4 of the 20 estimates of Eq. 7b (Table 4-8). This means that other than in these few cases, the equation that determines $M1_i^*$, Eq. 6, plays no role in the model. The properties of the model would not be affected if Eq. 6 were dropped for all countries for which $M1_i^*$ is omitted from Eqs. 7a and 7b.

Some Indirect Effects within a Country

It should be clear that there are very few unambiguous indirect effects in the model with respect to sign. The signs depend on the relative sizes of the coefficient estimates. It is useful, however, to consider the likely signs of some indirect effects, even though these signs are not necessarily logical consequences of the model.

Consider first the indirect effect of the exchange rate on GNP. The main direct effect of the exchange rate is on the price of imports, at least in the short run. The price of imports has a direct negative effect on imports, and the level of imports has a direct positive effect on GNP. In other words, an increase in the price of imports causes substitution from imports to domestically produced goods, which raises GNP. The exchange rate thus has an indirect positive effect on GNP through this channel (that is, depreciation increases GNP).

Depreciation also lowers the dollar price of the country's exports, which

through the trade-share equations has a positive effect on the other countries' demand for the given country's exports. Therefore, depreciation also increases GNP through this channel.

For some countries the exchange rate is an explanatory variable in the interest rate reaction function, which means that for these countries depreciation leads to an increase in the short-term interest rate. The short-term rate has a negative effect on GNP, and therefore depreciation has a negative effect on GNP through this channel.

Depreciation is likely to have a negative indirect effect on GNP through a fourth channel. The likely initial effect of a depreciation on the balance of payments is negative. Depreciation raises the local currency price of imports more than it does the local currency price of exports, which, other things being equal, has a negative effect on the balance of payments. Depreciation also lowers imports and raises exports, which has a positive effect on the balance of payments. This latter effect is, however, likely to be smaller initially than the price effect, and thus the initial net effect is likely to be negative. (This is the "J-curve" effect.) A decrease in the balance of payments decreases net foreign assets, which directly decreases imports and consumption and directly increases the short-term interest rate. Although the decrease in imports raises GNP, the decrease in consumption and the increase in the interest rate lowers GNP, and the net effect is likely to be negative. Depreciation is thus likely to have an initial indirect negative effect on GNP through this asset effect channel.

Depreciation has two main indirect effects on the GNP deflator, one positive and one ambiguous. The positive effect is through the price of imports, which has a direct positive effect on the GNP deflator. The second effect is through GNP. If the net effect of depreciation on GNP is positive, this will have a positive effect on the GNP deflator through the direct positive effect of demand pressure on the GNP deflator. If the net effect of depreciation on GNP is negative, the indirect effect on the GNP deflator is negative.

There are three main effects of the short-term interest rate on GNP, one negative, one ambiguous, and one positive. The negative effect is through consumption: an increase in the short-term rate increases the long-term rate; an increase in the short-term rate or the long-term rate decreases consumption, which lowers GNP. The ambiguous effect is through the exchange rate: an increase in the short-term rate has a negative effect on the exchange rate (an appreciation), which has an ambiguous effect on GNP. The positive effect is through imports: an increase in the short-term or the long-term rate lowers

imports, which, other things being equal, raises GNP. The consumption effect is likely to be the dominant one, and thus the net effect of the short-term rate on GNP is likely to be negative.

An increase in the short-term interest rate has two main effects on the GNP deflator, both negative. The first is the likely negative indirect effect of the short-term rate on GNP and thus on demand. The second is the effect on the exchange rate: the exchange rate appreciates, which lowers the price of imports, which lowers the GNP deflator.

9.5.2 Results for Eleven Experiments: The Construction of Tables 9-7 through 9-17

The results of eleven experiments are reported in this section. The first experiment is for the fixed exchange rate period 1970II – 1972I, and the others are for the flexible rate period 1976I – 1977IV. The experiments are as follows.

1. An increase in U.S. government spending (fixed exchange rate period)
2. An increase in U.S. government spending (flexible exchange rate period)
3. An increase in the U.S. short-term interest rate
4. An increase in German government spending
5. An increase in the German interest rate
6. A depreciation of the German exchange rate
7. An increase in U.K. government spending
8. A depreciation of the U.K. exchange rate
9. An increase in Japanese government spending
10. A depreciation of the Japanese exchange rate
11. An increase in the price of exports of the oil-exporting countries

The results are presented in Tables 9-7 through 9-17. Stochastic simulation is too expensive to perform for the MC model, and thus all of the results in these tables are from deterministic simulations. For all the simulations the estimated residuals were added to the stochastic equations and treated as exogenous. The base path for the experiments is thus the perfect tracking solution. The complete MC model was used for all the experiments except 11, where trade shares were taken to be exogenous. The special treatment for experiment 11 is discussed later in this section.

Results for 15 countries and 13 variables per country are presented in the tables for the two-quarter-ahead and six-quarter-ahead predictions. Except for the numbers for the balance of payments and the two interest rates, each number in the tables is the percentage change in the variable (in percentage

TABLE 9-7. Percentage change in the variable after two and six quarters induced by a sustained 1 percent autonomous increase in US real GNP (initial change in 1970 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	1.31	1.05	.10	.44	.39	.53	.00	.00	.02	.15	-.08	.03	1.07	1.34
Canada	.12	.18	.01	.17	.35	.52	.00	-.09	.07	.24	-.69	-2.11	.10	.24
Japan	.05	.15	.00	.05	-.03	-.01	.00	.00	.04	.20	.04	.12	.02	.10
Austria	-.01	-.05	-.00	-.00	.04	.10	.00	.00	.02	.12	-.00	-.00	-.04	-.26
Belgium	.02	-.05	.00	.02	.28	.65	.00	.00	.03	.15	-.14	-.99	.02	-.13
Denmark	.04	.07	.00	.02	.12	.30	.00	.00	.03	.15	-.20	-.56	.01	-.06
France	.00	-.08	.00	.01	.22	.54	.00	.00	.03	.13	-.03	-.26	.00	-.11
Germany	.01	-.02	.00	.01	.28	.62	.00	.00	.03	.16	-.44	-1.35	-.06	-.57
Italy	.02	.00	.01	.03	.04	.14	.00	.00	.02	.13	-.05	-.29	.02	-.05
Netherlands	.01	-.12	.00	-.00	.34	.80	.00	.00	.03	.15	-.75	-1.75	.01	-.17
Norway	.00	-.04	.00	.02	.00	.00	.00	.00	.02	.15	.00	-.01	.01	-.03
Sweden	.02	.05	.00	.03	.10	.22	.00	.00	.03	.16	.02	.09	-.00	-.08
Switzerland	.00	-.03	.00	.01	.04	.13	.00	.00	.03	.14	-.02	-.13	-.02	-.29
United Kingdom	.03	.03	-.00	.02	.12	.27	.00	.00	.03	.16	-.20	-.89	.04	.07
Finland	.01	-.01	.00	.02	-.00	.00	.00	.00	.02	.13	.01	.01	.02	-.00
US Alone	1.31	1.07	.10	.43	.40	.53	—	—	0	0	-.08	.02	1.07	1.37

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	.04	-.11	1.92	2.95	.12	.31	.09	.44	-.00	-.19	-95.072	-130.478
Canada	-.04	-.12	.05	.10	.13	.30	.02	.19	.78	1.02	27.132	34.395
Japan	.02	.08	.01	.15	.00	.00	.01	.09	.44	.54	7.182	9.396
Austria	-.07	-.17	.00	.00	.00	.00	.02	.08	.05	-.08	.019	.043
Belgium	.01	-.08	.00	.01	.07	.28	.02	.12	.06	-.13	.043	-.031
Denmark	.03	.07	.00	.02	.04	.15	-.04	.16	.14	.04	.002	.009
France	-.01	-.10	.00	-.01	.06	.21	.03	.13	.05	-.13	.012	-.003
Germany	-.05	-.23	.00	.01	.08	.24	.02	.09	.12	.10	.049	.165
Italy	.01	.00	.00	.01	.01	.06	.03	.13	.11	-.07	2.032	.500
Netherlands	-.00	-.19	.00	-.01	.06	.24	.03	.14	.04	-.21	.004	-.003
Norway	.00	-.03	.00	-.00	.00	.00	.12	.31	.03	-.16	.009	.009
Sweden	.01	.04	.00	.08	.02	.08	.02	.13	.08	-.01	.006	.003
Switzerland	-.04	-.17	.00	-.01	.02	.07	.01	.06	.12	.01	.006	.015
United Kingdom	.02	.04	.01	.02	.04	.12	.02	.12	.15	.10	1.806	.046
Finland	.01	-.00	.00	.01	.00	.00	.04	.19	.05	-.08	1.241	.006
US Alone	.04	-.10	1.92	2.98	.12	.30	.08	.41	0	0	-92.871	-92.480

Note: a. Change is absolute change, not percentage change, in units of local currency.

points) divided by something. For the spending increases (Tables 9-7, 9-8, 9-10, 9-13, and 9-15), the divisor is the change in government spending as a percentage of GNP (in percentage points). In other words, each number is $[(\hat{y}_{jt} - y_{jt})/y_{jt}]/(\Delta G_{it}/Y_{it})$, where $\hat{y}_{jt}$ is the two- or six-quarter-ahead predicted value of y_{jt} after the change, ΔG_{it} is the change in government spending in quarter t, and Y_{it} is the actual value of GNP in quarter t. (Remember that all changes are changes from the actual values, not changes from quarter to quarter.) Each number is thus the percentage change in the variable induced

TABLE 9-8. Percentage change in the variable after two and six quarters induced by a sustained 1 percent autonomous increase in US real GNP (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	1.31	1.07	.15	.64	.42	.59	—	—	.44	1.62	-.08	.10	.84	.81
Canada	.11	.17	.02	.26	.35	.59	.01	-.13	.32	1.20	-.40	-1.45	.08	.07
Japan	.05	.28	-.00	.10	-.06	-.11	-.34	-.20	-.01	1.10	.03	.23	.03	.12
Austria	-.01	.05	.00	.20	.11	.31	-.68	-2.14	.22	1.10	-.00	-.00	-.13	-.67
Belgium	.03	.13	.01	.18	.04	.10	-.64	-1.89	.20	1.27	-.01	.00	-.04	-.41
Denmark	-.05	-.14	-.01	.05	-.09	.09	-.86	-2.18	-.09	.86	.03	-.19	.03	-.39
France	-.04	-.36	.00	-.01	-.01	-.36	-.71	-2.87	.02	-.07	-.02	-.15	-.03	-.40
Germany	-.04	-.23	-.01	-.07	.13	.16	-.75	-2.24	-.05	.55	-.15	-.48	-.09	-.56
Italy	-.01	-.17	.01	.02	-.07	-.45	-.55	-2.34	.16	.30	.04	.30	-.00	-.05
Netherlands	-.02	-.14	-.00	-.00	.05	.10	-.68	-2.09	.02	.59	-.07	-.20	-.01	-.33
Norway	-.00	.00	.02	.19	.03	.04	-.41	-1.44	.27	1.48	.00	.08	-.02	-.46
Sweden	.09	.04	.04	.35	.07	.21	.05	-1.23	.87	1.84	.11	.47	-.07	-.45
Switzerland	-.02	-.24	.01	-.03	.08	.10	-.88	-2.81	-.01	.50	-.04	-.16	-.13	-.72
United Kingdom	.01	-.21	.01	-.18	-.01	-.10	-.79	-3.90	-.13	-1.40	.01	.10	.01	-.09
Finland	-.04	-.43	.04	.30	-.00	-.04	-.22	-1.02	.53	2.20	-.00	-.10	-.04	-.63
US Alone	1.31	1.09	.13	.48	.40	.53	—	—	0	0	-.10	-.01	.87	1.29

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	.02	-.19	2.07	2.92	.13	.33	.20	.99	.14	.51	-294.394	-443.698
Canada	-.05	-.15	.02	.08	.13	.33	.24	1.07	.74	.89	56.762	63.979
Japan	.03	.19	.01	.23	.00	.00	.17	.77	.27	.93	22.569	30.165
Austria	-.09	-.22	.00	.00	.00	.00	-.01	.25	-.00	-.06	-.083	-.284
Belgium	.02	.06	.00	.03	.01	.05	.02	.46	-.01	-.27	-.647	-3.132
Denmark	-.03	-.13	-.00	-.04	-.02	.02	.07	.90	-.12	-.72	.012	-.046
France	-.01	-.15	.00	-.07	-.00	-.11	.43	1.68	-.21	-1.59	.264	.968
Germany	-.05	-.22	.00	-.11	.04	.07	.26	1.02	-.12	-.70	.214	.295
Italy	.01	-.00	.00	-.04	-.02	-.17	.40	1.51	-.05	-.81	17.477	82.510
Netherlands	-.01	-.14	.00	-.05	.01	.03	-.01	.35	-.05	-.44	-.018	-.110
Norway	-.01	-.01	.00	-.00	.01	.02	.35	1.55	-.03	-.58	.003	-.059
Sweden	.02	.04	.00	.24	.01	.07	.45	1.81	.22	-.57	-.048	-.053
Switzerland	-.06	-.28	.00	-.22	.04	.07	.20	.76	-.07	-.84	.034	.042
United Kingdom	.01	.05	.01	-.11	-.00	-.04	.36	1.23	.00	-.99	47.549	249.548
Finland	-.01	-.23	.00	-.12	.00	.00	.67	2.66	-.19	-1.66	-.777	-57.673
US Alone	.03	-.08	2.07	2.95	.12	.31	.07	.40	0	0	-230.193	-290.720

Note: a. Change is absolute change, not percentage change, in units of local currency.

by a one-percent autonomous increase in GNP of the country in which the policy change was made.

For the interest rate increases (Tables 9-9 and 9-11), the divisor is the change in the interest rate (in percentage points). The actual change in the interest rate for the experiments was 2.0 percentage points, so the divisor was 2.0. Each number in these tables is thus the percentage change in the variable induced by a 1.0 percentage point increase in the interest rate. For the exchange rate increases (Tables 9-12, 9-14, and 9-16), the percentage change in the exchange rate was 10.0 percent and the divisor was 1.0. Each number in

TABLE 9-9. Percentage change in the variable after two and six quarters induced by a sustained 1 percentage point increase in the US short-term interest rate (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	-.34	-1.13	-.04	-.40	1.00	1.00	—	—	-.67	-1.77	-.67	-1.82	-.29	-2.04
Canada	-.10	-.62	-.01	-.33	.95	1.05	.08	.09	-.27	-1.07	-1.22	-3.50	-.21	-1.38
Japan	-.04	-.35	.04	.17	.17	.61	1.30	3.03	.95	1.92	-.07	-.51	-.14	-1.12
Austria	-.08	-.24	-.03	-.28	.28	.38	1.00	1.98	-.21	-.99	-.00	-.00	-.26	-.84
Belgium	-.10	-.58	-.02	-.26	.30	.39	.77	1.62	-.26	-1.12	-.11	-.70	-.00	-.39
Denmark	-.06	-.40	-.02	-.17	-.09	-.14	.83	1.85	-.46	-1.16	.03	-.34	.04	-.04
France	-.04	-.28	-.01	-.05	.26	.72	.71	2.20	-.22	-.35	-.04	-.36	.02	-.24
Germany	-.08	-.31	-.01	-.14	.50	.83	.91	1.93	-.02	-.62	-.51	-1.50	-.23	-1.33
Italy	-.03	-.17	-.04	-.21	.07	.38	.56	1.68	-.32	-.65	-.06	-.50	-.03	-.50
Netherlands	-.06	-.49	-.00	-.10	.20	.28	.83	1.80	-.04	-.58	-.26	-.70	-.04	-.47
Norway	-.04	-.16	-.04	-.24	.19	.38	.81	1.49	-.50	-1.70	-.04	-.26	-.04	-.52
Sweden	.02	.00	.04	.24	.21	.68	1.95	3.45	.90	.64	.05	.30	-.19	-.99
Switzerland	-.05	-.24	.02	.02	.30	.53	1.62	3.05	.54	.13	-.14	-.52	-.46	-1.74
United Kingdom	-.03	-.26	-.03	-.15	-.04	.01	.34	2.19	-.54	-.21	.02	-.12	-.03	-.48
Finland	-.02	-.12	-.03	-.26	-.00	-.03	1.00	1.65	-.37	-1.58	-.03	-.32	-.05	-.50
US Alone	-.34	-1.10	-.01	-.21	1.00	1.00	—	—	0	0	-.62	-1.63	-.36	-2.53

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	-.41	-1.12	-.50	-2.30	.31	.64	-.20	-.78	-.12	-.81	463.175	1907.530
Canada	-.20	-.71	-.02	-.23	.34	.64	-.30	-1.07	-.26	-1.93	-11.473	-102.456
Japan	-.06	-.51	-.00	-.25	.00	.00	-.17	-.43	-.12	-.86	-128.978	-275.178
Austria	-.26	-.56	.00	.00	.00	.00	.04	-.31	-.13	-.81	.447	1.270
Belgium	-.06	-.48	.00	-.12	.08	.20	-.08	-.57	-.11	-.78	.767	2.242
Denmark	-.03	-.34	-.00	-.07	-.02	-.09	-.27	-.98	-.13	-.85	.045	-.094
France	-.02	-.23	.00	-.06	.07	.28	-.59	-1.58	-.13	-.76	-.899	-3.617
Germany	-.17	-.62	.00	-.18	.14	.34	-.35	-1.03	-.09	-.64	-.408	-.160
Italy	-.01	-.15	.00	-.06	.02	.15	-.54	-1.48	-.13	-.77	-50.535	-278.212
Netherlakds	-.03	-.46	.00	-.15	.04	.10	-.05	-.51	-.13	-.87	-.052	-.165
Norway	-.06	-.25	.00	-.05	.03	.13	-.22	-1.32	-.10	-.75	.124	.326
Sweden	-.00	-.13	.00	.08	.05	.22	-.52	-1.37	-.09	-.71	-.673	-.962
Switzerland	-.21	-.75	-.03	-.24	.15	.32	-.25	-.71	-.13	-.79	-.131	-.047
United Kingdom	-.01	-.26	-.00	-.15	-.01	-.00	-.51	-1.36	-.12	-.79	-3.679	-328.702
Finland	-.01	-.10	.00	-.04	.00	.00	-.88	-2.39	-.10	-.70	-75.568	-119.221
US Alone	-.43	-1.20	-.50	-2.24	.31	.64	-.01	-.18	0	0	212.951	1708.547

Note: a. Change is absolute change, not percentage change, in units of local currency.

these tables is thus the percentage change in the variable induced by a 10.0 percent increase in the exchange rate. Finally, for the increase in the export prices (Table 9-17), the percentage change in the prices was 50.0 percent and the divisor was 1.0. Each number in this table is thus the percentage change in the variable induced by a 50.0 percent increase in the export prices.

The numbers for the balance of payments are not in percentage terms and have not been divided by anything; they are merely the actual changes in the balance of payments corresponding to whatever policy change was made. The balance-of-payments variables are in units of nominal local currency, and

TABLE 9-10. Percentage change in the variable after two and six quarters induced by a sustained 1 percent autonomous increase in German real GNP (initial change in 1976 I)

Country	Real GNP		GNP deflator		Short-term interest rate		Exchange rate		Import price		Money supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
US	.01	.04	-.01	-.04	-.00	-.01	—	—	-.13	-.48	-.01	-.03	.02	.16
Canada	.01	.04	-.00	-.01	-.00	-.01	.00	.01	-.08	-.30	.00	.02	.01	.11
Japan	.01	.05	-.00	-.01	-.01	-.02	.01	.04	-.08	-.28	.01	.03	.01	.10
Austria	.09	.17	.02	.11	-.01	-.00	.39	1.26	.03	.10	-.00	-.00	.11	.38
Belgium	.22	.27	.02	.13	.18	.59	.34	1.09	.03	.04	-.01	-.23	.28	.56
Denmark	.08	.15	.00	.03	.01	.04	.35	1.15	.05	.17	.06	.13	.07	.19
France	.07	.06	-.00	.02	.28	1.07	.30	1.16	.02	.18	.01	-.17	.06	.08
Germany	1.21	1.67	.20	1.18	.57	1.65	.40	1.30	.14	.34	.45	.62	1.52	2.07
Italy	.07	.14	.01	.10	.02	.22	.26	1.09	-.00	.19	.02	-.02	.10	.19
Netherlands	.28	.44	.02	.16	.32	1.05	.36	1.20	.11	.32	-.16	-.69	.26	.63
Norway	.08	.41	-.00	-.03	.21	.70	.22	.74	-.04	-.21	.01	.07	.02	-.56
Sweden	.05	.12	-.00	-.06	.05	.26	.15	.45	-.14	-.55	.05	.09	.06	.19
Switzerland	.08	.19	.01	.09	.02	.08	.39	1.34	.07	.25	.01	.01	.13	.23
United Kingdom	.05	.10	-.01	-.03	-.01	.04	.12	.71	-.11	-.12	.01	-.01	.07	.18
Finland	.05	.13	-.01	-.03	.00	.02	.22	.74	-.08	-.29	.03	.09	.07	.17

Country	Consumption		Investment		Long-term interest rate		Export price		Exports		Balance of payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6
US	.00	.03	.02	.08	-.00	-.00	-.05	-.18	.12	.25	60.253	164.235
Canada	.00	.02	.00	.02	-.00	-.00	-.08	-.29	.06	.22	5.823	18.569
Japan	.01	.03	.00	.05	.00	.00	-.06	-.23	.08	.19	4.285	7.662
Austria	.07	.16	.00	.00	.00	.00	.08	.24	.48	.73	.148	.170
Belgium	.15	.24	.00	.11	.04	.23	.07	.21	.51	.72	.875	1.294
Denmark	.06	.15	-.00	.06	.00	.02	.01	-.02	.30	.45	.021	-.015
France	.01	-.07	.00	.05	.07	.39	-.14	-.51	.38	.56	.067	-.382
Germany	.55	.77	.00	1.96	.16	.61	-.01	.12	.10	.22	-.865	-1.194
Italy	.02	.07	.00	.09	.00	.08	-.12	-.41	.40	.58	9.776	-40.812
Netherlands	.16	.39	.00	.34	.05	.29	.11	.35	.65	.91	.103	.080
Norway	.03	.15	.00	.08	.03	.20	-.04	-.20	.25	.38	.026	.149
Sweden	.02	.08	.00	.18	.01	.08	-.14	-.54	.23	.31	.035	.037
Switzerland	.03	.09	.03	.28	.01	.04	-.06	-.19	.34	.51	.004	-.033
United Kingdom	.03	.08	.02	.07	-.00	.02	-.13	-.45	.19	.34	5.684	-29.236
Finland	.02	.09	.00	.09	.00	.00	-.22	-.81	.21	.37	-1.367	-26.829

Note: a. Change is absolute change, not percentage change, in units of local currency.

thus it is not readily apparent from the tables how one country's balance of payments changed relative to another's. For the most part it is unnecessary to know this to understand the rest of the results; when it is necessary, the relative change will be mentioned in the text. The main interest in the balance-of-payments results for a country is the sign of the changes.

For the two interest rates, the changes are absolute changes (in percentage points) rather than percentage changes. The divisors are the same as they are for the other variables.

The exchange rate experiments, 6, 8, and 10, require that the exchange rate reaction function be dropped for the particular country in question. The

TABLE 9-11. Percentage change in the variable after two and six quarters induced by a sustained 1 percentage point increase in the German short-term interest rate (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	-.02	-.09	.03	.13	.01	.03	—	—	.48	1.32	.03	.10	-.06	-.49
Canada	-.01	-.09	.01	.08	.01	.05	-.00	-.03	.29	.84	-.02	-.10	-.02	-.27
Japan	-.01	-.06	.01	.08	.01	.05	.01	.02	.33	.90	-.00	-.03	-.04	-.25
Austria	-.03	-.08	-.01	.04	.01	.07	-1.29	-2.60	.06	.52	-.00	-.00	-.05	-.46
Belgium	-.10	-.17	-.01	-.02	.05	-.04	-1.14	-2.27	-.00	.48	-.05	-.11	-.10	-.58
Denmark	-.04	-.09	-.00	.03	-.02	.04	-1.16	-2.39	.02	.39	-.02	-.11	-.02	-.28
France	-.04	-.18	.00	-.00	.41	.20	-1.01	-2.56	.02	-.01	-.07	-.21	-.04	-.23
Germany	-.11	-.16	-.03	-.15	1.00	1.00	-1.35	-2.68	-.43	-.31	-1.20	-1.77	-.66	-1.50
Italy	-.03	-.12	.01	-.01	-.10	-.48	-.83	-2.25	.15	.09	.05	.34	-.03	.07
Netherlands	-.15	-.46	-.01	-.14	.44	.44	-1.23	-2.52	-.28	-.19	-.62	-.88	-.06	-.58
Norway	.01	.35	.00	.09	.37	.35	-.99	-1.96	.05	.76	-.03	.13	-.22	-.97
Sweden	-.02	-.12	.01	.05	.13	.03	-.90	-2.30	.18	.32	-.00	-.07	-.07	-.11
Switzerland	-.03	-.14	-.01	-.05	-.03	-.12	-1.27	-2.66	-.09	.16	.01	.04	-.02	-.05
United Kingdom	-.02	-.10	.02	.18	.03	-.02	-.40	-1.57	.48	.65	-.02	.01	-.03	-.14
Finland	-.03	-.15	.03	.22	.00	-.01	-.75	-1.59	.45	1.42	.01	.07	-.02	-.03

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	-.02	-.10	-.02	-.17	.00	.01	.17	.51	-.06	-.30	-234.466	-585.770
Canada	-.00	-.04	-.00	-.03	.01	.02	.30	.83	-.07	-.50	-15.258	-85.659
Japan	-.00	-.05	-.00	-.04	.00	.00	.24	.66	-.06	-.32	-11.523	-33.452
Austria	-.03	-.13	.00	.00	.00	.00	-.21	-.18	-.21	-.57	-.408	-.947
Belgium	-.06	-.19	.00	-.07	.02	-.00	-.19	-.07	-.22	-.61	-2.265	-5.240
Denmark	-.03	-.09	-.00	-.03	-.00	.02	.04	.47	-.15	-.46	-.028	-.013
France	-.03	.17	.00	-.06	.12	.14	.54	1.45	-.16	-.44	.815	2.914
Germany	-.39	-.60	.00	-.18	.30	.45	.29	.79	-.04	-.27	1.727	3.142
Italy	.00	.01	.00	-.05	-.03	-.19	.50	1.29	-.18	-.51	43.274	196.395
Netherlands	-.09	-.55	.00	-.25	.08	.17	-.31	-.32	-.28	-.74	-.136	-.164
Norway	-.05	.13	.00	.04	.07	.16	-.03	.56	-.11	-.32	.007	.087
Sweden	-.00	-.01	.00	-.10	.03	.03	.53	1.43	-.12	-.47	.153	.419
Switzerland	.00	.01	-.00	-.17	-.01	-.07	.25	.65	-.15	-.46	.063	.071
United Kingdom	-.01	-.05	-.00	-.06	.01	-.00	.48	1.32	-.09	-.36	-7.329	127.243
Finland	-.01	-.07	.00	-.06	.00	.00	.85	2.30	-.11	-.37	42.714	66.408

Note: a. Change is absolute change, not percentage change, in units of local currency.

exchange rate is instead taken to be exogenous and then changed by the specified amount. This procedure is somewhat artificial in that the interest rate reaction function for the particular country is not also changed. Presumably exchange rate and interest rate decisions are coordinated, so changing one but not the other is not necessarily realistic. These experiments, however, were performed solely with the aim of trying to understand the properties of the model; they are not meant to be realistic descriptions of actual policy-making decisions. Similar considerations apply to the German interest rate experiment, experiment 5.

The following discussion of the results is somewhat loose. Reference is

TABLE 9-12. Percentage change in the variable after two and six quarters induced by a sustained 10 percent increase in the German exchange rate (depreciation) (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	.09	.28	-.21	-.57	-.10	-.09	—	—	-3.24	-4.24	-.20	-.35	.56	2.06
Canada	.05	.31	-.09	-.44	-.11	-.14	.03	.12	-2.00	-2.80	.13	.38	.24	1.10
Japan	.01	.08	-.11	-.38	-.07	-.13	-.07	-.17	-2.19	-3.02	.01	-.01	.31	.99
Austria	-.00	-.39	.04	-.47	-.09	-.27	9.65	9.68	-.34	-1.71	-.00	-.00	.10	.64
Belgium	-.01	-.68	.06	-.28	1.20	1.03	8.35	8.35	-.03	-1.64	-.30	-1.51	-.08	-.25
Denmark	.08	-.28	.05	-.09	.32	-.07	8.86	8.86	.24	-1.07	-.18	-.19	-.21	.05
France	-.03	-.37	-.03	.18	1.03	2.21	8.37	10.56	.81	1.04	-.10	-.72	-.10	-.76
Germany	-.10	-.38	.09	.12	.64	1.04	10.00	10.00	2.99	1.19	-.56	-1.65	-.23	-1.73
Italy	-.04	-.00	-.10	.03	1.00	2.29	6.96	9.19	-.11	.63	-.65	-2.33	-.20	-1.90
Netherlands	.20	-.15	.08	.26	.68	.49	9.36	9.43	2.37	.85	-.54	-.46	-.38	-.47
Norway	.01	-.04	-.04	-.42	.50	.72	6.77	6.80	-.64	-2.61	-.05	-.36	-.11	-.66
Sweden	-.10	-.11	-.22	-.53	.02	.78	6.07	7.33	-1.64	-2.04	-.26	-.77	.26	-.90
Switzerland	.02	-.07	.06	.07	.27	.49	9.64	9.81	.75	-.72	-.11	-.41	-.50	-1.52
United Kingdom	.01	-.14	-.26	-.62	-.29	.04	3.46	7.08	-2.58	-.70	.15	-.34	.02	-.53
Finland	.03	.15	-.25	-.93	-.02	-.01	5.75	5.87	-2.70	-4.36	-.16	-.72	-.12	-1.01

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	.14	.41	.13	.57	-.03	-.06	-1.18	-1.79	.09	.26	617.978	510.500
Canada	.03	.17	.00	.12	-.04	-.08	-1.99	-2.74	.47	1.73	50.361	127.088
Japan	.03	.13	-.00	.07	.00	.00	-1.57	-2.21	.23	.69	28.042	28.925
Austria	.06	-.08	.00	.00	.00	.00	1.62	.76	-.09	-.73	1.029	1.092
Belgium	.02	-.47	.00	-.15	.31	.59	1.52	.48	-.14	-.80	6.357	7.846
Denmark	.04	-.23	-.00	.02	.08	-.02	.13	-1.16	.03	-.60	.007	-.093
France	-.04	-.52	.00	-.05	.27	.92	-3.49	-4.44	-.09	-.68	-4.050	-6.039
Germany	-.25	-1.02	.00	-.23	.17	.43	-1.96	-2.63	-.04	-.22	-3.607	-2.307
Italy	-.11	-.48	.00	-.03	.27	1.06	-3.22	-3.99	-.04	-.41	-287.036	-453.613
Netherlands	.14	-.01	.00	.14	.11	.21	2.67	1.56	-.11	-.90	.194	.122
Norway	-.07	-.27	.00	.02	.09	.27	.10	-1.68	.02	-.51	.164	.360
Sweden	-.04	-.29	.00	-.26	.01	.23	-3.53	-4.60	-.06	-.41	-.534	-.570
Switzerland	-.16	-.61	-.02	.01	.13	.29	-1.63	-2.09	-.01	-.42	-.264	-.115
United Kingdom	.01	-.40	.00	-.06	-.09	.01	-3.17	-4.06	.03	-.10	-56.048	-378.834
Finland	.00	-.01	.00	.08	.00	.00	-5.46	-7.01	.01	-.47	-176.527	-132.821

Note: a. Change is absolute change, not percentage change, in units of local currency.

sometimes made to a change in one endogenous variable "leading to" or "resulting in" a change in another endogenous variable. This is not, strictly speaking, correct because the model is simultaneous, but it does help to give a general idea of the model's properties. Not all results in the tables are explained, and not every possible indirect effect is noted. Emphasis is placed on the main results and effects and, as the discussion progresses, on the results in a table that are different from the results in previous tables. In what follows, the terms "GNP" and "income" are used interchangeably, interest rates are always short-term rates unless otherwise noted, and import and export prices are local currency prices unless otherwise noted.

TABLE 9-13. Percentage change in the variable after two and six quarters induced by a sustained 1 percent autonomous increase in United Kingdom real GNP (initial change in 1976 I)

Country	Real GNP		GNP deflator		Short-term interest rate		Exchange rate		Import price		Money supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
US	.01	.03	-.00	-.02	-.00	-.00	—	—	-.05	-.26	-.00	-.02	.01	.10
Canada	.02	.04	.00	.01	-.01	-.01	.00	.02	-.03	-.17	.01	.03	.03	.13
Japan	.01	.04	-.00	-.00	-.01	-.02	.01	.04	-.02	-.12	.00	.03	.01	.06
Austria	.03	.04	.01	-.02	-.00	-.01	.01	.09	-.05	-.25	-.00	-.00	.05	.18
Belgium	.07	.06	.00	-.01	.02	.02	.01	.08	-.08	-.38	.01	.02	.13	.35
Denmark	.14	.08	.00	-.04	.01	-.14	.03	.09	-.08	-.45	.10	.21	.13	.49
France	.04	.06	-.00	-.03	.01	.04	.01	.07	-.06	-.32	.02	.02	.04	.17
Germany	.04	.11	.00	.04	.01	.06	.01	.10	-.06	-.28	.02	.06	.05	.16
Italy	.03	.06	.00	-.01	-.01	-.01	.01	.08	-.05	-.24	.01	.05	.04	.15
Netherlands	.11	.15	.01	.04	.03	.07	.01	.09	-.06	-.33	.04	.06	.12	.35
Norway	.21	.20	-.00	-.05	-.01	.01	.01	.06	-.08	-.41	.08	.09	.23	.56
Sweden	.08	.16	.00	-.03	-.01	-.03	.03	.12	-.08	-.43	.08	.17	.08	.41
Switzerland	.05	.07	.01	-.00	.01	.01	.02	.11	-.08	-.48	.00	.01	.08	.25
United Kingdom	1.41	1.19	-.00	.36	.27	.41	.52	2.56	.47	2.29	.12	-.12	2.01	1.76
Finland	.09	.15	-.00	-.05	.01	.03	.00	.04	-.10	-.53	.07	.10	.13	.37

Country	Consumption		Investment		Long-term interest rate		Export price		Exports		Balance of payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6
US	.00	.02	.02	.06	.00	.00	-.01	-.08	.13	.24	51.303	120.412
Canada	.00	.03	.00	.02	-.00	-.00	-.02	-.12	.14	.21	13.296	18.359
Japan	.00	.03	.00	.04	.00	.00	-.02	-.10	.07	.16	3.468	5.957
Austria	.02	.05	.00	.00	.00	.00	-.02	-.13	.17	.26	.060	.104
Belgium	.05	.07	.00	.04	.01	.01	-.04	-.19	.20	.35	.397	.827
Denmark	.10	.13	-.00	.07	.00	-.06	-.04	-.27	.52	.53	.059	.038
France	.01	.03	.00	.03	.00	.01	-.05	-.27	.21	.30	.129	.142
Germany	.02	.08	.00	.09	.00	.02	-.03	-.16	.18	.31	.103	.195
Italy	.01	.04	.00	.04	-.00	-.01	-.04	-.23	.16	.26	9.699	11.272
Netherlands	.07	.18	.00	.13	.01	.02	-.04	-.22	.27	.36	.045	.042
Norway	.16	.18	.00	.19	-.00	-.00	-.07	-.38	.75	.85	.051	.035
Sweden	.03	.12	.00	.28	-.00	-.01	-.04	-.26	.36	.48	.066	.070
Switzerland	.02	.06	.01	.14	.00	.01	-.02	-.12	.19	.28	.017	.046
United Kingdom	.91	.56	.88	.74	.09	.20	-.02	-.06	.07	.23	-194.756	-422.917
Finland	.04	.13	.00	.16	.00	.00	-.07	-.39	.40	.49	18.327	24.275

Note: a. Change is absolute change, not percentage change, in units of local currency.

United States Spending Increase: Fixed Exchange Rate Period (Table 9-7)

The increase in U.S. government spending increased U.S. income, which in turn increased U.S. imports. This increased other countries' exports, which in turn increased their income and imports. This is the trade multiplier effect. The increase in U.S. income also led to an increase in the U.S. price level, which increased other countries' import prices. This led to an increase in other countries' export prices, which resulted in further increases in other countries' import prices. This is the price multiplier effect.

The other important effect in this case is the interest rate effect. The

TABLE 9-14. Percentage change in the variable after two and six quarters induced by a sustained 10 percent increase in the United Kingdom exchange rate (depreciation) (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	.03	.05	-.05	-.11	-.03	-.01	—	—	-.73	-.75	-.05	-.06	.17	.41
Canada	.01	.04	-.03	-.11	-.05	-.03	.02	.03	-.51	-.55	.06	.10	.09	.24
Japan	.01	.03	-.02	-.06	-.02	-.02	-.01	.01	-.42	-.46	.01	.02	.07	.20
Austria	-.03	-.06	-.12	-.30	-.03	-.05	.03	.12	-.80	-.82	-.00	-.00	.16	.19
Belgium	-.21	-.23	-.13	-.37	-.30	-.10	.03	.11	-1.19	-1.20	-.04	-.15	.32	.17
Denmark	-.15	-.44	-.11	-.38	-.61	-.38	.01	.05	-1.54	-1.56	.34	-.34	.47	.49
France	-.03	-.09	-.05	-.20	-.10	-.08	.04	-.02	-.96	-1.11	-.03	-.15	.20	.22
Germany	.04	.04	-.02	-.06	-.01	-.02	.04	.13	-.91	-.91	.03	.02	.05	.13
Italy	.01	-.00	-.11	-.28	-.08	-.09	-.02	-.08	-.86	-.97	.01	-.06	.07	.12
Netherlands	-.06	-.16	-.04	-.16	-.20	-.10	.03	.12	-.99	-1.11	.14	-.11	.21	.14
Norway	-.14	-.46	-.13	-.30	-.11	.00	.04	.09	-1.25	-1.28	-.08	-.38	.29	-.12
Sweden	-.05	-.23	-.13	-.42	-.19	-.26	.15	.16	-1.40	-1.47	-.14	-.75	.29	.40
Switzerland	-.03	-.15	-.08	-.35	-.04	-.07	.02	-.10	-1.49	-1.86	.00	-.06	.26	.38
United Kingdom	-.05	-.62	.73	2.98	1.62	-1.16	10.00	10.00	9.46	9.45	-1.10	.76	-.35	-2.80
Finland	.01	-.10	-.17	-.41	-.02	-.02	.02	.08	-1.50	-1.61	-.12	-.46	.05	.03

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	.04	.08	.04	.12	-.01	-.01	-.21	-.29	.07	.02	166.899	71.836
Canada	.01	.05	.00	.02	-.02	-.02	-.35	-.45	.14	.24	32.238	22.644
Japan	.01	.04	.00	.04	.00	.00	-.27	-.34	.10	.14	9.478	4.238
Austria	-.01	-.01	.00	.00	.00	.00	-.44	-.53	.08	.01	.214	.150
Belgium	-.14	-.13	.00	-.07	-.06	-.07	-.59	-.69	.12	-.05	1.832	1.447
Denmark	-.06	-.34	-.00	-.14	-.15	-.24	-.77	-.89	.06	-.34	.112	.043
France	-.01	-.03	.00	-.03	-.02	-.04	-.67	-.81	.09	-.07	.180	.080
Germany	.03	.08	.00	.07	-.00	-.01	-.43	-.51	.15	.02	.376	.207
Italy	.01	.03	.00	.01	-.02	-.05	-.61	-.77	.11	.02	35.193	11.846
Netherlands	-.03	-.08	.00	-.08	-.03	-.04	-.70	-.78	.10	-.08	.061	.066
Norway	-.07	-.37	.00	-.16	-.02	-.01	-1.05	-1.19	.01	-.92	.043	.003
Sweden	-.01	-.05	.00	-.22	-.04	-.09	-.65	-.87	.12	-.21	.157	.041
Switzerland	.01	-.01	.01	-.18	-.02	-.04	-.33	-.52	.09	-.01	.102	.118
United Kingdom	-.30	-2.12	.01	-.39	.53	-.27	.12	1.24	.18	.25	-892.626	-713.595
Finland	.01	-.03	.00	-.00	.00	.00	-.96	-1.14	.08	-.29	47.621	36.331

Note: a. Change is absolute change, not percentage change, in units of local currency.

increase in U.S. income and prices led to an increase in the U.S. interest rate through the reaction function of the Federal Reserve. This offset some of the increase in U.S. income that would otherwise have occurred and also led to an increase in other countries' interest rates. The interest rates for all countries except Japan were higher after two quarters. This worldwide increase in interest rates offset some of the increase in world income that would otherwise have occurred. For a number of countries the interest rate effect was large enough to lead to a net negative effect on GNP by the sixth quarter. In other words, the U.S. expansion caused GNP for some countries to fall because of the interest rate increase that resulted from the expansion.

TABLE 9-15. Percentage change in the variable after two and six quarters induced by a sustained 1 percent autonomous increase in Japanese Real GNP (initial change in 1976 I)

Country	Real GNP		GNP deflator		Short-term interest rate		Exchange rate		Import price		Money supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
US	.01	.02	-.01	-.02	-.00	-.00	—	—	-.09	-.20	-.01	-.02	.01	.09
Canada	.01	.03	-.00	-.00	-.00	-.01	.00	.01	-.03	-.08	.00	.02	.01	.08
Japan	1.29	2.29	.10	.65	.10	.38	.49	1.38	.47	1.32	.31	1.08	.36	.85
Austria	-.00	.00	-.00	-.02	-.00	-.00	.00	.02	-.04	-.10	-.00	-.00	.01	.03
Belgium	-.01	-.01	-.00	-.02	-.01	-.00	.00	.02	-.05	-.12	.01	-.01	.01	.04
Denmark	.00	.00	-.00	-.02	-.01	-.01	.00	.02	-.05	-.12	.01	-.01	.01	.04
France	.00	.00	-.00	-.01	-.00	.01	.01	.04	-.03	-.08	-.00	-.00	.01	.03
Germany	.00	.02	-.00	-.00	.00	.01	.00	.02	-.05	-.12	.00	.00	.00	.02
Italy	.00	.01	-.00	-.02	-.00	.00	.00	.02	-.04	-.09	-.00	-.01	.00	.02
Netherlands	-.00	.00	-.00	-.01	-.00	.00	.00	.02	-.04	-.10	.00	-.00	.01	.03
Norway	-.00	-.00	-.01	-.03	-.00	-.00	.00	.02	-.08	-.19	-.00	-.01	.01	.04
Sweden	.00	.01	-.00	-.02	-.00	-.00	.01	.03	-.05	-.11	-.00	-.01	.01	.03
Switzerland	.00	.01	-.00	-.01	-.00	.00	.00	.03	-.05	-.11	.00	-.00	.01	.05
United Kingdom	.00	.02	-.00	-.02	-.00	-.00	.00	.00	-.05	-.13	.00	.01	.01	.03
Finland	.00	.01	-.00	-.02	-.00	.00	-.00	.01	-.05	-.13	-.00	-.01	.00	.01

Country	Consumption		Investment		Long-term interest rate		Export price		Exports		Balance of payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6
US	.00	.02	.01	.05	-.00	-.00	-.02	-.05	.05	.15	39.366	87.069
Canada	.00	.01	.00	.01	-.00	-.00	-.02	-.06	.04	.16	5.176	14.273
Japan	.30	.82	.50	3.05	.00	.00	.07	.53	.01	.07	-36.872	-78.847
Austria	-.00	.00	.00	.00	.00	.00	-.03	-.08	.01	.04	.008	.025
Belgium	-.00	-.01	.00	-.00	-.00	-.00	-.04	-.10	.01	.04	.000	.021
Denmark	.00	-.00	-.00	.00	-.00	-.01	-.06	-.14	.02	.06	.001	.001
France	.00	.00	.00	.00	-.00	.00	-.05	-.13	.01	.04	-.012	-.039
Germany	.00	.01	.00	.01	.00	.00	-.03	-.08	.01	.05	.018	.048
Italy	.00	.00	.00	.00	-.00	.00	-.04	-.11	.01	.05	.229	-.990
Netherlands	-.00	-.00	.00	.00	-.00	-.00	-.05	-.12	.01	.04	-.004	-.006
Norway	.00	-.00	.00	-.00	-.00	-.00	-.08	-.19	.01	.05	.004	.009
Sweden	.00	.00	.00	.01	-.00	-.00	-.05	-.12	.01	.05	.002	.002
Switzerland	.00	.01	.00	.02	.00	.00	-.02	-.06	.02	.06	.003	.007
United Kingdom	.00	.02	.00	.01	-.00	-.00	-.04	-.11	.01	.06	1.266	4.245
Finland	.00	.01	.00	.00	.00	.00	-.07	-.18	.01	.04	-.653	-.684

Note: a. Change is absolute change, not percentage change, in units of local currency.

The U.S. increase had a negative effect on the U.S. balance of payments and a positive effect on the other countries' balance of payments. Imports declined for some countries even though GNP rose; this is due in part to the effects of higher interest rates and in part to the fact that import prices increased more initially than did domestic prices. An increase in import prices relative to domestic prices leads to a substitution away from imported goods. Note finally that the money supply decreased for many countries. Although income was higher, interest rates were also higher, and in many cases the negative interest rate effect dominated.

This completes the discussion of the first experiment. An interesting

TABLE 9-16. Percentage change in the variable after two and six quarters induced by a sustained 10 percent increase in the Japanese exchange rate (depreciation) (initial change in 1976 I)

Country	Real GNP 2	Real GNP 6	GNP deflator 2	GNP deflator 6	Short-term interest rate 2	Short-term interest rate 6	Exchange rate 2	Exchange rate 6	Import price 2	Import price 6	Money supply 2	Money supply 6	Imports 2	Imports 6
US	.06	.12	-.13	-.31	-.08	-.05	—	—	-1.93	-2.10	-.13	-.18	.38	1.10
Canada	.02	.09	-.04	-.16	-.10	-.09	.03	.12	-.76	-.92	.12	.29	.11	.46
Japan	-.14	-.53	.48	1.28	1.57	1.79	10.00	10.00	9.51	9.30	-.63	-1.61	-1.73	-5.56
Austria	-.03	-.03	-.09	-.34	-.03	-.07	.07	.40	-.85	-1.05	-.00	-.00	.17	.28
Belgium	-.17	-.15	-.10	-.33	-.23	-.06	.07	.35	-1.00	-1.19	-.03	-.10	.27	.32
Denmark	-.06	-.12	-.06	-.27	-.22	.00	.05	.33	-1.10	-1.25	.10	-.36	.22	.19
France	-.02	-.02	-.03	-.15	-.05	.07	.19	.60	-.71	-.78	-.02	-.11	.15	.21
Germany	.04	.09	-.02	-.07	-.03	-.01	.08	.42	-1.06	-1.20	.04	.05	.05	.21
Italy	.01	.06	-.09	-.25	.00	.08	.08	.38	-.78	-.87	-.03	-.18	.04	.06
Netherlands	-.05	-.09	-.03	-.14	-.15	-.06	.07	.39	-.88	-.98	.11	-.09	.17	.21
Norway	-.10	-.12	-.16	-.38	-.11	-.02	.06	.28	-1.76	-1.89	-.08	-.27	.29	.23
Sweden	-.02	-.05	-.08	-.34	.08	-.07	.09	.32	-1.07	-1.28	-.08	-.46	.18	.29
Switzerland	-.01	-.06	-.04	-.23	-.04	-.04	.12	.42	-1.01	-1.15	.01	-.02	.15	.28
United Kingdom	.03	.08	-.08	-.37	-.11	.01	.05	.14	-1.00	-1.37	.06	-.01	.04	.17
Finland	.03	.09	-.11	-.32	-.01	.01	.01	.22	-1.12	-1.38	-.07	-.22	.01	-.01

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-term interest rate 2	Long-term interest rate 6	Export price 2	Export price 6	Exports 2	Exports 6	Balance of payments[a] 2	Balance of payments[a] 6
US	.10	.24	.09	.27	-.02	-.04	-.37	-.62	-.10	-.39	456.514	177.409
Canada	.02	.10	-.00	.04	-.04	-.06	-.54	-.76	.18	.48	44.177	39.737
Japan	-.63	-1.88	-.03	-.56	.00	.00	.21	.78	.24	.55	-437.133	-204.277
Austria	-.00	.04	.00	.00	.00	.00	-.64	-.77	.08	.18	.124	.179
Belgium	-.12	-.12	.00	-.06	-.05	-.06	-.88	-1.02	.11	.23	-.103	.224
Denmark	-.03	-.15	-.00	-.05	-.05	-.04	-1.18	-1.38	.08	.13	-.020	-.011
France	-.01	-.01	.00	-.01	-.01	.02	-1.03	-1.33	.09	.18	-.351	-.663
Germany	.03	.11	.00	.08	-.01	-.01	-.68	-.87	.13	.20	.278	.202
Italy	.00	.02	.00	.02	.00	.03	-.92	-1.23	.10	.25	-1.880	-31.729
Netherlands	-.04	-.14	.00	-.06	-.02	-.03	-1.08	-1.19	.12	.24	-.093	-.065
Norway	-.06	-.10	.00	-.11	-.01	-.01	-1.64	-1.92	.09	.21	.059	.086
Sweden	-.01	-.02	.00	-.07	-.02	-.03	-.97	-1.35	.12	.18	.015	-.028
Switzerland	.01	.01	.00	-.09	-.02	-.03	-.48	-.70	.06	.09	.036	.020
United Kingdom	.02	.09	.01	.05	-.03	-.01	-.87	-1.26	.11	.22	17.649	17.244
Finland	.01	.05	.00	.06	.00	.00	-1.48	-1.92	.10	.18	-15.600	-16.666

Note: a. Change is absolute change, not percentage change, in units of local currency.

question is how the properties of the model compare to those of other models. It is difficult to make these comparisons because experiments across models generally differ, but some multiplier results for other multicountry econometric models are presented in Fair (1979b, tables 1 and 2) that provide a rough basis of comparison for the results in Table 9-7. In general, the present income multipliers are smaller and the price multipliers are larger than those of the other models. This result is as expected, because the other models are primarily trade multiplier models and thus have weak or nonexistent price multiplier and interest rate effects.

TABLE 9-17. Percentage change in the variable after two and six quarters by a sustained 50 percent increase in the price of exports of the oil-exporting countries (initial change in 1976 I)

Country	Real GNP		GNP deflator		Short-term interest rate		Exchange rate		Import price		Money supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
US	-.46	-1.10	.66	1.60	.39	.16	—	—	10.22	12.54	.74	.95	-1.92	-6.80
Canada	-.25	-1.38	.20	.42	.80	.71	-.25	-1.03	3.69	3.77	-1.02	-2.77	-.89	-4.43
Japan	-.23	-.55	.77	1.96	1.75	1.28	-1.18	-2.74	15.21	14.26	-.68	-1.17	-2.60	-7.48
Austria	.05	.06	.34	.99	.23	.37	-.39	-2.43	2.49	2.89	-.00	-.00	-.65	-1.57
Belgium	.02	-.02	.13	.51	.28	-.02	-.35	-2.06	1.79	3.13	-.01	-.03	-.76	-1.72
Denmark	.03	.30	.13	.66	.91	1.28	-.27	-1.93	1.96	4.09	-.67	-.56	-.74	-2.56
France	.11	-.01	.21	1.01	.63	.13	-.90	-2.94	4.73	3.91	.12	.46	-.93	-1.32
Germany	-.22	-.62	.08	.17	.24	.15	-.41	-2.45	4.41	3.99	-.29	-.76	-.27	-1.51
Italy	-.05	.18	.92	2.79	1.45	1.98	-.01	-.55	7.83	9.95	-.65	-.60	-.82	-2.48
Netherlands	.27	-.57	.17	.74	1.07	.05	-.36	-2.27	5.87	5.18	-.85	.02	-1.10	-2.44
Norway	.08	.48	.26	.81	.38	.14	-.26	-1.69	3.39	3.79	.09	.60	-.73	-2.51
Sweden	-.01	-.20	.17	.74	.42	.52	-.63	-3.53	3.19	2.40	.13	.68	-.65	-1.73
Switzerland	-.13	-.20	.02	.14	.08	-.01	-.65	-3.30	1.26	1.24	-.05	-.08	-.46	-1.06
United Kingdom	-.21	-.68	.51	2.32	1.06	-.88	-.16	-.27	6.74	7.46	-.75	.52	-.45	-2.41
Finland	-.11	-.28	.19	.70	.01	-.05	-.04	-1.33	2.20	5.79	.06	.36	-.20	-1.04

Country	Consumption		Investment		Long-term interest rate		Export price		Exports		Balance of payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6
US	-.60	-1.46	-.68	-2.35	.12	.16	.70	2.11	-.68	-1.21	-3291.746	-2506.534
Canada	-.21	-1.06	-.03	-.54	.29	.47	.44	1.35	-1.86	-6.59	-544.729	-654.937
Japan	-.73	-1.75	-.04	-.77	.00	.00	.86	2.50	-.71	-1.19	-722.171	-372.842
Austria	-.11	-.29	.00	.00	.00	.00	.36	.79	-.43	-1.05	-1.197	-1.106
Belgium	-.00	-.26	.00	-.03	.06	.06	.38	.97	-.74	-1.43	-5.575	-8.369
Denmark	-.05	-.01	-.00	.05	.23	.64	.61	1.82	-.68	-1.85	-.266	-.360
France	.04	-.07	.00	.05	.14	.15	.65	2.56	-.56	-1.20	-3.475	-1.254
Germany	-.18	-.85	.00	-.49	.06	.10	.42	1.50	-.71	-1.11	-3.098	-1.618
Italy	-.17	-.40	.00	.00	.40	1.05	.96	3.31	-.57	-.36	-716.023	-598.857
Netherlands	.04	-1.75	.00	.11	.17	.15	.47	1.09	-.56	-1.35	-1.634	-1.116
Norway	-.01	.27	.00	.13	.06	.11	.83	2.40	-.60	-2.26	-.520	-.308
Sweden	-.02	-.26	.00	-.07	.09	.21	.65	2.51	-.63	-1.76	-.630	-.002
Switzerland	-.11	-.29	-.05	-.45	.04	.01	.29	1.12	-.63	-.85	-.111	.044
United Kingdom	-.30	-1.67	-.04	-.50	.35	-.21	.78	3.18	-.59	-.62	-596.329	-339.250
Finland	-.04	-.26	.00	-.21	.00	.00	.95	3.62	-.52	-1.27	-116.597	-67.358

Note: a. Change is absolute change, not percentage change, in units of local currency.

United States Spending Increase: Flexible Exchange Rate Period (Table 9-8)

The results in Table 9-8 are for the flexible exchange rate period. One key difference between the fixed and flexible rate periods is that in the latter the U.S. interest rate has smaller direct effects on other countries' interest rates. The changes in the other countries' interest rates after two quarters are generally smaller in Table 9-8 than in Table 9-7. This means that there is less initial offset to the trade multiplier effect from higher interest rates in the flexible rate period.

There are four main effects of the U.S. spending increase on the exchange rates, three negative and one positive. The spending increase raised U.S. output and prices relative to those of the other countries, both of which have a negative effect on other countries' exchange rates (an appreciation). The U.S. balance of payments fell relative to those of the other countries (the balance of payments of other countries generally rose), and this also has a negative effect on exchange rates. The positive effect is the interest rate effect. The U.S. short-term interest rate rose relative to other countries' rates, and this has a positive effect on exchange rates (a depreciation). As can be seen in Table 9-8, the net effect is usually negative. Only for the two-quarter-ahead results for Canada and Sweden is the net effect positive (the interest rate effect dominating).

The price of exports of most countries increased. This is the price multiplier effect from the initial increase in U.S. prices. Exports for some countries increased and for other countries decreased. Whether exports for a particular country increase or decrease depends on the *relative* change in the country's export price (the trade share equations). The balance of payments for a number of countries fell. This may at first glance seem puzzling, since the J-curve effect that was discussed earlier implies that an appreciation should initially increase the balance of payments. What should be remembered, however, is that although almost all currencies appreciated relative to the dollar, they obviously did not all appreciate relative to each other. If a country's currency appreciated relative to the dollar but depreciated relative to most of its other trading partners, then its currency has effectively depreciated rather than appreciated, which will have an initial negative effect on the balance of payments.

The price of imports of most countries increased because of the general increase in export prices. For two countries, however, France and the United Kingdom, the change in import prices was negative after six quarters. After six quarters, the United Kingdom's currency had appreciated relative to all others and France's currency had appreciated relative to all others except the United Kingdom's. Appreciation has, other things being equal, a negative effect on the price of imports, and in these two cases it was large enough to dominate the positive effect from the general increase in export prices.

GNP for some countries was lower after two and/or six quarters. The three main things that can cause this are (1) an increase in the interest rates *RS* and *RB* in the country, (2) a decrease in exports, and (3) a decrease in the balance of payments. (A decrease in the balance of payments has a negative effect on GNP through the wealth effects.) One or more of these effects are operating

for countries that experienced a fall in GNP. With respect to the GNP deflator, there are two main effects operating on it, one through the price of imports and one through GNP. Given that the effects on these last two variables are not the same across countries, one would not expect the effect on the GNP deflator to be the same across countries, and it is in fact not: for some countries the GNP deflator is higher and for some it is lower.

The results at the bottom of Table 9-8 are for the US model alone. In this case the rest of the world is exogenous—in particular, exports and the price of imports are exogenous. One of the main differences in the results is that the increase in the GNP deflator is less for the US model alone. In the complete model the U.S. price of imports rose because of the depreciation of the dollar and the general increase in export prices, which had a positive effect on the GNP deflator. This effect is absent for the US model alone. Another main difference is that the fall in the balance of payments after six quarters is less for the US model alone. This is again due primarily to the fact that the price of imports rose in the complete model. The properties of the US model regarding the change in GNP are not sensitive to the treatment of the rest of the world: the GNP changes are almost identical in the two cases.

United States Interest Rate Increase (Table 9-9)

For this experiment, the U.S. interest rate reaction function is dropped and the U.S. interest rate is taken to be exogenous. The results of an increase in the U.S. interest rate are presented in Table 9-9. This increase lowered U.S. income and imports and led to a general contraction in world income and exports (trade multiplier effect).

The interest rate increase also led to a depreciation of the other countries' exchange rates. The depreciation of the German exchange rate after six quarters, for example, was 1.93 percent. For some countries, such as Japan and Sweden, the depreciation was large enough to lead to an increase in their import prices and then to their GNP deflators. The U.S. interest rate increase thus led for some countries to an increase in their inflation rates through the depreciation of their exchange rates.

The balance of payments of some countries (other than the United States) increased. In these cases the change in export revenue (export price times exports) was greater than the change in import costs (import price times imports). Exports fell for all countries, and except for the two-quarter-ahead results for Austria, export prices also fell. In almost all cases imports fell, and in most cases import prices fell.

The results at the bottom of Table 9-9 are for the US model alone. The fall in the U.S. GNP deflator is less in this case because there is no negative effect from a fall in import prices. The differences in the effects on GNP are again quite small.

German Spending Increase (Table 9-10)

This experiment corresponds to an increase in German government spending on German goods. It led to a worldwide increase in exports and income. The increase in German income led to an increase in the German GNP deflator. This increase and the increase in income led to a fairly large increase in the interest rate through the reaction function (1.65 percentage points after six quarters). This increase had a negative effect on the exchange rate, but it was more than offset by the positive price, output, and balance of payments effects: the German exchange rate depreciated. The German exchange rate has a positive effect on the exchange rates of the other European countries, and this resulted in a depreciation of the other European rates.

The Canadian and Japanese exchange rates, which are not tied to the German rate, changed very little. This means that these two rates, along with the U.S. exchange rate, appreciated relative to the European rates. This led to a fall in the import prices of Canada, Japan, and the United States, which led to a fall in their GNP deflators. The German expansion thus led to a fall in prices for some countries because of the exchange rate effect on prices.

German Interest Rate Increase (Table 9-11)

For this experiment, the German interest rate reaction function was dropped and the German interest rate was taken to be exogenous. The results of an increase in the German rate are presented in Table 9-11. This increase lowered German income and imports and led to a general contraction in world exports and income.

The relative increase in the German interest rate and balance of payments led to an appreciation of the mark, which in turn led to an appreciation of the other European currencies. The GNP deflator for Germany was lower because of the appreciation and the fall in income. Contrary to the case for the other countries, GNP for Norway rose. The Norwegian currency appreciated relative to the dollar but depreciated relative to the most European currencies, which resulted in an increase in Norway's price of imports. This led to a substitution away from imported goods that was large enough to lead to a net increase in GNP.

German Exchange Rate Increase (Table 9-12)

For this experiment, the German exchange rate reaction function was dropped and the German exchange rate was taken to be exogenous. The results in Table 9-12 are for an increase in the exchange rate of 10 percent (a depreciation).

It was argued earlier that the initial effect of a depreciation on the balance of payments is likely to be negative, and this is the case for Germany in Table 9-12, even after six quarters. The depreciation led to a decrease in German GNP. As already noted, the effect of a depreciation on GNP can go either way. In this case the negative effects from the increase in the interest rates and the fall in the balance of payments more than offset the positive effects from the rise in the price of imports and the relative fall in the price of exports. German exports actually decreased slightly in response to the depreciation, which seems unusual. There are two main reasons for this. The first is that the German depreciation is not large relative to the other European countries because the other countries' exchange rates are fairly closely tied to the German rate. This means that the German price of exports does not fall very much relative to the others, and in fact for some countries the price of exports fell more than it did for Germany. As a result, the German gain in trade shares through the trade share equations is not very large. The second reason is the general contraction in world exports that resulted from the German depreciation. Even though Germany gained some trade share, the total size of the export base was less. The increase in share was small enough and the decrease in the export base large enough to lead to a slight fall in German exports.

The depreciation of the German exchange rate led to a decrease in the U.S. GNP deflator. This is due to the fall in the U.S. price of imports, which in turn is due to the general appreciation of the dollar. The Canadian and Japanese GNP deflators fell for similar reasons. This experiment also resulted in an increase in GNP for the United States, Canada, and Japan, primarily because of the decreases in the short-term interest rates in the three countries. For the United States the main reason for the decrease in the interest rate was the decrease in the GNP deflator. For Canada and Japan the main reason was the increase in the balance of payments. The main reason for the increase in the balance of payments of the two countries (as well as of the United States) was the fall in the price of imports that resulted from the general appreciation of the currencies. The exports of the three countries increased, primarily as a result of the fact that all three countries expanded and all three trade considerably with each other.

United Kingdom Spending Increase (Table 9-13)

This experiment corresponds to an increase in U.K. government spending on U.K. goods. As in the German case in Table 9-10, the increase in spending in Table 9-13 led to a worldwide increase in exports and income. The U.K. exchange rate depreciated, as did the German exchange rate in Table 9-10. The other European exchange rates appreciated relative to the dollar, although only slightly; this is due primarily to the balance-of-payments effect on the exchange rate. The European countries benefited more from the U.K. expansion than did the United States with respect to the increase in exports, and thus their balance of payments improved more. The increase in U.K. income led to an increase in U.K. imports, and the depreciation of the U.K. exchange rate led to an increase in the U.K. price of imports. Both of these factors contributed to the decrease in the U.K. balance of payments.

United Kingdom Exchange Rate Increase (Table 9-14)

For this experiment, the U.K. exchange rate reaction function was dropped and the U.K. exchange rate was taken to be exogenous. The results in Table 9-14 are for an increase in the exchange rate of 10 percent (a depreciation).

As in the German case in Table 9-12, the depreciation led to a decrease in the balance of payments and a decrease in GNP. In contrast to the German case, the effects on the other European exchange rates were slight. The depreciation led, as in the German case, to a decrease in the GNP deflator and an increase in GNP for the United States, Canada, and Japan, although the effects in the U.K. case are smaller.

Japanese Spending Increase (Table 9-15)

This experiment corresponds to an increase in Japanese government spending on Japanese goods. As in the German and U.K. cases, the exchange rate depreciated in response to the expansion and the balance of payments decreased. The increase in imports of Japan in Table 9-15 is less than the increase in imports of Germany in Table 9-10 and of the United Kingdom in Table 9-13, which resulted in smaller effects on the rest of the world in Table 9-15.

Japanese Exchange Rate Increase (Table 9-16)

For this experiment, the Japanese exchange rate reaction function was dropped and the Japanese exchange rate was taken to be exogenous. The

results in Table 9-16 are for an increase in the exchange rate of 10 percent (a depreciation).

In this case, as in the German and U.K. cases, the depreciation led to a decrease in the balance of payments and a decrease in GNP. The European exchange rates depreciated relative to the dollar, primarily because the U.S. balance of payments benefited more from the Japanese depreciation than did the European balance of payments. The United States benefited more because the price of imports fell more; the price of imports fell more because the United States is a larger trading partner of Japan. U.S. GNP was higher and the U.S. GNP deflator was lower as a result of the Japanese depreciation.

Increase in the Price of Exports of the Oil-Exporting Countries (Table 9-17)

The oil-exporting countries in the model are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates, and Venezuela. The price of exports is exogenous for these countries. The experiment corresponded to a 50-percent increase in the price of exports of all these countries.

This experiment approaches, if not exceeds, the aggregation limits of the model. There is no specific treatment of oil in the model other than the fact that almost all of the exports of the oil-exporting countries are oil. If the ability of countries to substitute away from oil is less than it is for the other goods, the model has not adequately captured the effects of oil price changes. In particular, the degree of substitution implicit in the trade-share equations may be too high for oil. The trade share equations were thus not used for this experiment, and the shares were taken to be exogenous. This may underestimate the degree of substitution possible, but it is probably closer to the truth than is the other case. At any rate, because of this problem, the results of this experiment should be interpreted with considerable caution.

Different countries were affected quite differently in this experiment. The exchange rates of all countries appreciated relative to the dollar. This is due in large part to the generally larger decrease in the U.S. balance of payments relative to the decreases for the other countries. The price of imports rose for most countries, as expected, although part of the increase that would otherwise have occurred was offset by the appreciation of the exchange rates. The increase in import prices led to an increase in the GNP deflators, and thus there was a general worldwide increase in inflation.

GNP fell for many countries. This is due in part to the increase in the interest rate in many countries (because of the increase in inflation and the decrease in the balance of payments) and in part to the decrease in net foreign

assets (because of the decrease in the balance of payments). There was, in other words, both a negative interest rate effect and a negative asset effect on GNP. Imports fell for all countries because of the increase in the price of imports relative to the GNP deflator. For some countries this substitution effect was large enough to lead to an increase in GNP.

Although this is not shown in the table, the balance of payments of the oil-exporting countries rose substantially, as expected. This increase in net foreign assets then led to an increase in imports of the countries for which there are import equations (Libya, Nigeria, Saudi Arabia, and Venezuela). In some cases these increases were quite large. The six-quarter-ahead increases for Nigeria and Saudi Arabia, for example, were 20.6 and 57.2 percent, respectively. These increases were not, of course, large enough to offset completely the increases in the balance of payments of these countries (and thus the decreases in the balance of payments of the oil-importing countries).

9.5.3 Estimates of the Exchange Rate Effect on Inflation (Table 9-18)

The MC model can be used to estimate what will be called the "exchange rate effect" on inflation. One of the ways in which monetary and fiscal policies may affect a country's inflation rate is by first influencing its exchange rate, which in turn influences import prices, which in turn influence domestic prices. This is what is called the exchange rate effect on inflation. In order to estimate the size of this effect, one needs a model linking monetary and fiscal policies to exchange rates, exchange rates to import prices, and import prices to domestic prices; the MC model provides these links.

Exchange rates have an effect on domestic inflation in the model through their effects on import prices. The 10.0 percent depreciation of the mark in Table 9-12 resulted in an increase in the German GNP deflator of .12 percent after six quarters. For the U.K. results in Table 9-14 the increase was 2.98 percent, and for the Japanese results in Table 9-16 the increase was 1.28 percent.

The question considered in this section is how much of the change in inflation that results from a monetary or fiscal policy change can be attributed to the change in the exchange rate that results from the policy change. Estimates of this exchange rate effect on inflation are presented in Table 9-18. The results in the a rows are from the experiments discussed in Section 9.5.2. For the results in the b rows, the same experiments were performed except that all exchange rates were taken to be exogenous. Exchange rates, in other words, were assumed to be fixed. The difference in the two rows for a given

TABLE 9-18. Estimated effects of monetary and fiscal policies on inflation through their effects on exchange rates (results are for the country initiating the policy)

	US spending increase (Table 9-8)		German spending increase (Table 9-10)		UK spending increase (Table 9-13)		Japanese spending increase (Table 9-15)	
	2	6	2	6	2	6	2	6
GNP deflator:								
a	.15	.64	.20	1.18	.00	.36	.10	.65
b	.13	.49	.19	1.15	.00	.00	.08	.53
c	.13	.23	.05	.03	—	1.00	.20	.18
Price of imports:								
a	.44	1.62	.14	.34	.47	2.29	.47	1.32
b	.01	.08	.01	.10	.00	.02	.00	.03
Real GNP:								
a	1.31	1.07	1.21	1.67	1.41	1.19	1.29	2.29
b	1.31	1.08	1.20	1.63	1.39	1.25	1.29	2.28
Exchange rate:								
a			.40	1.30	.52	2.56	.49	1.38

	US interest rate increase (Table 9-9)		German interest rate increase (Table 9-11)	
	2	6	2	6
GNP deflator:				
a	-.04	-.40	-.03	-.15
b	-.00	-.22	-.00	-.05
c	1.00	.45	1.00	.67
Price of imports:				
a	-.67	-1.77	-.43	-.31
b	-.00	-.09	-.00	-.02
Real GNP:				
a	-.34	-1.13	-.11	-.16
b	-.35	-1.17	-.11	-.18
Exchange rate:				
a			-1.35	-2.68

Notes: a = Exchange rates endogenous.
b = Exchange rates exogenous.
c = (row a - row b)/row a.

quarter for the GNP deflator is an estimate of the exchange rate effect on inflation for the quarter. These differences as a percentage of the a row values are presented in the c row.

The estimates in Table 9-18 vary considerably across countries and type of experiment. Consider the c-row values for the six-quarter-ahead predictions for the spending experiments. For the United States, 23 percent of the increase in the GNP deflator that resulted from the U.S. spending increase is attributed to the exchange rate effect. With the exchange rates endogenous the increase in the GNP deflator is .64 percent, and with the exchange rates exogenous the increase is .49 percent. For Germany, only 3 percent of the

increase in the GNP deflator is attributed to the exchange rate. This small number is due to the fact that the other European exchange rates are closely tied to the German rate, and therefore a depreciation of the German exchange rate of, say, 10 percent is not much of a depreciation. For the United Kingdom, all of the increase in the GNP deflator is attributed to the exchange rate. The price equation for the United Kingdom (Eq. 5, Table 4-5) does not include the demand pressure variable (it was of the wrong sign), so the U.K. GNP deflator is not directly affected by GNP changes. Therefore, the only inflation that results from the U.K. spending increase is from the exchange rate effect. Japan is similar to the United States: 18 percent of the increase in the GNP deflator is attributed to the exchange rate effect.

With respect to the interest rate experiments, the estimates after six quarters are 45 percent for the United States and 67 percent for Germany. These estimates are higher than the corresponding estimates for the spending experiments. This is as expected, since interest rate changes in general have large effects on exchange rates.

9.5.4 Summary

It is difficult to summarize the MC results because they vary considerably across countries. Theoretically there are few unambiguous effects, and the empirical results show that there are few unambiguous empirical effects either. Regarding the effects on other countries from a policy change in one country, they depend considerably on relative positions, and thus it is common to find some countries affected one way and other countries affected the other way for a given policy experiment.

A few of the unambiguous empirical effects are the following. (1) Spending increases in a given country lead to a depreciation of the country's exchange rate. The interest rate effect, which works in favor of an appreciation, is dominated by the other effects discussed above. (2) Spending increases in a given country also lead to a decrease in its balance of payments. (3) Depreciation in a given country leads to an initial fall in its balance of payments and to a fall in its GNP. (4) An increase in a country's interest rate leads to an appreciation of its currency and to a decrease in its GNP.

One obvious feature of the results is that price, interest rate, and exchange rate linkages are quantitatively quite important. There are many channels; a key one is exchange rates affecting import prices, import prices affecting domestic prices and thus export prices, and export prices affecting other countries' import prices. Interest rates affect exchange rates directly, and they

are in turn affected by many other variables. Another important effect in the model is the wealth effect from changes in the balance of payments.

Another way of looking at the overall results is the observation that if the MC model is at all a good approximation of the economic linkages among countries, attempts to use very simple models (with unambiguous effects) for policy purposes are not likely to be very successful. Trade multiplier models, for example, seem likely to be quite misleading in this regard. In short, the world economy seems complicated, and insights gained from simple models may be misleading.