11

Analyzing Properties of the US Model

11.1 Introduction

The previous chapter discussed techniques for analyzing the properties of models, and this chapter applies these techniques to the US model. Section 11.2 contains a general discussion of the properties of the model. This is background reading for the multiplier analysis to come. Multipliers and their standard errors are computed in Section 11.3 using the method discussed in Section 10.2. Sections 11.2 and 11.3 are the two main sections in the book to read to get an understanding of the US model. If the model is a reasonable approximation of the actual economy, which the results in Chapter 8 suggest may be the case, then these two sections also provide insights into how the actual economy works.

Section 11.4 examines the sources of economic fluctuations in the US model using the method discussed in Section 10.3. Section 11.5 examines the choice of the optimal monetary-policy instrument in the model using the method discussed in Section 10.4. Section 11.6 examines the sensitivity of the properties of the model to the rational expectations assumption. It uses as an alternative version of the model the equations discussed in Chapter 5 with the values led eight quarters added. Section 11.7 examines the question of whether monetary policy is becoming less effective over time because of the growing size of the federal government debt. The model is first used to predict what the economy would have been like had tax rates been higher and interest rates lower in the 1980s, and then a monetary-policy experiment is performed using this economy. The results of this experiment are then compared to the results of the same experiment performed using the actual economy. Finally, the model is used in Section 11.8 to estimate what the economy would have been like in 1978 and 1990 had the Fed behaved differently. The exercises in Sections 11.7 and 11.8 are examples of counterfactual experiments discussed in Section 10.6.

11.2 A General Discussion of the US Model's Properties

Because the theoretical model in Chapter 2 was used to guide the specification of the US model, the qualitative properties of the two models are similar. Therefore, the discussion of the properties of the theoretical model in Chapter 2 is of relevance here. If there is disequilibrium in the theoretical model in the sense that the labor constraint is binding on households, then an increase in, say, government spending will result in an increase in output. Employment increases, the labor constraint becomes less binding on households, households spend more, employment increases further, and so on. Similarly, if government spending is increased in the US model, output and employment will increase. How much output increases relative to the price level depends on how close actual output (Y) is to potential output (YS). As can be seen from the demand pressure variable in equation 10, the closer is Y to YS, the more will the price level rise for a given change in Y. As Y approaches a value 4 percent greater than YS, the predicted price level approaches infinity, which effectively bounds Y below a value greater than 4 percent of YS.

The main way in which the economy expands in the US model from an increase in, say, government purchases of goods is as follows.

1. The level of sales of the firm sector (X) increases because of the increase in government purchases of goods: Equation 60.

2. The firm sector responds by increasing production (Y): Equation 11.

3. The increase in Y leads to an increase in investment (IKF), jobs (JF), and hours per job (HF): Equations 12, 13, and 14.

4. The increase in jobs and hours per job leads to an increase in disposable income (YD), which leads to an increase in household expenditures: Equations 1, 2, 3, and 4.

5. The increase in investment and household expenditures increases X, which leads to a further increase in Y, and so on.

Fiscal Policy Variables

The main federal government fiscal policy variables in the US model are the following:

COG	Purchases of goods
$D1G$	Personal income tax parameter
$D2G$	Profit tax rate
$D3G$	Indirect business tax rate
$D4G$	Employee social security tax rate
$D5G$	Employer social security tax rate
JG	Number of civilian jobs
JM	Number of military jobs
$TRGH$	Transfer payments to households

Some of these variables appear as explanatory variables in the stochastic equations and thus directly affect the decision variables; others indirectly affect the decision variables by influencing variables (through identities) that in turn influence, directly or indirectly, the decision variables. The effects of changing each of these variables (except JM) in the model are examined below.

Monetary-Policy Options

To see the various monetary-policy options in the model, it will be useful to list a subset of the equations in the US model. These are:

$$MH = f_9(RS, \cdots) \tag{9}$$

$$MF = f_{17}(RS, \cdots) \tag{17}$$

$$CUR = f_{26}(RS, \cdots) \tag{26}$$

$$BO/BR = f_{22}(RS - RD, \cdots) \tag{22}$$

$$BR = -G1 \cdot MB \tag{57}$$

$$0 = \Delta MB + \Delta MH + \Delta MF + \Delta MR + \Delta MG + \Delta MS - \Delta CUR \tag{71}$$

$$0 = SG - \Delta AG - \Delta MG + \Delta CUR + \Delta(BR - BO) - \Delta Q - DISG \tag{77}$$

$$M1 = M1_{-1} + \Delta MH + \Delta MF + \Delta MR + \Delta MS + MDIF \tag{81}$$

The other key equation is the interest rate reaction function, equation 30, which explains RS.

In considering the determination of the variables in the model for the various monetary-policy options, it will be convenient to match variables to equations. Remember, however, that this is done only for expositional convenience. The model is simultaneous, and nearly all the equations are involved in the determination of each endogenous variable.

Consider the matching of variables to equations in the block given above. The demand for money variables, MH, MF, and CUR, can be matched to the stochastic equations that explain them, equations 9, 17, and 26. Bank borrowing, BO, can be matched to its stochastic equation, 22, and total bank reserves, BR, can be matched to its identity, 57. MB can be matched to equation 71, which states that the sum of net demand deposits and currency across all sectors is zero. $M1$ can be matched to its identity, 81. This leaves equation 77, the federal government budget constraint.

The question then is what endogenous variable is to be matched to equation 77. The federal government savings variable, SG, is determined by an identity elsewhere in the model (equation 76), and so it is not a candidate. If equation 30 is included in the model (and thus RS matched to it), the obvious variable to match to equation 77 is AG, the net financial asset variable of the federal government. (AG will be called the "government security" variable. Remember that AG is negative because the federal government is a net debtor.) This means that AG is the variable that adjusts to allow RS to be the value determined by equation 30. In other words, the target bill rate is assumed to be achieved by the purchase or sale of government securities, i.e., by open market operations.

If AG is taken to be endogenous, the following variables in the above block are then exogenous: the discount rate, RD; the reserve requirement ratio, $G1$; demand deposit and currency holdings of the foreign sector, the state and local government sector, and the federal government sector, MR, MS, and MG; gold and foreign exchange holdings of the federal government, Q; the discrepancy term, $DISG$; and the variable that is involved in the definition of $M1$, $MDIF$.

Instead of treating AG as endogenous, one could take it to be exogenous and take either RD or $G1$ to be endogenous and match the one chosen to be endogenous to equation 77. This would mean that the target bill rate was achieved by changing the discount rate or the reserve requirement ratio instead of the amount of government securities outstanding. Since the main instrument of monetary policy in practice is open market operations, it seems better to treat AG as endogenous rather than RD or $G1$.

One can also consider the case in which equation 30 is dropped from the model, but yet both RS and $M1$ remain endogenous. In this case RS is matched to equation 77 and AG is taken to be exogenous. The interest rate is "implicitly" determined in this case: it is the rate needed to clear the asset market given a fixed value of AG. (In the numerical solution of the model in this case, RS is solved using equation 9, MH is solved using equation 71, MB is solved using equation 57, and BR is solved using equation 77.) When equation 30 is dropped, monetary policy is exogenous, and the response of the model to changes in AG can be examined.

In the exogenous monetary-policy case, the main way in which monetary policy affects the economy is by changing interest rates. Changes in AG change interest rates, which in turn change real variables. The main effects of interest rates on the real side of the economy are the direct and indirect effects on household expenditures (equations 1, 2, 3, and 4) and on nonresidential fixed investment of the firm sector (equation 12). The direct effects are from interest rates appearing as explanatory variables in the equations, and the indirect effects are from interest revenue being a part of disposable income and disposable income appearing in the expenditure equations. What this means is that the three instruments of monetary policy—AG, RD, and $G1$—all do the same thing, namely, they affect the economy by affecting interest rates. Using all three instruments is essentially no different from using one with respect to trying to achieve, say, some real output target. It also means in the endogenous monetary-policy case, where AG is endogenous and RD and $G1$ are exogenous, that changes in RD and $G1$ have virtually no effect on the real side of the economy. Any effects that they might have are simply "undone" by changes in AG in the process of achieving the target interest rate implied by equation 30.

It is also possible in the exogenous monetary-policy case to take some variable other than AG to be exogenous. One possible choice is the money supply, $M1$, and another is the level of nonborrowed reserves, $BR - BO$. Both of these are common variables to take as policy variables in monetary-policy experiments. If either of these is taken to be exogenous, AG must be endogenous.[1]

To return to fiscal policy for a moment, it should be obvious that fiscal policy effects are not independent of what one assumes about monetary policy. For a given change in fiscal policy, there are a variety of assumptions that can be made about monetary policy. The main possible assumptions are 1) equation

[1]The way in which the model is solved under alternative monetary-policy assumptions is explained in Table A.8 in Appendix A.

30 included in the model and thus monetary policy endogenous, 2) the bill rate exogenous, 3) the money supply exogenous, 4) nonborrowed reserves exogenous, and 5) government securities outstanding, AG, exogenous. In all but assumption 5, AG is endogenous. The sensitivity of fiscal policy effects to the first three of these assumptions is examined below.

Various Relationships

To conclude this general discussion of the model's properties, it will be useful to consider the relationships in the model between certain endogenous variables. Consider first the links from output to the unemployment rate. The first link is that when output increases, the number of jobs increases (equation 13). According to this equation, the initial percentage increase in the number of jobs is less than the percentage increase in output. Although the percentage increase in jobs is less than the percentage increase in output, the relationship between jobs and output is not constant across time. For example, how much the number of jobs changes in any one period depends in part on the amount of excess labor on hand, which varies over time. The second link is that when the number of jobs increases, the number of people holding two jobs increases (equation 8). This means that the number of new people employed increases by less than the number of new jobs (equation 85). How much the number of people holding two jobs changes in any one period depends in part on the value of the labor constraint variable, which also varies over time. The third link is that when the number of jobs increases, the number of people in the labor force increases (equations 5, 6, and 7). This means that the unemployment rate falls less than it otherwise would for a given increase in the number of new people employed (equations 86 and 87). How much the number of people in the labor force changes in any one period also depends on the value of the labor constraint variable.

The size of these links in the model is such that the unemployment rate initially drops less than the percentage change in output. Also, because the links vary in size over time, the relationship between output and the unemployment rate varies over time. At any one time the relationship depends on such things as the amount of excess labor on hand and the value of the labor constraint variable. Because this relationship is not constant, the variables do not obey Okun's law. There is no reason to expect Okun's law to hold in the sense of there being a stable relationship between output and the unemployment rate over time.

The relationship between output and the price level is also not necessarily stable over time in the model. In equation 10 other things affect the price level aside from output, in particular the price of imports, and when these other things change, the price level will change even if output does not. A tight relationship is even less likely to exist between the price level and the unemployment rate because of the many factors that affect the labor force and thus the unemployment rate but not necessarily output.

Consider finally the relationship between output and employment. Productivity defined as output per paid for worker hour, $Y/(JF \cdot HF)$, is procyclical in the model. When Y changes by a certain percentage, $JF \cdot HF$ 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.

11.3 Computing Multipliers and Their Standard Errors

11.3.1 Fiscal Policy Variables

Multipliers and their standard errors were computed in the manner discussed in Section 10.2. The 2SLS estimates in Chapter 5 were used for these results. The simulation period was 1989:3–1993:2, the last 16 quarters of the sample period. The first set of experiments concerns the fiscal policy variables, where one policy variable was changed per experiment. Eight experiments were performed, and the results are presented in Table 11.1. Results are presented for real GDP, the private nonfarm price deflator, the unemployment rate, the bill rate, and the federal government deficit.[2] The values in the 0 rows are the estimated effects from the deterministic simulations; the values in the a rows are the estimated effects from the stochastic simulations; and the values in the b rows are the estimated standard errors computed from the stochastic simulations. The number of repetitions for each stochastic simulation was 250. For the deterministic simulations the historical errors were added to the equations and treated as exogenous, thus making the base solution the perfect tracking solution. For the stochastic simulations the error terms were drawn from the $N(\hat{u}_t, \hat{\Sigma})$ distribution, where $\hat{u}_t$ is the vector of historical errors for

[2]It is easier to discuss the government deficit as a positive number, which is $-SGP$. Consequently, the variable presented in Table 11.1 is $-SGP$. SGP is in nominal terms.

Table 11.1
Estimated Multipliers and Their Standard Errors for Eight Fiscal Policy Experiments

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$GDPR$: Real GDP						
$COG \uparrow$	0	1.11	1.62	1.77	1.75	1.21	.87	.89
	a	1.11	1.63	1.77	1.76	1.17	.84	.87
	b	.07	.09	.11	.15	.29	.30	.31
$D1G \downarrow$	0	.32	.63	.83	.91	.69	.37	.33
	a	.32	.64	.84	.93	.70	.37	.32
	b	.06	.11	.15	.18	.24	.25	.25
$D2G \downarrow$	0	.00	.02	.03	.03	-.05	-.13	-.13
	a	.00	.02	.04	.04	-.05	-.13	-.14
	b	.00	.01	.02	.03	.08	.11	.11
$D3G \downarrow$	0	.59	1.26	1.70	1.89	1.33	.56	.46
	a	.60	1.27	1.72	1.91	1.30	.53	.44
	b	.10	.20	.27	.33	.49	.46	.40
$D4G \downarrow$	0	.33	.69	.91	1.01	.76	.38	.32
	a	.34	.69	.92	1.03	.76	.37	.31
	b	.06	.11	.15	.18	.24	.25	.24
$D5G \downarrow$	0	.01	.04	.07	.11	.20	.21	.22
	a	.01	.04	.07	.11	.20	.21	.22
	b	.00	.01	.02	.03	.04	.06	.09
$JG \uparrow$	0	1.11	1.31	1.32	1.28	.56	.32	.40
	a	1.11	1.31	1.32	1.28	.50	.27	.36
	b	.05	.09	.13	.16	.36	.36	.36
$TRGH \uparrow$	0	.33	.68	.90	1.00	.73	.34	.29
	a	.34	.69	.91	1.01	.73	.34	.29
	b	.06	.11	.15	.18	.23	.24	.22

period t. The coefficients were drawn from the $N(\hat{\alpha}, \hat{V})$ distribution, where $\hat{\alpha}$ is the vector of coefficient estimates and $\hat{V}$ is the estimated covariance matrix of $\hat{\alpha}$. The dimension of $\hat{\Sigma}$ is 30×30, and the dimension of $\hat{V}$ is 166×166.

For the first experiment COG was increased from its historical value each quarter by an amount equal to one percent of the historical value of $GDPR$ in that quarter. The units in Table 11.1 are as follows. For $GDPR$ and PF,

Table 11.1 (continued)

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
				PF: Price Deflator				
$COG \uparrow$	0	.00	.11	.28	.44	.80	.82	.82
	a	.00	.12	.30	.49	.92	.90	.92
	b	.00	.04	.10	.18	.41	.33	.40
$D1G \downarrow$	0	.00	.03	.09	.16	.36	.38	.37
	a	.00	.03	.10	.18	.42	.43	.43
	b	.00	.01	.04	.07	.19	.18	.31
$D2G \downarrow$	0	.00	.00	.00	.01	.01	-.01	-.04
	a	.00	.00	.00	.01	.01	-.01	-.04
	b	.00	.00	.00	.00	.02	.03	.05
$D3G \downarrow$	0	.00	.06	.18	.34	.80	.80	.71
	a	.00	.06	.20	.39	.98	.94	.84
	b	.00	.02	.08	.18	.64	.49	.49
$D4G \downarrow$	0	.00	.03	.10	.18	.40	.42	.39
	a	.00	.03	.10	.19	.46	.47	.46
	b	.00	.01	.04	.08	.21	.20	.31
$D5G \downarrow$	0	-.05	-.10	-.14	-.18	-.29	-.36	-.40
	a	-.05	-.10	-.14	-.18	-.28	-.35	-.37
	b	.01	.01	.02	.02	.04	.06	.17
$JG \uparrow$	0	.00	.21	.44	.63	1.02	.99	.99
	a	.00	.22	.47	.70	1.18	1.11	1.11
	b	.00	.07	.17	.27	.57	.43	.50
$TRGH \uparrow$	0	.00	.03	.10	.17	.40	.41	.38
	a	.00	.03	.10	.19	.45	.45	.43
	b	.00	.01	.04	.08	.20	.18	.26

a number in the 0 row is $100(\hat{\delta}_{itk}/\hat{y}^a_{itk})$, where $\hat{\delta}_{itk}$ is defined in equation 10.1. The $\hat{y}^a_{itk}$ values are the actual values because the base run is the perfect tracking solution. Since COG was changed by one percent of $GDPR$, a number in the 0 row for $GDPR$ or PF is the percentage change in the variable (in percentage points) that results from an exogenous increase in $GDPR$ of one percent. For UR, RS, and $-SGP$ a number in the 0 row is simply $\hat{\delta}_{itk}$, where the units are in percentage points for UR and RS and in billions of dollars for $-SGP$.

A number in the a row for $GDPR$ and PF is the mean of $100(\tilde{\delta}^j_{itk}/\tilde{y}^{aj}_{itk})$ across the J repetitions (J equals 250 for each experiment), where $\tilde{\delta}^j_{itk}$ is defined in equation 10.2. For UR, RS, and $-SGP$, a number in the a row

Table 11.1 (continued)

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		UR: Unemployment Rate						
$COG \uparrow$	0	-.32	-.66	-.93	-1.11	-.89	-.50	-.34
	a	-.32	-.64	-.89	-1.05	-.89	-.50	-.36
	b	.05	.07	.11	.14	.18	.19	.19
$D1G \downarrow$	0	-.06	-.18	-.30	-.40	-.27	.02	.18
	a	-.06	-.17	-.28	-.36	-.30	.00	.17
	b	.02	.05	.08	.12	.16	.14	.14
$D2G \downarrow$	0	.00	-.01	-.01	-.02	.01	.05	.06
	a	.00	-.01	-.01	-.02	.01	.05	.06
	b	.00	.00	.01	.02	.04	.05	.06
$D3G \downarrow$	0	-.13	-.39	-.67	-.90	-.72	-.07	.27
	a	-.12	-.37	-.64	-.85	-.73	-.08	.25
	b	.04	.09	.16	.22	.30	.27	.24
$D4G \downarrow$	0	-.06	-.18	-.32	-.43	-.28	.06	.26
	a	-.06	-.17	-.29	-.39	-.31	.04	.24
	b	.02	.05	.09	.13	.17	.15	.14
$D5G \downarrow$	0	.00	-.01	-.03	-.04	-.09	-.09	-.08
	a	.00	-.01	-.03	-.04	-.10	-.10	-.08
	b	.00	.00	.01	.01	.03	.03	.04
$JG \uparrow$	0	-1.42	-1.52	-1.57	-1.67	-.87	-.39	-.18
	a	-1.41	-1.49	-1.52	-1.59	-.84	-.38	-.20
	b	.02	.05	.09	.13	.20	.22	.22
$TRGH \uparrow$	0	-.10	-.26	-.42	-.56	-.49	-.22	-.08
	a	-.09	-.24	-.40	-.52	-.52	-.23	-.10
	b	.02	.05	.08	.12	.16	.14	.13

is simply the mean of $\tilde{\delta}^j_{itk}$, which is denoted $\bar{\tilde{\delta}}_{itk}$ in equation 10.3. A number in the b row for $GDPR$ and PF is the standard deviation of $100(\tilde{\delta}^j_{itk}/\tilde{y}^{aj}_{itk})$ from the J repetitions. For UR, RS, and $-SGP$, a number in the b row is the standard deviation of $\tilde{\delta}^j_{itk}$, which is the square root of $\tilde{s}^2_{itk}$ in equation 10.4.

The changes for the other policy variables in Table 11.1 were made to be comparable to the change in COG with respect to the initial injection of funds into the system. Consider, for example, the change in $D1G$. The aim is to change $D1G$ so that the decrease in personal income taxes in real terms is equal to the change in COG. From equation 47 in the model (see Table A.3), the variable for personal income taxes, THG, is equal to $[D1G + (TAUG \cdot YT)/POP]YT$, where YT is taxable income. Let ΔCOG denote the change

Table 11.1 (continued)

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
				RS: Bill Rate				
$COG\uparrow$	0	.43	.79	.90	.94	1.12	1.12	1.14
	a	.43	.79	.90	.95	1.11	1.08	1.11
	b	.08	.14	.15	.16	.21	.26	.31
$D1G\downarrow$	0	.12	.29	.41	.48	.59	.55	.53
	a	.12	.30	.42	.49	.60	.55	.53
	b	.03	.08	.10	.13	.18	.21	.24
$D2G\downarrow$	0	.00	-.02	-.03	-.04	-.08	-.10	-.09
	a	.00	-.02	-.03	-.04	-.08	-.10	-.10
	b	.00	.01	.03	.04	.05	.07	.09
$D3G\downarrow$	0	.23	.57	.83	.96	1.15	.98	.87
	a	.23	.58	.84	.99	1.15	.96	.85
	b	.06	.14	.20	.25	.34	.38	.40
$D4G\downarrow$	0	.13	.32	.46	.53	.65	.59	.55
	a	.13	.32	.46	.54	.66	.59	.55
	b	.03	.08	.11	.13	.19	.21	.24
$D5G\downarrow$	0	-.01	-.01	.00	.01	.07	.11	.15
	a	-.01	-.01	.00	.01	.06	.11	.15
	b	.00	.01	.01	.02	.03	.05	.06
$JG\uparrow$	0	.60	1.04	1.16	1.23	1.37	1.35	1.39
	a	.60	1.04	1.16	1.24	1.34	1.31	1.34
	b	.10	.15	.17	.19	.25	.31	.37
$TRGH\uparrow$	0	.13	.32	.45	.52	.63	.57	.52
	a	.13	.32	.46	.53	.64	.57	.52
	b	.03	.08	.11	.13	.18	.20	.23

in COG for a given quarter. The aim is to decrease $D1G$ in such a way that the decrease in THG is equal to $PG \cdot \Delta COG$, where PG is the price deflator for COG. The change in $D1G$ for the given quarter is thus $-(PG \cdot \Delta COG)/YT$. The values that were used for PG and YT for these calculations are the actual values, not the predicted values. The predicted values are, of course, affected by the change in $D1G$. All this procedure does is to change $D1G$ by an amount that would lead personal income taxes to decrease by the historical value of $PG \cdot \Delta COG$ if nothing else happened.

The changes in the other policy variables are similarly done. For $D2G$ the relevant tax variable is TFG, the level of corporate profit taxes, and the relevant equation in Table A.3 is 49. The other matchings are as follows: $D3G$

Table 11.1 (continued)

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$-SGP$: Federal Government Deficit						
$COG \uparrow$	0	9.8	8.8	8.5	8.6	12.3	15.7	17.9
	a	9.8	8.8	8.4	8.5	12.1	15.5	17.6
	b	.2	.3	.4	.6	.9	1.3	1.8
$D1G \downarrow$	0	12.1	11.7	11.5	11.5	13.7	16.5	18.4
	a	12.0	11.7	11.4	11.4	13.6	16.4	18.3
	b	.2	.3	.4	.6	.8	1.0	1.3
$D2G \downarrow$	0	12.9	13.2	13.6	13.8	15.1	16.5	17.5
	a	12.9	13.1	13.4	13.6	14.6	16.0	17.3
	b	1.5	2.1	2.5	2.7	3.7	3.9	4.5
$D3G \downarrow$	0	11.4	10.1	9.1	8.7	12.1	16.6	19.1
	a	11.4	10.0	9.0	8.5	11.9	16.4	18.7
	b	.3	.5	.8	1.0	1.3	1.5	2.1
$D4G \downarrow$	0	12.0	11.5	11.2	11.2	13.5	16.5	18.4
	a	12.0	11.5	11.2	11.1	13.4	16.4	18.3
	b	.2	.3	.4	.6	.8	1.0	1.3
$D5G \downarrow$	0	9.4	9.8	10.1	10.3	11.4	12.5	13.4
	a	9.4	9.8	10.1	10.3	11.4	12.4	13.3
	b	.1	.1	.2	.3	.5	.6	.8
$JG \uparrow$	0	11.4	11.3	11.3	11.7	15.8	19.3	21.7
	a	11.4	11.2	11.2	11.6	15.6	19.1	21.2
	b	.2	.4	.6	.7	1.2	1.7	2.4
$TRGH \uparrow$	0	12.0	11.5	11.2	11.1	13.4	16.4	18.4
	a	12.0	11.5	11.1	11.0	13.3	16.4	18.2
	b	.2	.3	.4	.6	.7	.9	1.2

0 = Estimated effects from deterministic simulations.
a = Estimated effects from stochastic simulations.
b = Estimated standard errors of a row values.
The units are percentage points except for $-SGP$,
which are billions of dollars.

to $IBTG$ and equation 51; $D4G$ to $SIHG$ and equation 53; $D5G$ to $SIFG$ and equation 54; JG to $WG \cdot JG \cdot HG$ (no separate equation), and $TRGH$ to itself (no separate equation).[3] To repeat, then, each of the policy variables

[3]The tax credit dummy variable, $TXCR$, is also a fiscal policy variable. It appears in the investment equation 12. A multiplier experiment could thus be run in which $TXCR$ was changed. In doing this, however, one would also have to estimate how much profit taxes would be changed by the $TXCR$ change and then adjust $D2G$ accordingly. No attempt was

was changed each quarter by an amount that based on the historical values of the variables in the model led to the same injection of funds into the economy as did the COG increase. In this sense all the experiments in Table 11.1 are of the same size.

Turning now to the results in Table 11.1, it is first immediately clear that the 0 and a rows are very close. Even though macroeconometric models are nonlinear, their predicted values based on deterministic simulations are generally close to the means from stochastic simulations, and this is certainly true for the results in the table. The results of the individual experiments will now be discussed.

COG **Increase**

Table 11.1 shows that the increase in COG leads to an increase in output (real GDP), the price deflator, and the bill rate and to a decrease in the unemployment rate. The government deficit rises. The reasons for the increase in output were discussed above, and this discussion will not be repeated here. The price deflator rises because of the effects of the increase in output on the demand pressure variable in the price equation 10. The Fed responds (equation 30) to the output and price increases by raising the bill rate. The unemployment rate falls because employment rises as a result of the output increase.

The output multiplier reaches a peak of 1.77 in the third quarter and declines after that. Part of the reason for the decline after three quarters is the higher value of the bill rate due to the Fed leaning against the wind.

The table shows that the government deficit ($-SGP$) rises in response to the COG increase. After four quarters the deficit is \$8.5 billion higher. Although not shown in the table, this increase is less than the increase in nominal government spending ($PG{\cdot}COG$). This is because of the endogenous increase in tax revenue as a result of the expanding economy. The deficit increases are, however, considerably higher by the end of the sixteen quarter period. This is due in large part to the increase in government interest payments that results from the higher interest rates. The relationship between government spending changes and changes in the government deficit is examined in more detail in Section 11.3.7 below.

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made to run a $TXCR$ experiment for the present results. If such an experiment were run, the effects on real GDP would be small because the estimate of the coefficient of $TXCR$ in equation 12 is small.

$D1G$ Decrease

The decrease in $D1G$, the personal income tax parameter, increases disposable income (YD), which has a positive effect on household expenditures. It also increases the after tax interest rates (RSA and RMA), which have a negative effect on household expenditures. Table 11.1 shows that the net effect on the economy is expansionary. The effects of the tax rate decrease are, however, smaller than the effects of the COG increase. This is a standard result. Tax rate decreases generally have smaller effects than government spending increases in models because part of the decrease in tax payments of households is saved.

The decreases in the unemployment rate are much smaller for the $D1G$ decrease than for the COG increase, and in fact by quarter 12 the unemployment rate is higher for the $D1G$ experiment than it was in the base case. This is because the decrease in $D1G$ increases the after tax wage rate (WA), which has a positive effect on the labor supply variables $L2$ and $L3$ and on the number of people holding two jobs (LM). (It also has a negative effect on $L1$, but this is more than offset by the positive effect on $L2$ and $L3$.) Other things being equal, an increase in the labor force leads to an increase in the unemployment rate. The same is true of an increase in LM, since an increase in the number of people holding two jobs means that the total number of people employed rises less than the total number of jobs. These positive effects on the unemployment rate thus offset some of the negative effects from the increase in jobs as a result of the output increase, and in fact, as just noted, by quarter 12 the net effect is positive.

The difference between the unemployment rate effects for the COG and $D1G$ experiments is a good way of seeing why Okun's law is not met in the model. A number of things affect the unemployment rate aside from output.

$D2G$ Decrease

Table 11.1 shows that the decrease in $D2G$, the profit tax rate, has little effect on output. This result, however, is probably not trustworthy. The way in which the profit tax rate affects the economy in the model is the following. When the profit tax rate is decreased, this leads to an increase in after tax profits and thus to an increase in dividends paid by firms. This in turn leads to an increase in disposable income. Also, over time interest payments by firms drop because they need to borrow less due to the higher after tax profits. On the other hand, the government needs to borrow more, other things being equal, because it is receiving less in profit taxes, and so interest payments by the government rise.

The net effect of these interest payment changes on disposable income could thus go either way. Since dividends are slow to respond to after tax profit changes and since the interest payment changes nearly cancel each other out, the net effect on disposable income is small, which leads to only small changes in household expenditures and thus in output.

If the output multipliers from a profit tax rate increase are in fact as low as in Table 11.1, they suggest that a very effective way to decrease the federal government deficit would be to raise the profit tax rate. This would raise revenue and have little negative impact on real output. It is likely, however, that changes in $D2G$ affect the economy in ways that are not captured in the model. For example, it may be that firms pass on an increase in profit tax rates in the form of higher prices, which is not part of the model. I tried adding $D2G$ in various ways to the price equation 10 to see if an effect like this could be picked up, but with no success. It may be that profit tax rates are not changed often enough for reliable results to be obtained. At any rate, the model is probably not trustworthy regarding the effects of $D2G$ changes on the economy.

$D3G$ **Decrease**

A decrease in $D3G$, the indirect business tax rate, decreases the consumption price deflators PCS, PCN, and PCD (equations 35, 36, and 37), which decreases the overall price deflator for the household sector PH (equation 34). The decrease in PH raises real disposable income, YD/PH, which has a positive effect on household expenditures in equations 1, 2, 3, and 4.

The results in Table 11.1 show that the decrease in $D3G$ has a positive effect on output. After four quarters the output effect is slightly larger than it is for the COG experiment. On the other hand, the fall in the unemployment rate is less for the $D3G$ experiment than it is for the COG experiment. This is because the fall in PH raises the real wage, which has a positive effect on labor force participation. This in turn leads the unemployment rate to fall less than otherwise. In fact, as was the case for the $D1G$ experiment, the unemployment rate is higher than it was in the base case by the end of the 16 quarter period.

$D4G$ **Decrease**

A decrease in $D4G$, the employee social security tax rate, is similar to a decrease in $D1G$ in that it increases disposable personal income. The results for this experiment are thus similar to those for the $D1G$ experiment. One small difference between the two experiments is that the after tax interest rates RSA and RMA are affected by changes in $D1G$ but not $D4G$ (equations 127 and 128). The social security tax is only a tax on wage income.

$D5G$ Decrease

A decrease in $D5G$, the employer social security tax rate, lowers the cost of labor to the firm sector, which has a negative effect on the price level (equation 10). The lower price level leads to an increase in real disposable income, which, among other things, has a positive effect on household expenditures. The overall effect on real GDP is, however, fairly small, and like the $D2G$ experiment, this experiment suggests that an effective way to lower the government deficit would be to increase $D5G$. This would lower the deficit without having much effect on output. Again, these results are probably not trustworthy. There are likely to be other firm responses to a change in $D5G$ that are not captured in the model. In particular, firms may pass on changes in $D5G$ in the form of wage changes, and this is not part of the model.

JG Increase

An increase in JG, the number of civilian jobs in the federal government, leads to an increase in employment and thus disposable personal income. This in turn leads to an increase in household expenditures. The output increases for the JG experiment are somewhat below the output increases for the COG experiment (except for the first quarter). On the other hand, the initial decreases in the unemployment rate are larger for the JG experiment. There is a large immediate change in jobs for the JG experiment, whereas for the COG experiment, much of the initial increase in output is produced by firms lowering the amount of excess labor on hand and increasing hours worked per worker rather than increasing jobs.

$TRGH$ Increase

An increase in $TRGH$, the level of transfer payments to the household sector, increases disposable personal income, which increases household expenditures. The output effects of this experiment are similar to those of the $D1G$ experiment. The unemployment rate, however, falls less for the $D1G$ experiment than it does for the $TRGH$ experiment. This is because of the labor

Table 11.2
Estimated Multipliers and Their Standard Errors for a Decrease in RS of One Percentage Point

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$GDPR$: Real GDP						
$RS\downarrow$	0	-.01	.05	.14	.24	.48	.44	.32
	a	-.01	.05	.14	.24	.49	.46	.34
	b	.01	.03	.06	.08	.17	.24	.29
		PF: Price Deflator						
$RS\downarrow$	0	.00	.00	.00	.01	.10	.17	.22
	a	.00	.00	.00	.02	.12	.19	.27
	b	.00	.00	.01	.01	.06	.10	.18
		UR: Unemployment Rate						
$RS\downarrow$	0	.00	-.01	-.05	-.09	-.22	-.22	-.13
	a	.00	-.01	-.04	-.09	-.24	-.24	-.15
	b	.00	.01	.02	.04	.09	.12	.14
		$-SGP$: Federal Government Deficit						
$RS\downarrow$	0	-1.7	-2.0	-2.5	-3.1	-5.0	-6.4	-7.7
	a	-1.7	-2.0	-2.5	-3.1	-5.1	-6.6	-8.0
	b	.1	.1	.2	.3	.7	1.1	1.6

See notes to Table 11.1.

force increase in the $D1G$ experiment caused by the lowering of the tax rate. There is no such tax rate effect at work for the $TRGH$ experiment.

The Estimated Standard Errors

The estimated standard errors (the b row values) in Table 11.1 in general seem fairly small. This result is consistent with the results in Table 8.5, which show that the contribution of the uncertainty of the coefficient estimates to the total uncertainty of the forecast is generally relatively small. Most of the uncertainty of multipliers comes from the uncertainty of the coefficient estimates, and if the effects of coefficient uncertainty are small, multiplier uncertainty will be small.

The results in the b rows in Table 11.1 are thus encouraging regarding the accuracy of the properties of the model, provided that the model is correctly specified. The assumption of correct specification is the key restriction in the present context. Table 8.5 shows that misspecification contributes some to the total variances of the forecasts from the US model, and so it should be taken into account in the estimation of the standard errors of the multipliers. It is an open question as to how this can be done. Given that it was not done here, the present estimates of the standard errors must be interpreted as only lower bounds.

Another way of trying to get a sense of how much confidence to place on the multiplier results is to examine their sensitivity to alternative specifications, where the alternative specifications are supported by the data as much or nearly as much as the original specification. This is done in Section 11.3.4 below regarding the specification of the import equation and in Section 11.6 regarding the use of the rational expectations assumption.

11.3.2 A Monetary-Policy Experiment: RS Decrease

The most straightforward way to examine the effects of monetary policy in the model is to drop the interest rate reaction function (equation 30), take the bill rate RS to be exogenous, and then compute multipliers for a change in RS. The results of doing this are reported in Table 11.2. The experiment is a sustained decrease in RS of one percentage point, and the simulation period is the same as that for the fiscal policy experiments: 1989:3–1993:2. The units in Table 11.2 are the same as those in Table 11.1. Remember from earlier discussion that a change in RS has both a substitution effect and an income effect on the economy. The substitution effect from a decrease in the bill rate is positive, but the income effect is negative.

The results in Table 11.2 show that the overall effect on real GDP from the one percentage point decrease in RS is moderate. After four quarters the rise in $GDPR$ is .24 percent, and after eight quarters the rise is .49 percent. After two years the percentage rise in $GDPR$ is thus about half of the percentage point decrease in RS. The federal government deficit is $5.1 billion lower after eight quarters, which is in part because of the lower government interest payments and in part because of higher tax receipts caused by the more expansionary economy.

It will be seen in Section 11.7 that the model suggests that the effect on output of a decrease in RS would be slightly larger if the federal government debt had not grown so much during the 1980s.

11.3.3 Sensitivity of Fiscal Policy Effects to Assumptions about Monetary Policy

All the experiments in Table 11.1 used the interest rate reaction function as the monetary-policy assumption. It is possible to make other assumptions, and Table 11.3 presents results from making two other assumptions. The results from three experiments are reported in the table. The first experiment is the same as the first experiment in Table 11.1, namely an increase in COG with the interest rate reaction function used. The second experiment is the change in COG with RS held unchanged from its base period values, and the third experiment is the change in COG with $M1$ held unchanged from its base period values. The results for $M1$ are also presented in Table 11.3, along with the results for $GDPR$, PF, UR, RS, and $-SGP$.

In both the first and third experiments the bill rate rises in response to the COG increase, which leads output to increase less for these two experiments than for the second experiment where the bill rate is kept unchanged. After eight quarters the increase in RS is 1.12 percentage points in the first experiment and .40 percentage points in the third experiment. After, say, eight quarters the output differences across the three experiments are modest. This is because, as seen above, the effects of a change in RS on output are modest.

The bill rate rises more in the first experiment than in the third, which results in the first experiment being less expansionary than the third. According to the interest rate reaction function, which is used for the first experiment, the Fed leans against a COG increase by actually having the money supply contract. (See the results for $M1$ for the first experiment in Table 11.3). When the money supply is constrained to be unchanged in the third experiment, the lean in terms of higher interest rates is thus not as great. In other words, the monetary-policy behavior that is reflected in the estimated interest rate reaction function is less accommodating than the behavior of keeping $M1$ unchanged in the wake of an increase in government spending.

11.3.4 Sensitivity of Fiscal Policy Effects to the Specification of the Import Equation

It was seen in the discussion of the import equation in Section 5.7 that the level of nonfarm firm sales dominated disposable income in the equation in the sense of having a higher t-statistic when both variables were included in the equation. Collinearity was such, however, that neither variable was significant. (Disposable income was chosen for the final specification of the equation

Table 11.3
Estimated Multipliers and Their Standard Errors for an Increase in COG under Three Monetary Policy Assumptions

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$GDPR$: Real GDP						
$COG\uparrow$Eq.30	0	1.11	1.62	1.77	1.75	1.21	.87	.89
	a	1.11	1.63	1.77	1.76	1.17	.84	.87
	b	.07	.09	.11	.15	.29	.30	.31
$COG\uparrow RS$ex.	0	1.10	1.64	1.84	1.90	1.65	1.35	1.26
	a	1.11	1.65	1.85	1.91	1.61	1.31	1.20
	b	.07	.09	.11	.14	.33	.28	.24
$COG\uparrow M1$ex.	0	1.10	1.64	1.82	1.86	1.50	1.18	1.13
	a	1.11	1.65	1.84	1.88	1.46	1.15	1.11
	b	.07	.09	.12	.17	.40	.33	.23
		PF: Price Deflator						
$COG\uparrow$Eq.30	0	.00	.11	.28	.44	.80	.82	.82
	a	.00	.12	.30	.49	.92	.90	.92
	b	.00	.04	.10	.18	.41	.33	.40
$COG\uparrow RS$ex.	0	.00	.11	.28	.45	.90	1.00	1.07
	a	.00	.12	.30	.50	1.07	1.13	1.22
	b	.00	.04	.10	.19	.61	.47	.50
$COG\uparrow M1$ex.	0	.00	.11	.28	.45	.87	.94	.99
	a	.00	.11	.29	.53	.99	1.00	1.02
	b	.00	.04	.11	.49	.63	.46	.37
		UR: Unemployment Rate						
$COG\uparrow$Eq.30	0	-.32	-.66	-.93	-1.11	-.89	-.50	-.34
	a	-.32	-.64	-.89	-1.05	-.89	-.50	-.36
	b	.05	.07	.11	.14	.18	.19	.19
$COG\uparrow RS$ex.	0	-.32	-.67	-.96	-1.17	-1.11	-.75	-.50
	a	-.32	-.65	-.91	-1.10	-1.11	-.77	-.54
	b	.04	.07	.11	.15	.21	.21	.21
$COG\uparrow M1$ex.	0	-.32	-.67	-.95	-1.16	-1.04	-.67	-.44
	a	-.32	-.65	-.91	-1.09	-1.01	-.65	-.46
	b	.05	.08	.12	.15	.22	.21	.19

because this is consistent with the use of disposable income in the household expenditure equations.) This is thus a case in which the data do not discriminate well between two possible variables, and it is of interest to see how sensitive the properties of the model are to the use of the two variables. The more sensitive the properties are, the less confidence can be placed on them

Table 11.3 (continued)

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
				RS: Bill Rate				
COG ↑Eq.30	0	.43	.79	.90	.94	1.12	1.12	1.14
	a	.43	.79	.90	.95	1.11	1.08	1.11
	b	.08	.14	.15	.16	.21	.26	.31
COG ↑RSex.	0	.00	.00	.00	.00	.00	.00	.00
	a	.00	.00	.00	.00	.00	.00	.00
	b	.00	.00	.00	.00	.00	.00	.00
COG ↑$M1$ex.	0	.11	.21	.25	.32	.40	.35	.39
	a	.11	.19	.26	.33	.41	.38	.39
	b	.05	.08	.10	.15	.15	.13	.16
				$-SGP$: Federal Government Deficit				
COG ↑Eq.30	0	9.8	8.8	8.5	8.6	12.3	15.7	17.9
	a	9.8	8.8	8.4	8.5	12.1	15.5	17.6
	b	.2	.3	.4	.6	.9	1.3	1.8
COG ↑RSex.	0	9.1	7.3	6.4	6.0	7.2	8.6	9.0
	a	9.1	7.3	6.3	5.9	6.9	8.4	8.7
	b	.3	.3	.5	.6	.9	.8	1.1
COG ↑$M1$ex.	0	9.3	7.7	7.0	6.9	8.9	10.9	12.0
	a	9.3	7.6	6.9	6.6	8.9	11.0	12.0
	b	.3	.3	.5	1.2	.9	1.1	1.5
				$M1$: Money Supply				
COG ↑Eq.30	0	-.09	-.25	-.43	-.57	-1.13	-1.50	-1.67
	a	-.09	-.25	-.42	-.56	-1.09	-1.43	-1.62
	b	.03	.09	.14	.19	.38	.54	.69
COG ↑RSex.	0	.04	.10	.17	.26	.60	.82	.93
	a	.04	.10	.18	.26	.62	.84	.95
	b	.01	.03	.05	.08	.16	.20	.20
COG ↑$M1$ex.	0	.00	.00	.00	.00	.00	.00	.00
	a	.00	.00	.00	.00	.00	.00	.00
	b	.00	.00	.00	.00	.00	.00	.00

Eq.30 = Equation 30 used. RSex.= RS exogenous.
$M1$ex. = $M1$ exogenous.
See notes to Table 11.1.

because the data do not discriminate between the two variables.

The COG, $D1G$, and $TRGH$ experiments in Table 11.1 were performed with the sales variable replacing the disposable income variable in the import equation. Otherwise, everything else was the same. The results are reported in Table 11.4 for $GDPR$. The results for the first version are the same as those in Table 11.1, and the results for the second version are for the sales variable

Table 11.4
Estimated Multipliers for Three Experiments and Two Versions of the Import Equation

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$GDPR$: Real GDP						
$COG \uparrow$	1	1.11	1.62	1.77	1.75	1.21	.87	.89
	2	1.06	1.53	1.62	1.56	.96	.69	.75
$D1G \downarrow$	2	.32	.63	.83	.91	.69	.37	.33
	2	.36	.72	.96	1.08	.90	.62	.63
$TRGH \downarrow$	2	.33	.68	.90	1.00	.73	.34	.29
	2	.37	.77	1.03	1.16	.93	.58	.59

1 = Income variable in the import equation (regular version).
2 = Sales variable in the import equation.
Results are from deterministic simulations.

replacing the disposable income variable in the import equation. Only the results from deterministic simulations are presented in Table 11.4.

The results for the COG experiment show that the output multipliers are larger for the first version than for the second. The reason for this is the following. When COG increases, the level of sales directly increases, whereas disposable income only indirectly increases (as income expands due to the expanding economy). Therefore, imports respond more quickly in the second version because they are directly affected by sales. In the first version they respond only as disposable income responds. Since imports respond more in the second version, the output response is less because imports subtract from GDP.

In the other two experiments in Table 11.4 the output response is greater in the second version than in the first, contrary to the case in the first experiment. The reason for this is the following. When $D1G$ or $TRGH$ increase, disposable income directly increases, whereas sales only indirectly increase (as the disposable income increase induces an increase in sales). Therefore, imports respond more quickly in the first version, resulting in a smaller output increase.

The eight quarter ahead multipliers in Table 11.4 are the following for the three experiments: 1.21 versus .96 for the first, .69 versus .90 for the second, and .73 versus .93 for the third. These differences of .25, .21, and .20 compare to the eight quarter ahead estimated standard errors in Table 11.1 of .29, .24, and .23, respectively. The differences are thus slightly less than one standard

Table 11.5
Estimated Multipliers for a COG Increase for Alternative Sets of Coefficient Estimates

	Number of Quarters Ahead						
	1	2	3	4	8	12	16
			$GDPR$: Real GDP				
2SLS	1.11	1.62	1.77	1.75	1.21	.87	.89
2SLAD	1.09	1.61	1.81	1.85	1.41	1.02	1.07
3SLS	1.11	1.56	1.67	1.63	1.19	.91	.87
FIML	1.10	1.34	1.38	1.36	1.18	1.07	1.05
MU	1.10	1.62	1.76	1.75	1.19	.81	.82
			PF: Nonfarm Price Deflator				
2SLS	.00	.11	.28	.44	.80	.82	.82
2SLAD	.00	.11	.26	.43	.83	.88	.91
3SLS	.00	.15	.35	.55	.98	1.03	1.06
FIML	.00	.16	.35	.53	.98	1.13	1.30
MU	.00	.11	.28	.44	.80	.81	.80
			RS: Bill Rate				
2SLS	.43	.79	.90	.94	1.12	1.12	1.14
2SLAD	.35	.68	.86	.96	1.27	1.28	1.32
3SLS	.39	.72	.81	.84	1.02	1.04	1.07
FIML	.06	.17	.26	.32	.43	.43	.45
MU	.43	.79	.90	.95	1.13	1.10	1.11
			UR: Unemployment Rate				
2SLS	-.32	-.66	-.93	-1.11	-.89	-.50	-.33
2SLAD	-.34	-.68	-.96	-1.16	-1.07	-.69	-.52
3SLS	-.30	-.59	-.82	-.97	-.82	-.54	-.36
FIML	-.26	-.46	-.61	-.72	-.65	-.53	-.41
MU	-.32	-.66	-.93	-1.11	-.91	-.50	-.29

error. Therefore, if the differences in Table 11.4 were to be taken as estimates of multiplier uncertainty due to possible misspecification of the import equation, the total multiplier uncertainty would be about double this. This is, of course, only a very crude way of trying to estimate multiplier uncertainty due to misspecification, but it may be suggestive of the likely size of this uncertainty.

11.3.5 Sensitivity of the Multipliers to Alternative Coefficient Estimates

It is straightforward to compute multipliers for different sets of coefficient estimates. If quite different multipliers are obtained for different sets of consistent estimates, say 2SLS versus 3SLS, this may be a cause of concern since one does not expect this to be true in a correctly specified model.

Multipliers are presented in Table 11.5 for the five sets of coefficient estimates that have been obtained for the US model—2SLS, 2SLAD, 3SLS, FIML, and MU. The multipliers are for the COG experiment with the interest rate reaction function used. These results are based on deterministic simulations. It can be seen that the multipliers are quite close across the different estimates. The largest difference is for the FIML multipliers for the bill rate, which are less than half the size of the others. As in Section 8.5, the overall FIML results stand out somewhat from the rest. Given that the FIML forecasts are on average not as accurate as the others in Table 8.4, the FIML results in Table 11.5 are probably the least trustworthy. Otherwise, the differences in Table 11.5 are not large enough to have much economic significance. This closeness of the results complements the closeness of the results in Section 8.5 regarding the predictive accuracy of the model.

11.3.6 Multipliers from a Price Shock: PIM Increase

The next experiment examined is an increase in the import price deflator, PIM. It was increased by 10 percent in each of the quarters of the simulation period (from its base period values). The simulation period was the same as in Table 11.1: 1989:3–1993:2. The results are presented in Table 11.6. The units in Table 11.6 are the same as those in Table 11.1.

The results show that an increase in PIM is contractionary and inflationary. When PIM increases, the domestic price level increases (equation 10), which leads to a fall in real disposable income. This in turn leads to a fall in household expenditures. The Fed responds to the initial change in prices by increasing the bill rate, which is another reason for the fall in expenditures. After the second quarter, however, the bill rate is lower, which is the output effect dominating the price effect in the interest rate reaction function (equation 30). After eight quarters output is 1.27 percent lower and the price level is 1.77 percent higher in response to the 10 percent increase in import prices. This experiment is the best example in the model of a situation in which real output and the price level are negatively correlated.

11.3.7 The Deficit Response to Spending and Tax Changes

When the economy expands, tax revenues increase and some government expenditures like unemployment benefits decrease, and when the economy

Table 11.6
Estimated Multipliers and Their Standard Errors for an Increase in PIM of 10 percent

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$GDPR$: Real GDP						
$PIM \uparrow$	0	-.33	-.75	-1.10	-1.30	-1.24	-.90	-.85
	a	-.33	-.77	-1.12	-1.33	-1.27	-.94	-.87
	b	.06	.14	.20	.26	.38	.40	.41
		PF: Price Deflator						
$PIM \uparrow$	0	.35	.64	.89	1.09	1.79	2.43	2.93
	a	.35	.65	.90	1.10	1.77	2.42	2.90
	b	.03	.05	.08	.11	.23	.27	.34
		UR: Unemployment Rate						
$PIM \uparrow$	0	.07	.20	.34	.45	.48	.18	-.07
	a	.06	.20	.37	.51	.56	.24	-.02
	b	.02	.06	.10	.14	.22	.22	.23
		RS: Bill Rate						
$PIM \uparrow$	0	.35	.26	-.05	-.23	-.45	-.51	-.59
	a	.34	.23	-.07	-.25	-.48	-.54	-.63
	b	.15	.18	.17	.19	.29	.35	.41
		$-SGP$: Federal Government Deficit						
$PIM \uparrow$	0	1.2	1.9	2.3	2.2	.0	-3.7	-6.9
	a	1.2	1.9	2.3	2.2	.1	-3.7	-6.9
	b	.3	.5	.7	.8	1.1	1.3	1.6

See notes to Table 11.1.

contracts, tax revenues decrease and some government expenditures increase. On this score, then, the government deficit decreases when the economy expands and increases when the economy contracts. Working in the opposite direction, on the other hand, is the fact that the Fed may lower interest rates in contractions and raise them in expansions. As interest rates fall, interest payments of the government fall, which decreases the deficit, and as interest rates rise, interest payments rise, which increases the deficit.

It is of obvious interest to policy makers to know how the deficit responds to changing economic conditions. In particular, if one is contemplating lowering the deficit by decreasing government spending or raising taxes, which will presumably affect the economy, it is important to know how the changes in the economy will affect the deficit. It may be, for example, that to lower the deficit by $10 billion takes more than a $10 billion cut in government spending.

It is easy in a model like the US model to estimate how much the deficit changes as government spending or taxes change, and the purpose of this section is to provide such estimates. These estimates will, of course, depend on what is assumed about monetary policy, since fiscal policy effects in the model depend on the monetary-policy assumption. Of the three assumptions examined in Section 11.3.3—the Fed behaves according to the interest rate reaction function (equation 30), the Fed keeps the bill rate unchanged, and the Fed keeps the money supply unchanged—the one that mitigates the effects of a government spending change or a tax change the most is the use of the reaction function. The results in Table 11.3 show that the bill rate rises the most (in response to the government spending increase) when equation 30 is used. Although not shown in the table, when there is a government spending *decrease*, the bill rate falls the most when equation 30 is used. (The results in Table 11.3 are close to being symmetrical for positive and negative fiscal policy changes.) The least mitigating assumption is when the bill rate is kept unchanged in response to the fiscal policy change.

The estimates in this section were obtained as follows. The simulation period was, as for the multiplier experiments above, 1989:3–1993:2. Also, as above, the residuals from the estimation of the stochastic equations were first added to the stochastic equations, which results in a perfect tracking solution for the model when the actual values of the exogenous variables are used.

Three fiscal policy changes were then made for two monetary-policy assumptions, resulting in six experiments. For the first fiscal policy change, COG was decreased each quarter so as to make the nominal decrease in government spending ($PG \cdot COG$) \$10 billion.[4] For the second fiscal policy change, $D1G$ was increased each quarter so as to make the nominal increase in personal income taxes (THG from equation 47) \$10 billion. For the third fiscal policy change, $TRGH$, which is in nominal terms, was decreased by \$10 billion each quarter. The two monetary-policy assumptions used were equation 30 and the policy of keeping the bill rate unchanged.

If there were no response of the economy to the fiscal policy changes, the change in the federal government deficit, $-SGP$, would be $-$\$10 billion in each case. The key question then is how much the changes in $-SGP$ deviate from $-$\$10 billion. The results for the six experiments are presented in Table 11.7.

[4]Since PG is an endogenous variable in the model, COG is in effect an endogenous variable in this experiment (with $PG \cdot COG$ being exogenous). Its value each quarter is whatever is needed to make $PG \cdot COG$ \$10 billion less than its base value. A similar situation holds for $D1G$ in the second fiscal policy change.

Table 11.7
Estimated Effects on the Federal Government Deficit of Six Fiscal Policy Experiments

		Number of Quarters Ahead						
		1	2	3	4	8	12	16
		$-SGP$: Federal Government Deficit						
$COG \downarrow$	Eq.30	-7.7	-6.8	-6.4	-6.5	-9.0	-11.1	-12.2
	RS ex.	-7.2	-5.7	-4.9	-4.6	-5.3	-6.1	-6.2
$D1G \uparrow$	Eq.30	-9.7	-9.5	-9.4	-9.5	-11.4	-13.0	-14.0
	RS ex.	-9.5	-9.0	-8.6	-8.5	-9.3	-10.2	-10.7
$TRGH \downarrow$	Eq.30	-9.5	-8.9	-8.5	-8.4	-10.1	-11.9	-12.8
	RS ex.	-9.3	-8.5	-7.8	-7.5	-8.0	-9.2	-9.7

Eq.30 = Equation 30 used.
RSex. = RS exogenous.
Results are from deterministic simulations.
Units are billions of current dollars.

Consider the COG results first. When the bill rate is unchanged, the fall in the deficit is \$7.2 billion in the first quarter and \$5.7 billion in the second quarter. The fall reaches a low of \$4.4 billion in the fifth quarter, and then rises to a little over \$6 billion in the fourth year. The government thus loses about 40 cents of each one dollar cut in spending in terms of the impact on the budget if the Fed responds by keeping interest rates unchanged.

The results are much different if the Fed behaves according to equation 30. In this case the decreases in the deficit never fall below \$6.4 billion, and by the twelfth quarter the decreases are greater than the \$10 billion fall in spending. This is because of the lower interest rates. Although not shown in the table, the fall in RS after a few quarters was a little over .8 percentage points with equation 30 used. By the end of the period the decrease in federal government interest payments ($INTG$) was \$6.5 billion. The decrease in GDP was, of course, also less in this case because of the stimulus from the lower interest rates.

The $D1G$ results are presented next in Table 11.7. It is known from Table 11.1 that changes in $D1G$ have smaller impacts on GDP than do changes in COG, and the results in Table 11.7 reflect this. The decreases in the deficit are larger for the $D1G$ increase than for the COG decrease. Even with the bill rate held constant, the decrease in the deficit is greater than \$10 billion after 12 quarters. Although not shown in the table, government interest payments are noticeably lower in this case after about two years even with the bill rate held constant because the government debt is lower due to smaller past deficits. For example, by the sixteenth quarter interest payments were $2.4 billion lower. This lower level of interest payments is the primary reason for the deficit reductions greater than $10 billion. The deficit reductions are, of course, even larger when equation 30 is used. In this case the table shows that the fall in the deficit is $14.0 billion by the end of the period. The change in government interest payments caused by various policy changes is now a non trivial part of the overall change in the government deficit. These payments change when interest rates change and when the government debt changes due to current and past deficit changes.

The final results in Table 11.7 are for the $TRGH$ decrease. It can be seen from Table 11.1 that the impact of a change in $TRGH$ on GDP is generally in between the impacts for the COG and $D1G$ changes, although closer to the impacts for the $D1G$ change. Again, the results in Table 11.7 reflect this. The results are in between the COG and $D1G$ results, but close to the $D1G$ results.

To conclude, the present results show that the Fed plays a large role in deficit reduction issues. If the Fed leans against the wind as equation 30 specifies, then a policy of reducing the deficit by contractionary fiscal policies will be much more successful than if the Fed does not allow the interest rate to fall. The results also show that government tax and transfer changes are better tools than government spending changes on goods for lowering the deficit because they have smaller impacts on output. However, although not shown in the table, in all cases for the experiments in Table 11.7 the effects on output were negative, and so deficit reduction is not without some costs even for the most optimistic case in the table. In order to make the output costs zero, the Fed would have to behave in a more expansionary way than that implied by equation 30. One can, of course, never rule out the possibility that the Fed would behave in a more expansionary way in response to some deficit reduction plan than would be implied by its historical behavior. One should thus think about the results in Table 11.7 that use equation 30 as being based on historical Fed behavior.

11.4 Sources of Economic Fluctuations in the US Model[5]

Section 10.3 discussed a procedure for examining the sources of economic fluctuations in macroeconometric models, and this section uses this procedure to examine the sources of economic fluctuations in the US+ model.

Remember that the US+ model is the US model with the addition of 91 autoregressive equations for the exogenous variables. For this model the covariance matrix of the error terms is 121×121, and it is taken to be block diagonal. The first block is the 30×30 covariance matrix of the structural error terms, and the second block is the 91×91 covariance matrix of the exogenous variable error terms. Only error terms were drawn for the stochastic simulations (not also coefficients). The results for real GDP are presented in Table 11.8, and the results for the price deflator are presented in Table 11.9.

The Results for Real GDP

The results in Table 11.8 are based on 30 stochastic simulations of 1000 repetitions each. The first simulation was one in which none of the equations' error terms was fixed. Each of the other 29 simulations consisted of fixing one or more of the error terms in the 121 equations. Each number in Table 11.8 is the difference between the two variances as a percent of the overall variance (in percentage points). In terms of the notation in Section 10.3, each number is $100[\tilde{\delta}_{it}(k)/\tilde{\sigma}_{it}^2]$.

The results in Table 11.8 are divided into five categories: 1) demand shocks, 2) financial shocks, 3) supply shocks, 4) fiscal shocks, and 5) shocks from the interest rate reaction function, which can be interpreted as monetary-policy shocks. This grouping is somewhat arbitrary, but it is useful for organizing the discussion.

Consider the demand shocks first. Nine demand shocks were analyzed: three types of consumption (CS, CN, CD), three types of investment (IHH, IVF, IKF), labor demand (JF, HF, HO), imports (IM), and exports (EX). For each of the nine simulations, one equation's error term was fixed except for the simulation regarding labor demand, where three equations' error terms were fixed. In addition, a tenth simulation was run in which the error terms in all eleven equations were fixed. The first total presented for the demand shocks in Table 11.8 is the value computed from the tenth simulation, and the second total is the sum of the nine individual values. The difference between

[5] The material in this section is an updated version of the material in Section IV in Fair (1988a).

Table 11.8
Variance Decomposition for Real GDP

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
				$GDPR$: Real GDP				
Demand Shocks:								
CS	5.9	5.8	4.4	5.0	4.8	4.5	4.3	4.3
CN	2.0	2.4	2.5	2.4	1.7	1.5	1.3	1.1
CD	3.4	3.6	3.6	3.1	1.8	1.5	1.5	1.3
IHH	6.3	6.6	6.3	6.3	6.6	6.6	5.5	4.9
IVF (eq. 11)	1.2	-1.5	-.8	-1.0	.8	1.0	.5	.0
IKF	2.1	1.9	1.7	2.1	2.2	1.6	1.8	1.4
JF, HF, HO	.2	-.2	-.2	.5	1.0	.8	1.0	1.2
IM	8.7	7.7	10.9	8.5	4.9	5.0	4.9	4.8
EX	45.9	39.3	37.4	38.5	37.6	35.2	35.2	31.9
Total[a]	81.1	73.2	68.5	64.9	62.6	60.6	57.8	53.7
Total[b]	75.7	65.6	65.8	65.3	61.6	57.7	55.9	51.0
Financial Shocks:								
MH, MF, CUR	.0	.0	.0	.0	.0	.0	.0	.1
RB, RM	.6	.9	1.1	1.0	1.0	.9	.8	1.0
CG	.0	-.1	.0	.0	.2	.3	.5	.6
Total[a]	.6	.9	1.1	.9	1.0	1.1	1.2	1.5
Total[b]	.6	.9	1.1	1.0	1.1	1.1	1.3	1.7

the two totals is an indication of how much the correlation of the error terms across equations matters. If each of the eleven error terms were uncorrelated with all the other error terms in the model, the two totals would be the same.

The results in the table show that the demand shocks account for between 75.7 and 81.1 percent of the variance of GDP for the first quarter, depending on which total is used. The contribution declines to between 51.0 and 53.7 percent for the eighth quarter. Export shocks contribute by far the most to the total, with import shocks the next most important. The household sector's variables—CS, CN, CD, and IHH—contribute more than do the firm sector's variables—IVF, IKF, JF, HF, and HO—to the variance of GDP. Remember, however, that a result like the one that plant and equipment investment (IKF) shocks have a small effect on the variance of GDP does not mean that plant and equipment investment is unimportant in the model. It simply means that the effects of the shocks to the plant and equipment investment equation are relatively small.

The next type of shocks presented in Table 11.8 are financial shocks. Three

Table 11.8 (continued)

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
Supply Shocks:								
PF	.2	.5	.8	.9	.7	.9	1.0	1.3
WF	.1	.5	-.2	-.5	-.2	-.5	-.6	-.4
PIM	.3	.3	1.1	1.7	3.7	4.6	5.9	7.8
$POP1, 2, 3$	-.1	-.2	-.1	.1	.1	-.1	-.1	-.1
Total[a]	.3	.7	1.3	1.7	4.0	5.2	6.2	8.3
Total[b]	.4	.9	1.6	2.2	4.2	4.9	6.2	8.7
Fiscal Shocks:								
COG	5.6	5.4	4.1	3.0	2.9	1.6	1.5	.8
Fed tax rates	.9	1.0	1.0	.4	.2	.9	1.8	2.6
JG, JM, HG	-.8	-.1	.3	.4	.5	.5	.6	.5
$TRGH$	-2.2	-1.5	-1.4	-.7	-.2	.2	.1	.6
COS	3.7	3.8	2.7	2.7	2.7	2.4	2.4	2.0
S&L tax rates	-.7	-1.2	-1.4	-2.0	-2.2	-2.1	-2.0	-1.9
JS	.4	.1	.3	.2	.2	.2	.8	.9
$TRSH$	6.3	10.6	12.9	12.5	11.5	11.1	10.9	9.1
Total[a]	14.4	21.1	23.1	22.0	20.9	20.3	20.0	19.0
Total[b]	13.3	18.1	18.6	16.5	15.5	14.8	16.0	14.9
Federal Reserve Shocks:								
RS	.0	-.1	-.2	-.4	-.4	.1	.7	.7

[a]Computed from stochastic simulation with all the relevant error terms set to zero at the same time.
[b]Sum of the individual values.

financial shocks were analyzed: shocks to money demand (MH, MF, CUR), shocks to long term interest rates (RB, RM), and shocks to stock prices (CG). The results show that the effects of these shocks are quite small.

The effects of supply shocks are presented next. Four supply shocks were analyzed: shocks to the aggregate price level (PF), shocks to the aggregate wage rate (WF), shocks to the price of imports (PIM), and shocks to population ($POP1$, $POP2$, $POP3$). The results show that the supply shocks account for a rising proportion of the variance across the horizon, reaching between 8.3 and 8.7 percent by the eighth quarter. Almost all of this contribution is from the price of imports.

The effects of fiscal shocks are presented next. Eight fiscal shocks were analyzed: shocks to federal government purchases of goods (COG), federal

Table 11.9
Variance Decomposition for the Nonfarm Price Deflator

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
			PF: Price Deflator					
Demand Shocks:								
CS	.0	-.1	-.2	-.3	.7	3.1	1.9	3.1
CN	.0	.0	.1	-1.4	-2.8	-.1	-.8	1.2
CD	.0	.0	.3	.6	1.0	.5	-1.1	.7
IHH	.0	.3	.9	1.6	2.9	6.2	5.0	8.4
IVF (eq. 11)	.0	-.4	-.5	-.5	-.4	-1.6	-2.4	-1.3
IKF	.0	.5	1.0	1.2	.4	3.0	.0	1.3
JF, *HF*, *HO*	.0	.1	.2	.4	.5	1.8	.6	.9
IM	.0	.5	.4	.4	1.1	4.5	2.5	9.7
EX	.0	.0	.8	3.3	8.3	14.7	17.7	23.3
Total[a]	.0	1.0	3.0	6.3	12.2	19.0	24.0	31.8
Total[b]	.0	.9	2.8	5.1	11.5	32.1	23.5	47.3
Financial Shocks:								
MH, *MF*, *CUR*	.0	.0	.0	.0	-.2	-.2	-.2	-.6
RB, *RM*	.0	.0	.1	.2	-1.3	-.5	.4	.9
CG	.0	.0	-.1	-.2	-.3	-1.3	-2.2	-1.1
Total[a]	.0	.0	.0	-.1	-1.8	-1.2	-.9	.8
Total[b]	.0	.0	.0	.0	-1.8	-2.0	-2.1	-.8

tax rates ($D1G$, $D2G$, $D3G$, $D4G$, $D5G$), federal jobs and hours (JG, JM, HG), federal transfer payments to persons ($TRGH$), state and local government purchases (COS), state and local tax rates ($D1G$, $D2G$, $D3G$), state and local jobs (JS), and state and local transfer payments to persons ($TRSH$). The results show that the fiscal shocks are the second largest contributor to the variance of GDP. For the first quarter the contribution is between 13.3 and 14.4 percent, and for the eighth quarter the contribution is between 14.9 and 19.0 percent. The largest contributor to the effects of the fiscal shocks is $TRSH$. The tax rates and labor variables contribute very little.

The effects of the shocks to the interest rate reaction function are presented last in Table 11.8. The results show that these effects are very small.

The overall results for real GDP thus show that demand shocks contribute the most to the variance of real GDP, with fiscal shocks contributing the next most. Supply shocks are of growing importance over the horizon, but still account for less than 10 percent of the variance after eight quarters. The effects of financial shocks and shocks to the interest rate reaction function are

Table 11.9 (continued)

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
Supply Shocks:								
PF	97.4	91.7	81.5	68.1	50.5	38.0	27.7	20.6
WF	-1.0	-1.5	-2.4	-2.8	-3.9	-3.3	-2.1	-1.6
PIM	1.7	7.1	14.2	23.1	30.9	38.3	36.0	38.2
$POP1, 2, 3$	.0	.0	.0	.0	.1	.1	.0	.2
Total[a]	100.0	99.0	96.2	91.4	81.3	73.6	66.3	60.5
Total[b]	98.0	97.3	93.3	88.4	77.6	73.1	61.5	57.3
Fiscal Shocks:								
COG	.0	-.1	.1	.4	.8	2.1	2.3	3.6
Fed tax rates	.1	.0	-.1	-.1	-1.4	-5.1	-7.9	-3.6
JG, JM, HG	.0	.1	.1	.0	.5	-1.5	-1.9	-.2
$TRGH$	.0	-.1	-.1	-.1	.2	2.4	-3.7	-5.4
COS	.0	.0	.0	.5	-.3	2.0	2.8	4.5
S&L tax rates	.0	.0	.0	-.1	-2.1	-4.2	-5.1	-4.7
JS	.0	.0	.0	.2	.9	1.4	-.5	-.1
$TRSH$	.0	.0	.0	.5	3.1	8.7	8.8	13.2
Total[a]	.1	-.1	.2	1.8	6.4	12.8	15.5	21.8
Total[b]	.1	-.1	.1	1.4	1.6	5.8	-5.4	7.4
Federal Reserve Shocks:								
RS	.0	.0	.0	.1	.4	1.0	.2	1.9

[a]Computed from stochastic simulation with all the relevant error terms set to zero at the same time.
[b]Sum of the individual values.

very small.[6]

The Results for the Price Deflator

The results for the private nonfarm price deflator are presented in Table 11.9. They are based on the same stochastic simulations as those used for the GDP results. The results show that most of the variability for the first few quarters is due to shocks to the price equation, but after about four quarters other shocks begin to matter. In quarter 8 demand shocks account for between 31.8 and 47.3 percent of the variance, and fiscal shocks account for between 7.4 and 21.8 percent.

[6]This general conclusion is the same as the one reached from the results in Table I in Fair (1988a) based on earlier data and estimates.

Within the category of supply shocks, shocks to the price of imports grow in importance over time, contributing 38.2 percent after 8 quarters. There are two reasons for the importance of the shocks to the import price deflator. The first is that the import price deflator has a large effect on the domestic price level in the domestic price equation. The second is that the autoregressive import price equation has a fairly large variance. There are thus large shocks to the import price deflator in the stochastic simulations, which have a large impact on the variance of the GDP deflator through the price equation.[7]

The Effects of the Error Term Correlation Across Equations

The two totals for each type of shock in Table 11.8 are close to each other, and none of the major conclusions from the results depend on which total is used. For example, the eight quarter ahead totals for the demand shocks are 53.7 and 51.0, which are quite close. In this sense the correlation of the error terms across equations is not a problem. The two totals for the demand shocks and fiscal shocks in Table 11.9, on the other hand, are noticeably different for quarters 6, 7, and 8. For example, the eight quarter ahead totals for the demand shocks are 31.8 and 47.3. For these quarters the totals based on summing the individual values are greater than the other totals for the demand shocks and smaller for the fiscal shocks. The "non summation" totals for the demand and fiscal shocks should probably be used in Table 11.9, since these at least take into account the correlation of the error terms within groups. At the same time the estimated effects of the individual components should be discounted somewhat because their sum differs so much from the other total. The two totals for the supply shocks in Table 11.9 are, however, fairly close, and so the estimated effects of the individual supply components are probably more trustworthy.

Comparison with Other Results

The present results can be compared to those of Blanchard and Watson (1986) (BW). Using a four equation model, BW provide estimates of the percent of the variance of GDP[8] due to four shocks: demand, supply, money supply, and

[7]Earlier results in Table II in Fair (1988a) for the price deflator attributed less to fiscal shocks and more to supply shocks for quarters 6, 7, and 8 than the results in Table 11.9. Otherwise, the general conclusion from both tables is the same.

[8]BW actually examine the variance of GNP, not GDP, but for ease of exposition GDP will be used in the present discussion.

fiscal.[9] Their demand shocks are probably closest to the first two categories of shocks in Table 11.8 (demand shocks plus financial shocks). (For the following comparisons the first total in Tables 11.8 and 11.9 for each category of shock will be used.) For the one quarter ahead forecast, BW estimate that 74.0 percent of the variance of GDP is due to demand shocks. The relevant number in Table 11.8 is 81.1 + 0.6 = 81.7 percent. For the four quarter ahead forecast, the BW estimate is 54.0 percent, which compares to 64.9 + 0.9 = 65.8 in Table 11.8. The supply shocks are 3.0 for BW versus 0.3 in Table 11.8 for the one quarter ahead forecast and 15.0 versus 1.7 for the four quarter ahead forecast. The fiscal shock comparisons are 19.0 versus 14.4 for one quarter ahead and 16.0 versus 22.0 for four quarters ahead. The BW money supply shocks are closest to the shocks to the interest rate reaction function here. The comparisons are 4.0 versus 0.0 for one quarter ahead and 16.0 versus −0.4 for four quarters ahead. The main differences in these results is that four quarters out the US+ model has more contribution from the demand and fiscal shocks and less from the supply and monetary-reaction shocks.

Regarding the variance of the price deflator, BW attribute about three fourths of the variance to supply shocks and about one fourth to demand shocks for one quarter ahead. (The effects of the other shocks are minor.) The values four quarters ahead are two thirds and one third. In Table 11.9 100 percent of the variance is attributed to supply shocks one quarter out and 91.4 percent four quarters out. Four quarters out demand shocks account for 6.3 percent and fiscal shocks 1.8 percent. The present results thus attribute more of the variance to supply shocks. Remember, however, that the total for the supply shocks in Table 11.9 masks important individual differences, in this case the shocks to the domestic price equation versus shocks to the import price deflator. The import price deflator is not a variable in the BW model.

Finally, Bernanke (1986) has employed the BW methodology to estimate a number of small models and then to provide estimates of the decomposition of the variance of output. For the "Money-Credit" model,[10] 53.3 percent of the variance of output is attributed to demand shocks eight quarters out, which compares to 53.7 percent in Table 11.8. Fiscal shocks account for 12.1 percent, compared to 19.0 in Table 11.8, and supply shocks account for 12.4 percent, compared to 8.3 in Table 11.8. These differences are fairly small, with the US+ model attributing slightly more to fiscal shocks and slightly less to supply shocks than does Bernanke's model.

[9] The results cited here are taken from Blanchard and Watson (1986), Table 2.3, p. 133.
[10] The results cited here are taken from Bernanke (1986), Table 5, p. 74.

Conclusion

The procedure used in this section allows one to get a good idea of the quantitative contribution of various shocks to the variance of endogenous variables like real GDP and the price deflator. The results for the US+ model show that there are number of important contributors to the overall variance. It is clearly not the case that only one or two shocks dominate. There are thus no simple stories to be told about the sources of output and price variability, at least not within the context of a macroeconometric model like the one used here.

Accuracy of the Stochastic Simulations

Results are presented in Table 11.10 that help give one an idea of the precision of the estimates based on 1000 repetitions. These are the results used for real GDP in Table 11.8. The units are billions of 1987 dollars. The first row in Table 11.10 presents the estimates of the variance of real GDP, and the second row presents the estimated standard errors of the variance estimates. The variance estimates are fairly precise, with estimated standard errors less than 5 percent of the variance estimates. The next two rows pertain to the stochastic simulation in which the error term in the export equation is fixed. The values of the difference are presented in the first of the two rows, and the estimated standard errors of the difference values are presented in the second of the two rows. The same two rows are then presented for the simulation in which the error term in the stock price equation is fixed. The results show that for exports the standard errors are around 10 percent of the difference values, which gives a reasonable amount of precision. For stock prices the differences are small, except perhaps for the predictions seven and eight quarters ahead. For quarters two through six the standard errors are large relative to the differences, although, as just noted, the differences themselves are quite small.

From an examination of results like those in Table 11.10 for all the variables, the standard errors of the difference values in general seemed small enough to allow meaningful comparisons to be made, although they were still fairly far from zero.[11] Remember that these estimates are based on the trick of using the same draws for both simulations. Without this trick, the standard errors are much too large for anything meaningful to be done with the difference values.

[11] The results in Table III in Fair (1988a) are similar to those in Table 11.10 except that the differences for the stock price equation fixed are larger both absolutely and relative to their standard errors in Table III than in Table 11.10.

Table 11.10
Estimated Precision of the Stochastic Simulation Estimates for Real GDP

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
$\grave{\sigma}^2$	136.1	387.4	693.7	964.9	1208.8	1422.6	1592.4	1688.8
$[var(\grave{\sigma}^2)]^{1/2}$	(6.0)	(17.1)	(31.2)	(44.7)	(54.2)	(64.1)	(72.0)	(71.4)
Error Term in the Export Equation Fixed								
$\grave{\delta}(k)$	62.5	152.3	259.7	371.5	455.0	500.8	559.9	538.2
$\{var[\grave{\delta}(k)]\}^{1/2}$	(5.0)	(14.0)	(24.4)	(35.7)	(44.0)	(50.8)	(55.5)	(56.1)
Error Term in the Stock Price Equation Fixed								
$\grave{\delta}(k)$	.028	.35	-.07	.45	-2.13	-3.87	-7.44	-10.35
$\{var[\grave{\delta}(k)]\}^{1/2}$	(.003)	(.38)	(1.11)	(1.98)	(2.79)	(3.60)	(4.21)	(4.90)

Units are billions of 1987 dollars.
Estimates are based on 1000 trials.

11.5 Optimal Choice of Monetary-Policy Instruments in the US Model[12]

Section 10.4 discussed a procedure for comparing the use of different monetary-policy instruments, and this section is an application of this procedure. The procedure requires stochastic simulation, and the US+ model was used for the stochastic simulations. As in the previous section, the covariance matrix of the error terms was taken to be block diagonal, and only error terms were drawn for the repetitions (not also coefficients). As discussed below, equation 30 is dropped from the model for the results in this section, and so the covariance matrix of the error terms is 120×120 rather than 121×121 as in the previous section. The first 29 equations form the first block, and the 91 exogenous variable equations form the second block. The simulation period was 1970:1–1971:4, and the number of repetitions per stochastic simulation was 1000. A similar trick was used here as was used in the previous section for the stochastic simulations, namely the same draws of the error terms were used for the computations of both $\tilde{\sigma}_{it}^2(r)$ and $\tilde{\sigma}_{it}^2(M)$.

When the bill rate (RS) is the policy variable (i.e., exogenous for the stochastic simulation), a path for it is needed. Likewise, when the money supply ($M1$) is the policy variable,[13] a path for it is needed. The paths were

[12] The material in this section is an updated version of the material in Fair (1988b).

[13] When the money supply is the policy instrument, the question arises as to whether it is the nominal or the real money supply that is the instrument. This question does not arise in Poole's analysis because the price level is exogenous. For present purposes the nominal

Table 11.11
Percentage Difference Between the Variance Under the Money Supply Policy and the Variance Under the Interest Rate Policy

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
$GDPR$	.5	13.3	19.4	21.0	14.7	8.6	2.6	.7
CS	86.8	62.5	46.2	36.7	30.9	19.4	12.2	7.2
CN	.6	26.6	23.7	22.4	16.7	13.6	7.3	4.3
CD	16.8	12.8	9.0	10.3	7.4	5.5	2.3	.5
IHH	27.9	107.5	91.8	76.0	61.5	53.9	40.1	38.7
IKF	.2	.2	2.5	4.1	4.5	4.2	1.6	-1.3
IVF	.0	.7	7.7	14.6	16.1	9.5	9.2	10.4
IM	.8	1.8	1.5	4.4	3.1	3.9	2.8	1.1
CG	219.6	386.8	454.9	413.3	524.2	493.7	399.9	428.7
$PCGDPD$	.9	.7	2.0	1.4	9.7	13.0	2.3	-9.6
UR	.7	5.5	12.2	16.4	14.5	10.9	5.3	2.2
$PIEF$	15.6	9.0	14.6	9.1	13.6	7.1	10.1	2.3

chosen as follows. A dynamic simulation was first run over the eight quarter period with the error terms set to zero and the interest rate reaction function (equation 30) included in the model. The predicted values of the bill rate from this simulation were then taken as the values for the interest rate path. Likewise, the predicted values of the money supply were taken as the values for the money supply path. Once these paths are chosen, equation 30 is then dropped from the model. All the simulations are done without equation 30 in the model.

The percentage differences between the two variances are presented in Table 11.11 for selected variables in the model. In terms of the notation in Section 10.4, each number in the table is $100[\tilde{\sigma}^2_{it}(M) - \tilde{\sigma}^2_{it}(r)]/\tilde{\sigma}^2_{it}(r)$. Remember that for Poole's loss function i is equal to real GDP, and so the results in Table 11.11 for real GDP are the percentage differences between the two loss function values.

The results for real GDP show that the interest rate policy is better for all eight quarters, although for quarters 1, 7, and 8, the differences are very small. The largest difference is four quarters ahead, where the variance under the money supply policy is 21.0 percent larger than the variance under the interest rate policy. The differences for some of the other variables in Table

money supply is taken to be the policy instrument.

Table 11.12
Percentage Difference Between the Variance Under the Money Supply Policy and the Variance Under the Interest Rate Policy: No Shocks to the Money Equations

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
GDPR	.3	6.6	9.5	8.6	4.5	.9	-5.0	-8.0
CS	42.5	36.0	21.8	13.3	9.8	2.8	-2.8	-6.7
CN	.9	9.1	8.1	5.2	3.9	2.0	-3.1	-5.2
CD	7.4	4.2	4.8	2.9	2.4	2.4	-.7	-2.2
IHH	13.5	43.4	39.3	32.9	25.1	20.7	9.0	8.6
IKF	.1	.2	.8	1.8	1.5	.8	-1.0	-3.6
IVF	.0	.5	2.2	7.6	6.7	4.1	2.7	1.4
IM	.6	.7	.5	2.0	1.8	.9	-.3	-1.1
CG	94.2	173.9	194.7	163.3	226.4	230.4	199.5	202.3
PCGDPD	.4	.3	1.2	1.5	2.2	6.2	.3	-6.2
UR	.3	2.1	5.6	6.7	5.3	3.4	-.3	-4.4
PIEF	5.2	3.3	3.2	.3	1.8	-1.2	-1.9	-5.6

11.11 are quite large. In particular, the differences for CS, IHH, and CG are large and positive, which means that the variances for these three variables are considerably larger under the money supply policy than under the interest rate policy.

An interesting case to consider next is one in which there are no shocks to the money equations. If in Poole's model there are no shocks to the LM function, the money supply policy is better, and it is of interest to see if something similar holds for the US model. This can be done by setting the error terms in the four money equations (equations 9, 17, 22, and 26) to zero across all repetitions and running the stochastic simulations again. The results of doing this are presented in Table 11.12 for real GDP and its components.

The results in Table 11.12 are more favorable for the money supply policy than are the results in Table 11.11, which is as expected. For quarters 7 and 8 the variances of real GDP under the money supply policy are smaller, and for the other six quarters the variances under the money supply policy are closer to the variances under the interest rate policy than they are in Table 11.11. The overall change in results is thus what one would expect from Poole's analysis: the money supply policy does better relative to the interest rate policy when there are no shocks to the money equations.

Table 11.13
Percentage Difference Between the Variance Under the Optimal Policy and the Variance Under the Interest Rate Policy

	Number of Quarters Ahead							
	1	2	3	4	5	6	7	8
GDPR	.1	.0	-.1	.0	-.4	-1.4	-2.3	-2.7
CS	-.3	-.6	-1.7	-2.0	-3.0	-4.5	-5.5	-6.2
CN	.0	.6	.4	.1	.0	-.3	-.8	-1.1
CD	.5	.8	.6	.4	.2	-.2	-.4	-.9
IHH	.7	1.2	1.2	1.9	1.7	1.6	.7	.2
IKF	.0	.0	-.2	-.5	-.9	-1.2	-1.8	-2.4
IVF	.0	.1	.1	.2	.5	-.4	-1.0	-.3
IM	-.1	.0	.0	.2	.1	.1	-.1	-.5
CG	4.1	3.8	1.5	3.3	4.9	2.9	2.5	.8
PCGDPD	.0	.0	.1	-.1	.2	.6	-.1	-.8
UR	.1	-.1	-.3	-.1	-.4	-.8	-1.7	-2.4
PIEF	-.7	-1.0	-.7	-1.1	-.9	-1.8	-1.9	-3.0

The Optimal Policy

The optimal policy is defined here to be the policy where the Fed behaves according to the equation

$$\log M = \log M^* + \beta(r - r^*) \tag{11.1}$$

where M^* and r^* are, respectively, values of the money supply and the interest rate from the base path (values that do not change from repetition to repetition) and β is the parameter to be determined. The optimal value of β was determined as follows. Equation 10.9 was added to the model and a particular value of β was chosen. A stochastic simulation of 1000 repetitions was run, and the variances of GDP for the eight quarters were recorded. Another value of β was chosen, and a new stochastic simulation was run. This process was repeated for a number of values of β, and the value of β that led to the smallest variances of GDP was taken to be the optimal value. The value that was chosen as the optimal value was .025. The results using this value of β are presented in Table 11.13, where the numbers are the percentage differences between the variance under the optimal policy and the variance under the interest rate policy.

The main conclusion to be drawn from the results in Table 11.13 is that the optimal policy is very close to the interest rate policy. The percentage differences in the table are very small. For example, the eight quarter ahead variance of real GDP under the optimal policy is only 2.7 percent less than under the interest rate policy. Clearly, not much is to be gained by using the optimal policy over the interest rate policy.[14]

11.6 Sensitivity of Multipliers to the Rational Expectations Assumption in the US Model[15]

Section 4.5 discussed how the RE hypothesis can be tested within the context of a macroeconometric model, and Chapter 5 carried out these tests for the US model. This section considers how the economic significance of the RE hypothesis can be examined. How much difference to the properties of a model does the addition of the led values make? Two versions of the US model are examined here. The first version consists of the basic equations in Table 5.1–5.30 in Chapter 5 with three modifications. The three modifications concern the treatment of serial correlation of the error terms. The solution program for models with rational expectations used here can only handle first order autoregressive errors, and so the specification of equation 4 was changed from second to first order and the specification of equation 11 was changed from third to first order. The third modification was that the specification of equation 23 was changed from a first order autoregressive error to no autoregressive error. This was done because collinearity problems prevented the Leads +8 specification from being estimated under the assumption of a first order autoregressive error for equation 23. This version of the model will be called Version 1. It has no led values in it.

With the exception of equations 4, 10, 11, and 23, the second version replaces the basic equations in Tables 5.1–5.30 in Chapter 5 with the equations estimated for the Leads +8 results. These equations have values led 1 through

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[14]The results in Tables 11.11, 11.12, and 11.13 are similar to those in Tables 1, 2, and 5 in Fair (1988b), respectively. The interest rate policy does a little better in the present results than in the earlier results, and so there is a little more support here for the interest rate policy. The main conclusion about the optimal policy, namely that it is quite close to the interest rate policy, is the same for both sets of results.

In Fair (1988b) two versions of the US model were analyzed that were not analyzed here, one with more interest sensitive expenditures imposed on the model and one with rational expectations in the bond market imposed on the model. In the first version the interest rate policy gains relative to the money supply policy, and in the second version money supply policy gains relative to the interest rate policy.

[15]The material in this section is an updated version of the material in Section 5 in Fair (1993b).

Table 11.14
Estimated Multipliers for the US Model with Rational Expectations

	Sustained COG Increase					
		$GDPR$			PF	
	1	2	2^a	1	2	2^a
1968:1	–	–	-.21	–	–	.00
1968:2	–	–	-.57	–	–	-.03
1968:3	–	–	-.87	–	–	-.09
1968:4	–	–	-1.01	–	–	-.16
1969:1	–	–	-.90	–	–	-.22
1969:2	–	–	-.54	–	–	-.26
1969:3	–	–	.01	–	–	-.27
1969:4	–	–	.67	–	–	-.25
1970:1	1.19	1.31	2.46	.00	.00	-.19
1970:2	1.59	1.93	3.07	.10	.11	.01
1970:3	1.70	2.11	3.00	.21	.26	.30
1970:4	1.70	2.09	2.63	.32	.41	.59
1971:1	1.69	2.03	2.19	.41	.53	.82
1971:2	1.59	1.87	1.68	.50	.64	.98
1971:3	1.46	1.68	1.19	.58	.74	1.08
1971:4	1.34	1.51	.84	.65	.80	1.10
1972:1	1.21	1.37	.61	.70	.84	1.09
1972:2	1.10	1.30	.55	.75	.88	1.05
1972:3	1.01	1.25	.59	.77	.92	1.01
1972:4	.94	1.24	.70	.79	.96	.98

1 = Non RE Version.
2 = RE Version, unanticipated changes.
2^a = RE Version, anticipated changes.

The COG increase was 1 percent of real GDP.
The increase began in 1970:1.

8 times in them, with the coefficients for each variable constrained to lie on a second degree polynomial with an end point constraint of zero. Equation 11 is an exception because the order of the autoregressive error was dropped from two to one, and equation 23 is an exception because the order was dropped from one to zero. Equation 10 is an exception because the basic equation was used instead of the Leads +8 version. This was done to preserve the restrictions that are imposed on the coefficients in equations 10 and 16. This is not likely to be an important exception because the led values were not significant in equation 10 (see Table 5.10). Finally, equation 4 is an exception because the equation with a first order autoregressive error and Leads +8 did not have sensible coefficient estimates. The equation used in this case is the same as

Table 11.14 (continued)

	Sustained *RS* Decrease					
	GDPR			*PF*		
	1	2	2[a]	1	2	2[a]
1968:1	–	–	.03	–	–	.00
1968:2	–	–	.07	–	–	.00
1968:3	–	–	.10	–	–	.01
1968:4	–	–	.09	–	–	.02
1969:1	–	–	.06	–	–	.03
1969:2	–	–	-.02	–	–	.03
1969:3	–	–	-.14	–	–	.03
1969:4	–	–	-.29	–	–	.02
1970:1	-.00	-.04	-.41	.00	.00	-.00
1970:2	.11	.15	-.27	-.00	-.00	-.02
1970:3	.26	.36	-.06	.01	.01	-.04
1970:4	.41	.54	.15	.02	.03	-.04
1971:1	.53	.65	.32	.05	.06	-.03
1971:2	.62	.71	.45	.08	.10	-.01
1971:3	.69	.73	.53	.11	.13	.02
1971:4	.75	.72	.59	.15	.17	.06
1972:1	.77	.67	.58	.19	.20	.09
1972:2	.77	.60	.55	.24	.23	.12
1972:3	.76	.51	.48	.28	.26	.16
1972:4	.74	.41	.39	.31	.28	.19

1 = Non RE Version.
2 = RE Version, unanticipated changes.
2[a] = RE Version, anticipated changes.

The *RS* decrease was 1 percentage point.
The decrease began in 1970:1.

the one for Version 1, namely the equation with a first order autoregressive error (as opposed to second in Table 5.4) and no led values. This version of the model will be called Version 2.

Any equations in Chapter 5 for which no led values were tried are the same for both versions. Also, the identities are the same for both versions. The estimation period for any equation with led values had to end in 1990:4 rather than 1993:2, and so to make both versions comparable, all the equations for both versions were estimated only through 1990:4. The estimation techniques were 2SLS and Hansen's method. The first stage regressors are the ones listed in Table A.7 except for the equations with led values and a first order autoregressive error (equations 11 and 14), where the first stage regressors are all lagged once.

It should be noted that because of the reestimation only through 1990:4, the coefficient estimates for Version 1 are not the same as the coefficient estimates in Tables 5.1–5.30. The specification is the same (with the three exceptions noted above), but the estimates are not. This shorter estimation period was, however, used for the Leads +8 tests in the tables, and so the results for these tests in the tables are precisely the comparison of the equations of Version 1 versus those of Version 2 (with the three exceptions noted above).

It should also be noted that Version 2 has fewer restrictions imposed on it than are imposed on most RE models. The only restrictions imposed before estimation are that there are eight leads and the coefficients of the led values lie on a second degree polynomial. In many RE models at least some of the coefficients are chosen *a priori* rather than estimated. For example, the RE version of the model in Fair (1979b) simply imposes rational expectations in the bond and stock markets without estimation. It is thus quite possible for Version 2 to have properties similar to those of Version 1 and yet for other, more restricted RE models to have very different properties from those of their non RE versions.

Version 2 is solved under the assumption that expectations are rational in the Muth sense. In particular, it is assumed that agents use the model in solving for their expectations and that their expectations of the exogenous variables are equal to the actual values. These two assumptions imply that agents' expectations of the future values of the endogenous variables are equal to the model's predictions of them. Version 2 is solved using the EP solution method discussed in Section 7.10.

Four policy experiments were performed. The first two are a sustained increase in federal government purchases of goods in real terms (COG) beginning in 1970:1. For experiment 1 the change is unanticipated, and for experiment 2 the change is anticipated as of 1968:1. The second two experiments are a sustained decrease in the bill rate (RS) beginning in 1970:1. For experiment 3 the change is unanticipated, and for experiment 4 the change is anticipated as of 1968:1. For the second two experiments the interest rate reaction function (equation 30) is dropped and the bill rate is taken to be exogenous. The results for real GDP and the private nonfarm price deflator are presented in Table 11.14. Both the anticipated and unanticipated results are the same for Version 1 because future predicted values do not affect current predicted values—Version 1 is not forward looking in this sense.

The results for each experiment were obtained as follows. The version was first solved using the actual values of all exogenous variables. These solution values are the "base" values. The policy variable was then changed and the version was solved again. The difference between the predicted value of a variable from this solution and the predicted value from the first solution is the estimate of the response of the variable to the policy change.

Before discussing the results, it should be noted that the experiments were performed without concern about possible wrong signs of the coefficient estimates of the led values. Although not shown in Tables 5.1–5.30, not all signs for the led values were what one might expect. The aim of the exercise in this section is not to test theories, but to see how much difference the addition of the led values makes to a model's properties, regardless of what their coefficient estimates might be. It may be that other theories would imply different signs, and so this section has remained agnostic about the signs. Likewise, no concern was given as to whether the led values were statistically significant or not. Aside from the exceptions mentioned above, all the equations estimated using Leads +8 in Chapter 5 were used regardless of the significance levels of the led values.

The results are presented in Table 11.14. Consider first the results for the unanticipated government spending increase. For this case Version 2 has slightly higher multipliers than Version 1. The three quarter ahead multiplier is 2.11 for Version 2 versus 1.70 for Version 1. Although not shown in the table, the sum of the output increases over the 12 quarters is $117 billion for Version 1 and $139 billion for Version 2. The effects on real GDP are thus fairly similar for Versions 1 and 2 for the unanticipated case, with Version 2 being slightly more expansionary.

For the anticipated spending increase the changes in real GDP for the first six quarters after the announcement are negative for Version 2, but the changes are noticeably larger than in the unanticipated case once the policy action is taken in 1970:1. Although not shown in the table, the sum of the output increases over the 20 quarters is $115 billion, which is very close to the $117 billion for Version 1. The reason the output increases are negative for the first few quarters after the announcement for Version 2 has to do with the investment equation 12. Although not shown in Table 5.12, the coefficient estimates for the future output changes are negative for the Leads +8 results. The initial changes in investment are thus negative because of the positive future output changes, and this effect is large enough to make the initial changes in output negative. It is not necessarily sensible, of course, for current investment to be a negative function of future output, but, as discussed above, the point of this section is not to worry about signs.

The results for the price deflator for the COG increase parallel fairly closely those for output, which is as expected since output appears in the demand pressure variable in the price equation 10.

The differences between the two versions are also fairly modest for the bill rate decrease. These results are presented in the second half of Table 11.14. Again, the largest differences occur for the anticipated case, where there is about a year's delay after the change in the bill rate is implemented before positive effects on output begin to appear. Also, the output increases are smaller for the rest of the horizon in the anticipated versus unanticipated case.

Overall, the results in Table 11.14 show fairly modest differences in the policy properties of the model from the addition of the led values.[16] This conclusion is perhaps not surprising given the results in Chapter 5. With the exception of three household expenditure equations, most of the led values in Chapter 5 are not significant, and so one would not expect them to contribute in important ways to the properties of the model.

11.7 Is Monetary Policy Becoming Less Effective?[17]

It is well known that the federal government debt as a percent of GDP has risen substantially since 1980. For example, $-AG$, which is the federal government debt variable in the model, rose as a percent of GDP from 16.9 in 1980:1 to 45.5 in 1993:2.[18] (Remember that AG is the value of net financial assets of the federal government. It is negative because the federal government is a net debtor. For ease of exposition, $-AG$ will be referred to as the government debt.) Much of this increase in the government debt was financed by U.S. households, which is an increase in AH in the model.

One consequence of the increasing size of the government debt is that the size of the income effect of interest rate changes on demand is increasing relative to the size of the substitution effect. The larger is the debt, the larger is the change in interest payments of the government ($INTG$) (and thus the interest receipts of those holding the debt) for a given change in interest rates. This means, for example, that household income (YD), which includes interest receipts, is falling more over time for a given fall in interest rates because of

[16]The results in Table 11.14 are similar to those in Table 2 in Fair (1993b) based on earlier data and estimates. The main difference is that the differences between Versions 1 and 2 for the bill rate decrease are somewhat larger in Table 2 than in Table 11.14. The same general conclusion, however, is drawn from both sets of results.

[17]The material in this section is taken from Fair (1994b).

[18]For these calculations GDP is taken to be at an annual rate, which means that it is multiplied by four from the variable in the model.

the increasing holdings of government debt by households. A fall in income from a fall in interest rates has a negative effect on demand, which offsets at least some of the positive substitution effect. The ability of the Federal Reserve to, say, stimulate the economy by lowering interest rates may thus be decreasing over time due to the increasing size of the income effect relative to the substitution effect. The purpose of this section is to try to estimate how large this decrease in the effectiveness of monetary policy has been since 1980.

The US model is used to examine this question. The model is first used to estimate what the economy would have been like between 1980 and 1990 had the federal government debt not risen so much. Call this economy the "alternative" economy. The model is then used to run the same monetary-policy experiment for both the actual and alternative economies. The difference in results for the two economies is an estimate of how much the effectiveness has been changed as a result of the rise in the government debt.

An alternative procedure to that followed here would simply be to run the monetary-policy experiment for an earlier period when the government debt was not as large and compare these results to those for a later period. The problem with this procedure, however, is that other things would be different as well between the two periods, and it would not be clear how much of the difference in results to attribute to government debt differences as opposed to other differences. The procedure used here controls better for other differences.

The Alternative Economy

In creating the alternative economy the aim was to raise the personal income tax rate ($D1G$) to generate more tax revenue and thus lower the deficit from its historical path while at the same time lowering the bill rate (RS) to keep real GDP ($GDPR$) roughly unchanged from its historical path. For this work equation 30, the interest rate reaction function, was dropped from the model so that RS could be treated as an exogenous policy variable. The beginning quarter for the changes was 1980:1, and the changes were sustained through 1990:4.

The residuals from the estimation of the stochastic equations were first added to the equations and taken as exogenous.[19] This results in a perfect tracking solution when the actual values of the exogenous variables are used. Then various paths of $D1G$ and RS were tried. It turned out that a sustained

[19] Adding the estimated residuals to the equations before solving the model assumes that the shocks that occurred in the actual economy also occur in the alternative economy. The two economies have the same shocks, but different values of $D1G$ and RS.

Table 11.15
Comparison of the Actual and Alternative Economies

		$-SGP$			$-AG$			AH	
Quar.	Alt.	Act.	Dif.	Alt.	Act.	Dif.	Alt.	Act.	Dif.
1980:1	3.9	9.3	-5.4	440.2	446.7	-6.5	2346.9	2312.7	34.2
1980:2	10.0	15.4	-5.5	451.9	464.7	-12.8	2530.5	2496.2	34.3
1980:3	12.5	18.4	-5.9	471.0	489.9	-18.9	2673.1	2634.8	38.3
1980:4	10.3	16.9	-6.6	475.5	501.4	-26.0	2782.9	2743.0	39.9
1981:1	3.1	10.5	-7.5	490.7	524.4	-33.7	2802.7	2763.6	39.1
1981:2	4.4	12.5	-8.1	491.3	533.5	-42.2	2826.5	2789.7	36.8
1981:3	5.1	14.0	-8.9	497.7	549.3	-51.5	2697.5	2664.7	32.8
1981:4	12.1	21.6	-9.5	514.0	575.2	-61.2	2826.6	2799.1	27.5
1982:1	14.7	24.8	-10.0	539.6	611.3	-71.6	2745.6	2724.6	20.9
1982:2	17.5	28.1	-10.6	552.8	635.4	-82.6	2764.3	2750.5	13.9
1982:3	25.7	36.8	-11.1	589.0	682.9	-93.9	2883.0	2877.2	5.7
1982:4	34.6	45.9	-11.3	620.2	725.8	-105.7	3049.5	3052.6	-3.1
1983:1	33.1	44.8	-11.7	670.0	787.4	-117.5	3204.6	3217.1	-12.5
1983:2	30.0	42.2	-12.2	707.3	837.1	-129.8	3388.9	3411.3	-22.4
1983:3	34.0	46.9	-12.9	730.2	873.3	-143.1	3411.8	3444.6	-32.8
1983:4	32.6	46.1	-13.6	743.1	900.1	-157.0	3343.5	3386.9	-43.3
1984:1	26.6	40.9	-14.3	783.8	955.4	-171.6	3315.4	3370.9	-55.5
1984:2	23.5	38.4	-14.9	811.3	997.9	-186.6	3319.7	3386.6	-67.0
1984:3	25.3	40.9	-15.6	850.3	1052.8	-202.5	3440.0	3519.2	-79.2
1984:4	30.5	46.6	-16.2	869.9	1088.9	-218.9	3442.1	3534.4	-92.4
1985:1	21.0	37.5	-16.5	898.4	1134.5	-236.1	3613.7	3719.4	-105.7
1985:2	34.5	51.6	-17.1	933.5	1187.2	-253.8	3726.3	3845.5	-119.2
1985:3	28.1	45.5	-17.4	963.0	1234.2	-271.2	3656.0	3789.8	-133.8
1985:4	28.9	46.8	-17.9	1010.6	1299.9	-289.2	3913.0	4060.8	-147.7
1986:1	27.4	45.8	-18.5	1044.8	1353.1	-308.3	4152.5	4315.1	-162.6
1986:2	37.0	56.0	-18.9	1087.8	1415.3	-327.6	4250.5	4428.7	-178.2
1986:3	35.7	54.9	-19.2	1124.6	1471.8	-347.2	4119.0	4312.4	-193.3
1986:4	24.8	44.4	-19.6	1144.5	1512.0	-367.5	4244.1	4454.2	-210.1
1987:1	27.4	47.4	-20.0	1167.0	1554.5	-387.5	4678.4	4903.2	-224.7
1987:2	12.1	32.5	-20.4	1179.4	1587.3	-407.9	4710.4	4950.6	-240.2
1987:3	12.4	33.6	-21.2	1196.3	1625.7	-429.5	4245.0	4501.0	-256.0
1987:4	16.1	38.2	-22.1	1205.5	1657.1	-451.6	4231.3	4503.6	-272.2
1988:1	17.0	39.4	-22.4	1237.1	1711.3	-474.2	4336.8	4625.6	-288.8
1988:2	10.5	33.6	-23.1	1255.3	1752.9	-497.5	4425.4	4731.4	-306.0
1988:3	6.1	29.9	-23.8	1278.2	1799.7	-521.5	4407.9	4731.0	-323.2
1988:4	9.3	33.8	-24.5	1293.6	1839.7	-546.1	4475.2	4816.0	-340.8
1989:1	2.1	27.5	-25.4	1305.6	1877.2	-571.6	4581.5	4940.6	-359.1
1989:2	1.4	27.4	-26.0	1328.5	1926.5	-598.0	4874.9	5251.7	-376.8
1989:3	5.9	32.0	-26.1	1357.3	1981.2	-624.0	5020.1	5414.9	-394.8
1989:4	8.5	35.4	-26.8	1376.0	2027.1	-651.1	5044.8	5458.3	-413.6
1990:1	14.2	41.6	-27.5	1395.4	2074.4	-679.0	5045.5	5477.8	-432.3
1990:2	9.8	38.0	-28.2	1401.8	2109.5	-707.8	5149.4	5601.7	-452.2
1990:3	7.1	36.2	-29.1	1405.0	2141.9	-737.0	4822.3	5294.8	-472.5
1990:4	18.9	47.8	-28.8	1414.3	2180.5	-766.2	5125.8	5617.4	-491.5

increase in $D1G$ of 1 percentage point and a sustained decrease in RS of 2 percentage points over the 1980:1–1990:4 period led to little change in $GDPR$ from the base path and a substantial decrease in the deficit (and thus the debt).

Table 11.15 (continued)

	INTG			*SH*			*GDPR*		
Quar.	Alt.	Act.	Dif.	Alt.	Act.	Dif.	Alt.	Act.	Dif.
1980:1	11.5	12.5	-1.0	18.6	23.7	-5.1	940.2	942.4	-2.2
1980:2	12.1	13.3	-1.3	29.2	34.5	-5.3	917.5	920.6	-3.0
1980:3	11.6	13.1	-1.5	26.7	32.8	-6.1	919.0	921.4	-2.4
1980:4	12.0	13.8	-1.8	27.0	34.0	-7.0	938.2	939.3	-1.1
1981:1	14.4	16.7	-2.3	23.1	31.0	-7.9	956.7	956.4	.3
1981:2	14.6	17.2	-2.6	25.2	33.8	-8.6	953.5	952.0	1.5
1981:3	15.2	18.3	-3.1	32.2	41.5	-9.3	962.5	960.0	2.5
1981:4	15.9	19.5	-3.6	38.1	48.0	-9.9	950.6	947.5	3.2
1982:1	16.1	20.1	-4.0	38.1	48.4	-10.3	937.4	933.8	3.5
1982:2	16.3	20.9	-4.5	43.3	54.1	-10.8	941.0	937.5	3.6
1982:3	16.8	21.8	-5.0	41.3	52.4	-11.1	933.0	929.6	3.4
1982:4	16.4	21.7	-5.3	37.7	49.1	-11.3	931.9	928.8	3.1
1983:1	16.1	21.8	-5.7	37.2	48.6	-11.4	941.4	938.6	2.8
1983:2	16.2	22.4	-6.2	26.5	38.3	-11.8	964.5	962.0	2.5
1983:3	17.0	23.8	-6.8	24.5	36.6	-12.2	979.2	977.0	2.2
1983:4	17.4	24.8	-7.4	23.3	35.9	-12.6	996.1	994.2	1.9
1984:1	18.3	26.3	-8.0	27.9	40.7	-12.9	1020.2	1018.6	1.6
1984:2	18.4	26.9	-8.5	28.1	41.4	-13.2	1036.3	1034.9	1.4
1984:3	20.0	29.4	-9.4	31.7	45.5	-13.8	1044.2	1043.2	.9
1984:4	20.6	30.6	-10.0	26.8	40.9	-14.1	1048.4	1048.0	.4
1985:1	20.6	31.1	-10.5	16.4	30.3	-14.0	1056.9	1056.9	.0
1985:2	20.9	31.9	-11.0	35.2	49.6	-14.4	1062.9	1063.2	-.2
1985:3	20.4	31.7	-11.3	13.4	27.8	-14.4	1075.9	1076.3	-.4
1985:4	20.5	32.3	-11.8	19.6	34.3	-14.6	1082.3	1082.8	-.4
1986:1	20.4	32.7	-12.3	21.6	36.3	-14.7	1096.2	1096.7	-.5
1986:2	20.3	33.0	-12.7	26.4	41.5	-15.0	1094.8	1095.2	-.4
1986:3	19.6	32.5	-12.9	11.3	26.3	-15.0	1103.1	1103.4	-.3
1986:4	19.4	32.8	-13.3	12.0	27.2	-15.2	1106.1	1106.3	-.2
1987:1	19.3	33.0	-13.7	15.0	30.2	-15.2	1115.4	1115.5	.0
1987:2	19.2	33.4	-14.2	-5.6	9.7	-15.3	1129.7	1129.4	.3
1987:3	19.5	34.4	-14.8	-2.2	13.6	-15.8	1139.3	1138.8	.5
1987:4	20.2	35.8	-15.6	10.1	26.3	-16.3	1156.3	1155.7	.6
1988:1	19.2	34.9	-15.7	9.8	26.0	-16.3	1164.5	1163.8	.6
1988:2	19.8	36.3	-16.4	9.0	25.8	-16.7	1176.8	1176.2	.6
1988:3	20.0	37.0	-17.0	9.8	27.0	-17.2	1184.1	1183.6	.5
1988:4	20.2	37.8	-17.6	10.8	28.3	-17.5	1195.3	1194.9	.4
1989:1	21.3	40.0	-18.6	11.1	29.3	-18.1	1204.4	1204.4	.0
1989:2	22.0	41.5	-19.4	4.2	22.5	-18.3	1209.4	1209.8	-.3
1989:3	21.4	41.1	-19.7	7.9	26.3	-18.4	1209.1	1209.8	-.6
1989:4	21.8	42.2	-20.4	14.0	32.7	-18.7	1213.3	1214.2	-.9
1990:1	21.9	42.9	-21.0	13.6	32.6	-19.0	1223.5	1224.6	-1.1
1990:2	22.4	44.2	-21.8	17.9	37.5	-19.5	1228.0	1229.3	-1.2
1990:3	23.0	45.8	-22.7	17.4	37.2	-19.8	1225.2	1226.6	-1.5
1990:4	21.2	43.6	-22.4	28.4	47.8	-19.4	1215.3	1216.8	-1.5

Units are billions of 1987 dollars for real GDP and billions of current dollars for the others. The flow variables are at quarterly rates.

The actual value of the bill rate ranged between 5.3 and 15.1 percent during this period, and so the lowest value of the bill rate was 3.3 percent for this simulation.[20]

The actual and predicted values of six variables from this simulation are presented in Table 11.15. The six variables are the federal government deficit ($-SGP$), the federal government debt ($-AG$), net financial assets of the household sector (AH), interest payments of the federal government ($INTG$), household saving (SH), and real GDP ($GDPR$). Remember that the deficit, interest payments, and household saving variables are at quarterly rates in billions of current dollars, and real GDP is at a quarterly rate in billions of 1987 dollars. The variables $-AG$ and AH are stock variables in billions of current dollars.

Table 11.15 shows that by the end of the simulation period the federal debt was $766.2 billion less than the actual (historical) value. The federal deficit was $28.8 billion less at a quarterly rate, which at an annual rate is $115.2 billion. The level of federal interest payments was $22.4 billion less. Household saving was $19.4 billion less, which was caused in part by the lower interest rates. The level of net financial assets of the household sector was $491.5 billion less by the end of the simulation period, which was due to the lower past levels of household saving. Therefore, as expected, raising the personal tax rate and lowering the bill rate led to less government dissaving and less household saving. Note that the real GDP path is similar to the actual path, which was the aim of the simulation.

Although not shown in Table 11.15, nonresidential fixed investment of the firm sector (IKF) is higher in the alternative economy than the actual economy. In equation 12 IKF depends positively on output and negatively on the bond rate. Output is roughly the same in both economies, but the bond rate is lower in the alternative economy, and so investment is higher in the alternative economy. In 1990:4 nonresidential fixed investment was 1.8 percent higher in the alternative economy than the actual economy. More investment means a larger capital stock (KK), and by 1990:4 KK was 3.0 percent higher in the alternative economy. Thus, as expected, lower interest rates with output held constant led to more private investment.

The results in Table 11.15 are interesting in their own right in that they show that a 1 percentage point increase in the average personal income tax rate

[20] Although the data used in this book go through 1993:2, the simulation period used in this section was taken to end in 1990:4. By the end of 1992 the actual value of the bill rate was down to 3.0 percent, and a 2 percentage point drop in the bill rate would have lowered it to 1.0 percent, which is extremely low by historical standards. I am reluctant to push the model into values that are too far outside the range used in the estimation, and this is the reason for stopping in 1990:4.

and a 2 percentage point decrease in the bill rate beginning in 1980:1 would have remarkably changed the debt structure of the U.S. economy by the end of the 1980s while having only trivial effects on real GDP.

The Monetary-Policy Experiment

Given the alternative economy, the next step is to run a monetary-policy experiment for the two economies and compare the results. The monetary-policy experiment is a sustained decrease in the bill rate of 1 percentage point beginning in 1987.1. The experiment runs through 1990:4, for a total of 16 quarters.[21] For these experiments the residuals were added to the stochastic equations and taken to be exogenous. This means that when the model is solved using the actual values of the exogenous variables, a perfect tracking solution results. The actual values are thus the "base" values. For the alternative economy the "actual" values of the bill rate and $D1G$ are the values relevant for this economy, and the perfect tracking solution is the solution that reproduces the data for this economy. The residuals are the same for both economies. For each experiment the bill rate was lowered by 1 percentage point in each of the 16 quarters and the model solved.[22] A comparison of the results for the two economies is presented in Table 11.16 for selected variables. The sum of the changes across the 16 quarters is presented for some of the variables, which is a useful summary statistic.

The results in Table 11.16 show that government interest payments fell more in the actual than in the alternative economy—$51.9 billion versus $34.9 billion over the 16 quarters. This resulted in a larger fall in disposable income in the actual economy—$19.4 billion versus $3.6 billion. The (negative) effect from the fall in income is thus larger in the actual economy, which resulted in less household demand and thus smaller real GDP increases. The increase in real GDP over the 16 quarters is $60.1 billion in the actual economy versus $68.1 billion in the alternative economy, a difference of 13.3 percent. It is also the case, however, that the difference between the real GDP increases in Table 11.16 grows larger as the number of quarters ahead increases. By the 16th quarter the change in real GDP from the base value is .35 percent in the alternative economy compared to .27 percent in the actual economy, a difference of 29.6 percent. Note finally from Table 11.16 that the government

[21] The smallest value of the bill rate for these experiments was 2.5 percent in 1987:1 for the alternative economy.

[22] The experiment for the actual economy is the same as the one done for the results in Table 11.2 except that the starting quarter here is 1987:1 as opposed to 1989:3 in Table 11.2.

Table 11.16
Estimated Multipliers in the Actual and Alternative Economies for a Decrease in the Bill Rate of One Percentage Point

		Number of Quarters Ahead							
		1	2	3	4	8	12	16	Sum
				$GDPR$: Real GDP					
$RS \downarrow$	Act.	-.01	.05	.15	.25	.47	.38	.27	60.1
	Alt.	-.00	.06	.17	.27	.51	.44	.35	68.1
				PF: Price Deflator					
$RS \downarrow$	Act.	.00	.00	.00	.02	.16	.30	.33	–
	Alt.	.00	.00	.01	.02	.18	.35	.38	–
				$INTG$: Federal Government Interest Payments					
$RS \downarrow$	Act.	-1.4	-1.6	-1.7	-1.9	-2.9	-4.2	-5.6	-51.9
	Alt.	-1.1	-1.1	-1.2	-1.3	-2.0	-2.8	-3.6	-34.9
				YD: Disposable Personal Income					
$RS \downarrow$	Act.	-2.0	-1.9	-1.8	-1.4	-.3	-.9	-2.3	-19.4
	Alt.	-1.7	-1.6	-1.4	-1.0	.5	.5	-.4	-3.6
				$-SGP$: Federal Government Deficit					
$RS \downarrow$	Act.	-1.4	-1.6	-2.1	-2.6	-4.4	-5.6	-6.5	-68.9
	Alt.	-1.1	-1.3	-1.8	-2.2	-3.8	-4.7	-5.1	-57.4

Act. = Actual economy.
Alt. = Alternative economy.
Sum = Sum of the effects across the 16 quarters.

Values are percentage changes (in percentage points) from the base values for $GDPR$ and PF and absolute changes (in billions of current dollars at a quarterly rate) from the base values for the others.

deficit decreases more in the actual economy than in the alternative economy. This is primarily due to the larger drop in government interest payments in the actual economy.

Two Other Alternative Economies

To examine the robustness of the results to the use of different fiscal-policy tools to generate the alternative economy, two other alternative economies were generated. For the first the level of transfer payments from the federal government to households ($TRGH$) was cut, and for the second the level of government purchases of goods (COG) was cut. These cuts replaced the income tax increase. The bill rate change in both cases was as above, namely a decrease of 2 percentage points in the bill rate from its base value each quarter.

For the first of the two other alternative economies, the level of transfer payments was decreased each quarter from its base value by 1 percent of the historical value of taxable income (YT). This decrease is comparable in size to the 1 percentage point increase in the average personal income tax rate above. The quarterly decreases ranged from $4.8 to $11.6 billion at quarterly rates. As seen in Table 11.1, changing the level of transfer payments in the model has very similar effects to changing the personal income tax rate, and the results using transfer-payment decreases were quite similar to those using tax-rate increases. Real GDP in the alternative economy was little changed from that in the actual economy; the government debt was much less; and the level of net financial assets of the household sector was much less. The results for the monetary-policy experiment were very similar to those in Table 11.16 for the alternative economy. The sum of the real GDP increases across the 16 quarters was $68.5 billion, which compares to $68.1 billion in Table 11.16, and the change in the 16th quarter was .35, which is the same as in Table 11.16. The same conclusions clearly hold when transfer-payment decreases replace tax-rate increases.

For the second of the two other alternative economies, the level of government purchases of goods was decreased each quarter by exactly the amount needed to keep real GDP unchanged from its base value. As also seen in Table 11.1, changing government purchases of goods has more of an impact on GDP in the model than does changing transfer payments or changing personal tax rates. Therefore, the decrease in expenditures on goods needed to keep real GDP unchanged in light of the bill rate decrease was less than the decrease in transfer payments needed or the increase in personal taxes needed. The federal government deficit thus decreased less in this case, and so the government debt decreased less. In 1990:4 the government debt was $593.3 billion lower than in the actual economy, which compares to $766.2 billion in Table 11.15. The level of household net financial assets was $426.6 billion lower than in the actual economy in 1990:4, which compares to $491.5 billion in Table 11.15.

The results for the monetary-policy experiment in this second case were similar to those in Table 11.16 for the alternative economy. The sum of the real GDP increases across the 16 quarters was $67.2 billion. This is 11.8 percent more than in the actual economy, which compares to 13.3 percent more in Table 11.16. The change in the 16th quarter was .33. This is 22.2 percent more than in the actual economy, which compares to 29.6 percent more in Table 11.16. These slightly smaller percentages are as expected, since the alternative economy in the current case has a larger government debt (and a smaller level of household net financial assets) than does the alternative economy used for the results in Table 11.16. The differences are, however, fairly modest, and the same basic conclusion holds here as holds in the other two cases.

Conclusion

The results in Table 11.15 show that the financial asset and liability structure of the U.S. economy would have been considerably different by 1990 had the average personal income tax rate been 1 percentage point higher and the bill rate 2 percentage points lower beginning in 1980. The government would have dissaved less and the household sector would have saved less, resulting in a substantially lower government debt by 1990 and a substantially smaller level of net financial assets of the household sector.

The results in Table 11.16 show that the effectiveness of monetary policy in changing real GDP is between about 13 and 30 percent less, depending on the measure used, in the actual economy than it would be if the economy were instead the alternative economy in Table 11.15. A similar conclusion is reached for two other alternative economies, one generated by cutting transfer payments instead of increasing taxes and one generated by cutting government purchases of goods instead of increasing taxes.

11.8 What if the Fed had Behaved Differently in 1978 and 1990?

As discussed in Section 10.6, one can use a model to ask what the economy would have been like had some government policy been different. For example, an interesting question to consider is what the economy would have been like had the Fed not had such a tight monetary policy during the 1978–1983 period. This question was examined using the US model. The 1978:3–1983:4 period was considered. Equation 30 was dropped from the model, and the estimated residuals were added to the other stochastic equations and taken to be exogenous. The bill rate was then taken to be equal to its 1978:2 value (6.48) for each quarter of the period and the model was solved for this set of values. The solution values from this simulation are estimates of what the economy would have been like had the Fed not tightened and had the same shocks (estimated residuals) occurred. The results are presented in Table 11.17. (The differences for $GDPR$ and PF in the table are percentage differences rather than absolute differences.) The first thing to note from the table is that the bill

Table 11.17
Estimated Economy if the Fed had not Raised Interest Rates in 1978:3–1983:4

	RS			*GDPR*			*PF*		
Quar.	Est.	Act.	Dif.	Est.	Act.	Pdif.	Est.	Act.	Pdif.
1978:3	6.48	7.32	-.83	915.7	915.7	.00	.563	.563	.00
1978:4	6.48	8.68	-2.20	928.0	927.4	.06	.575	.575	.00
1979:1	6.48	9.36	-2.88	931.0	928.5	.27	.586	.586	.01
1979:2	6.48	9.37	-2.89	933.5	927.9	.60	.601	.601	.03
1979:3	6.48	9.63	-3.15	944.8	935.9	.95	.616	.616	.08
1979:4	6.48	11.80	-5.32	950.5	938.4	1.28	.628	.627	.17
1980:1	6.48	13.46	-6.98	958.6	942.4	1.72	.647	.645	.28
1980:2	6.48	10.05	-3.57	941.9	920.6	2.32	.662	.659	.43
1980:3	6.48	9.24	-2.75	945.6	921.4	2.63	.675	.671	.55
1980:4	6.48	13.71	-7.23	963.7	939.3	2.60	.690	.685	.68
1981:1	6.48	14.37	-7.89	982.4	956.4	2.71	.708	.702	.83
1981:2	6.48	14.83	-8.35	981.0	952.0	3.05	.723	.716	1.01
1981:3	6.48	15.09	-8.61	992.6	960.0	3.40	.741	.733	1.17
1981:4	6.48	12.02	-5.54	983.1	947.5	3.76	.757	.747	1.36
1982:1	6.48	12.89	-6.41	970.0	933.8	3.87	.769	.757	1.50
1982:2	6.48	12.36	-5.88	972.8	937.5	3.76	.778	.766	1.59
1982:3	6.48	9.71	-3.22	962.8	929.6	3.58	.788	.775	1.67
1982:4	6.48	7.93	-1.45	958.2	928.8	3.17	.797	.784	1.71
1983:1	6.48	8.08	-1.60	961.8	938.6	2.48	.803	.790	1.72
1983:2	6.48	8.42	-1.94	978.2	962.0	1.68	.808	.794	1.70
1983:3	6.48	9.19	-2.71	986.7	977.0	.99	.815	.802	1.67
1983:4	6.48	8.79	-2.31	999.3	994.2	.51	.824	.811	1.60

	UR			$-SGP$		
Quar.	Est.	Act.	Dif.	Est.	Act.	Dif.
1978:3	6.02	6.02	.00	5.1	5.5	-.4
1978:4	5.86	5.88	-.01	3.4	4.5	-1.1
1979:1	5.79	5.87	-.08	.6	2.3	-1.7
1979:2	5.51	5.71	-.20	-.7	1.7	-2.4
1979:3	5.46	5.86	-.40	1.6	4.8	-3.3
1979:4	5.32	5.93	-.61	1.9	6.9	-5.0
1980:1	5.45	6.29	-.84	2.0	9.3	-7.3
1980:2	6.25	7.32	-1.06	8.3	15.4	-7.1
1980:3	6.42	7.68	-1.25	10.4	18.4	-8.0
1980:4	6.06	7.39	-1.33	6.1	16.9	-10.8
1981:1	6.00	7.42	-1.42	-2.3	10.5	-12.8
1981:2	5.84	7.39	-1.55	-1.5	12.5	-14.0
1981:3	5.76	7.41	-1.65	-2.3	14.0	-16.3
1981:4	6.49	8.23	-1.75	5.5	21.6	-16.1
1982:1	7.03	8.84	-1.81	7.2	24.8	-17.5
1982:2	7.59	9.42	-1.83	9.9	28.1	-18.2
1982:3	8.13	9.94	-1.80	19.3	36.8	-17.5
1982:4	9.05	10.67	-1.62	29.8	45.9	-16.1
1983:1	9.07	10.39	-1.32	29.5	44.8	-15.3
1983:2	9.14	10.10	-.96	27.4	42.2	-14.8
1983:3	8.70	9.35	-.66	32.4	46.9	-14.5
1983:4	8.25	8.53	-.28	32.4	46.1	-13.7

Dif. = Est. − Act.
Pdif. = 100[(Est. − Act.)/Act. − 1].

Table 11.18
Estimated Economy if the Fed had Lowered Interest Rates in 1990:3–1993:2

	RS			$GDPR$			PF		
Quar.	Est.	Act.	Dif.	Est.	Act.	Pdif.	Est.	Act.	Pdif.
1990:3	3.00	7.49	-4.49	1226.3	1226.6	-.02	1.031	1.031	.00
1990:4	3.00	7.02	-4.02	1219.5	1216.8	.22	1.041	1.041	.00
1991:1	3.00	6.05	-3.05	1217.1	1209.5	.64	1.051	1.051	.01
1991:2	3.00	5.59	-2.59	1226.1	1213.9	1.00	1.059	1.058	.05
1991:3	3.00	5.41	-2.41	1233.3	1218.2	1.24	1.066	1.065	.10
1991:4	3.00	4.58	-1.58	1236.7	1219.9	1.38	1.072	1.071	.16
1992:1	3.00	3.91	-.91	1247.3	1230.5	1.36	1.083	1.080	.23
1992:2	3.00	3.72	-.72	1254.1	1239.1	1.21	1.092	1.089	.29
1992:3	3.00	3.13	-.13	1261.7	1249.5	.97	1.096	1.092	.35
1992:4	3.00	3.08	-.08	1275.6	1267.1	.67	1.105	1.101	.39
1993:1	3.00	2.99	.01	1274.3	1269.5	.37	1.115	1.110	.41
1993:2	3.00	2.98	.02	1276.7	1275.5	.09	1.120	1.116	.41

	UR			$-SGP$		
Quar.	Est.	Act.	Dif.	Est.	Act.	Dif.
1990:3	5.58	5.57	.01	28.1	36.2	-8.1
1990:4	5.94	5.99	-.05	39.1	47.8	-8.7
1991:1	6.32	6.50	-.19	27.3	36.3	-9.0
1991:2	6.38	6.73	-.34	41.4	51.5	-10.1
1991:3	6.26	6.74	-.48	43.0	54.4	-11.5
1991:4	6.41	6.99	-.58	50.1	61.2	-11.1
1992:1	6.62	7.26	-.64	57.1	67.6	-10.5
1992:2	6.85	7.47	-.62	59.8	70.0	-10.2
1992:3	7.00	7.54	-.54	63.9	72.7	-8.7
1992:4	6.90	7.32	-.42	58.0	66.0	-8.1
1993:1	6.74	7.01	-.27	58.8	65.9	-7.1
1993:2	6.85	6.96	-.11	49.3	55.7	-6.4

See notes to Table 11.17.

rate value of 6.48 is much lower than the actual rates that occurred. The actual bill rate peaked at 15.1 percent in 1981:3.

The results in Table 11.17 show, as expected, that output would have been higher, the unemployment rate lower, and the price level higher had the Fed not tightened. By the end of the period the price level would have been 1.6 percent higher. In 1981 and 1982 output would have been over 3 percent higher and the unemployment rate would have been over 1.5 percentage points lower. Whether this is a policy that one thinks should have been followed depends on the weights that one attaches to the price level and output. Is the gain of the added output greater than the loss of a higher price level? Remember that in using the US model to consider this question the data do not discriminate well among alternative forms of the demand pressure variable. At some point the price level is likely to rise rapidly as output increases, and this point cannot be pinned down. Therefore, one has to be cautious in using the model to consider tradeoffs between output and the price level. Having said this, however, the experiment in Table 11.17 does not push the economy into extreme output ranges, and so the tradeoff estimates in this case may not be too bad. If the tradeoff estimates are to be trusted, they suggest that one would really have to hate higher prices not to think that the Fed overdid it a bit during this period.

Another interesting period to consider is the period starting with the recession of 1990–1991, where there was a recession followed by sluggish growth. The question examined here is what this period would have been like had the Fed lowered the bill rate to 3.0 percent right at the beginning of the recession (in 1990:3) and kept it there. This contrasts to its actual behavior, where it lowered the bill rate gradually, only reaching 3.0 percent by the end of 1992. The 1990:3–1993:2 period was considered. Again, equation 30 was dropped from the model, and the estimated residuals were added to the other stochastic equations and taken to be exogenous. The bill rate was then taken to be equal to 3.0 for each quarter of the period and the model was solved for this set of values. The solution values from this simulation are estimates of what the economy would have been like had the Fed kept the bill rate at 3.0 percent and had the same shocks (estimated residuals) occurred. The results are presented in Table 11.18. The format of this table is the same as that of Table 11.17.

Again, as expected, the results show that output would have been higher, the unemployment rate lower, and the price level higher had the bill rate been 3.0 percent. At the peak difference the unemployment rate is .6 percentage points lower and output is 1.4 percent higher. The price level at the end is .4 percent higher. These results thus suggest that had the Fed followed this policy it could not have completely eliminated the sluggish growth that occurred during this period.