A Fiscal Policy Rule for Stabilization

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Abstract

A tax rate rule for stabilization purposes is proposed in this paper. Stochastic simulation results suggest that this rule would be a considerable help to monetary policy in its stabilization effort.

1 Introduction

Most people would agree that it is the Federal Reserve's responsibility to try to stabilize the U.S. economy. Congress passes, say, a five-year budget plan, where paths of tax rates, entitlement rates, and discretionary spending items are chosen, and monetary policy is left with the job of adjusting to shocks. There are, of course, stabilization features of the budget plan—the automatic stabilizers. Tax payments rise and fall as income rises and falls, and some expenditure items rise and fall as income falls and rises. But these stabilizers only go part way toward smoothing out fluctuations due to shocks, and so monetary policy is left with much of the work.

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Most people would also agree that the economy responds to monetary policy changes with a lag, where the peak effect may be more than a year after a change. This makes monetary policy a less than perfect tool for stabilization purposes. Also, the size of the effect of a given monetary policy change may be smaller now than it used to be because of the large federal government debt. A large federal government debt, much of it owned by U.S. households, means that income changes from a change in interest rates are large, and the positive income effects on spending run counter to the negative substitution effects.[1] The net effect of a given change in interest rates on, say, real output is thus smaller than it used to be because of the now larger income effect. Section 3 provides estimates of the current ability of monetary policy to stabilize the economy assuming no help from fiscal policy except from the automatic stabilizers. It will be seen that much is left to be stabilized.

The main idea of this paper is to propose a fiscal policy rule that would help monetary policy in its stabilization effort. A tax rate rule is proposed, where a particular tax rate or set of rates would be automatically adjusted each quarter as a function of the state of the economy. Congress would vote on the parameters of the tax rate rule as it was voting on the general budget plan, and the tax rate or set of rates would then become another automatic stabilizer.

Which tax rate or rates? There are many rates that can be quickly eliminated. Income tax rates do not seem good because of the administrative costs of changing withholding rates frequently and of the increased difficulty of filling out tax returns at the end of the year if rates changed within the year. One would also not want to use

[1]See Fair (1994), pp. 320-328, for a discussion of this.

tax rates or expenditure items that are closely tied to social policy regarding income distribution. For example, programs aimed at helping people at the low end of the income distribution or at the low and high ends of the age distribution are not good candidates for stabilization tools. Also, for obvious reasons, defense expenditures are not good candidates. Finally, sin tax rates are not good candidates because there seems little reason to want the spending distortions caused by these tax rates to fluctuate cyclically.

Having eliminated much of the federal budget as possibilities for the rule, the main items left are indirect business tax (IBT) rates. Consider, for example, the federal gasoline tax rate. If the short run demand for gasoline is fairly price inelastic, a change in the after-tax price at the pump will have only a small effect on the number of gallons purchased. In this case a change in the gasoline tax rate is like a change in after-tax income. Another possibility would be a national sales tax if such a tax existed. If the sales tax were broad enough, a change in the sales tax rate would also be like a change in after-tax income.

For the experiments below a constructed federal IBT rate based on data from the national income and product accounts is used for the tax rate rule. In practice a specific tax rate or rates, such as the gasoline tax rate, would have to be used, and this would be decided by the political process. The tax rate rule is presented in Section 4, and the results show that this rule would help monetary policy in its stabilization efforts.

Regarding stabilization rules, the previous literature has focused almost exclusively on monetary policy rules.[2] There are, of course, textbook discussions of automatic stabilizers. Also, there was much discussion many years ago (about the time of the Kennedy administration) of using fiscal policy, such as investment tax credits, to try to stimulate the economy. I have been unable to find in the literature, however, tax rate rules of the kind proposed in this paper.

As is the case in the literature on monetary policy rules, this paper is concerned with stabilization issues, not issues regarding the size of the long run growth rate of the economy. The following analysis concerns deviations around base paths, and the base paths are taken as given.

2 The MC Model

The multicountry econometric (MC) model in Fair (1994) is used for the results in this paper. An updated version of this model has been used for the present work, and this version is presented on the website mentioned in the introductory footnote. There is an estimated interest rate rule for each of the main countries in the model, including the United States, and so monetary policy is endogenous. Fiscal policy is exogenous except for automatic stabilizers.

There are 38 countries in the MC model for which stochastic equations are estimated.[3] There are 31 stochastic equations for the United States and up to 15

[2] Some of the more recent studies on monetary policy rules are Clark (1994), Croushore and Stark (1994), Fair and Howrey (1996), Feldstein and Stock (1993), Hall and Mankiw (1993), Judd and Motley (1993), and Thornton (1995). Widely cited earlier studies include McCallum (1988), Taylor (1985), and Tobin (1980). Taylor (1985, fn. 1, p. 61) cites much of the literature prior to 1985.

[3] The 38 countries are the United States, Canada, Japan, Austria, France, Germany, Italy, the Netherlands, Switzerland, the United Kingdom, Finland, Australia, South Africa, Korea, Bel-

each for the other countries. The total number of stochastic equations is 365, and the total number of estimated coefficients is 1653. In addition, there are 1049 estimated trade share equations. The total number of endogenous and exogenous variables, not counting the trade shares, is about 4500. Trade share data were collected for 59 countries, and so the trade share matrix is 59×59.[4]

The estimation periods begin in 1954 for the United States and as soon after 1960 as data permit for the other countries. They end between 1996 and 1998. The estimation technique is two stage least squares except when there are too few observations to make the technique practical, where ordinary least squares is used. The estimation accounts for possible serial correlation of the error terms. The variables used for the first stage regressors for a country are the main predetermined variables in the model for the country. A list of these variables is available from the website.[5]

There is a mixture of quarterly and annual data in the MC model. Quarterly equations are estimated for 14 countries (the first 14 in footnote 3), and annual equations are estimated for the remaining 24. However, all the trade share equations are quarterly. There are quarterly data on all the variables that feed into the trade share equations, namely the exchange rate, the local currency price of exports, and the total

gium, Denmark, Norway, Sweden, Greece, Ireland, Portugal, Spain, New Zealand, Saudi Arabia, Venezuela, Colombia, Jordan, Syria, India, Malaysia, Pakistan, the Philippines, Thailand, China, Argentina, Chile, Mexico, and Peru.

[4]The 21 other countries that fill out the trade share matrix are Brazil, Turkey, Poland, Russia, Ukraine, Egypt, Israel, Kenya, Bangladish, Hong Kong, Singapore, Vietnam, Nigeria, Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, the United Arab Emirates, and an all other category.

[5]The experiments in this paper are for a period ending prior to 1999. No adjustments thus needed to be made for the beginning of the EMU in 1999. On the website some of the equations in the model are changed beginning in 1999 to incorporate the EMU. Beginning in 1999, the exchange rate equations of the individual EMU countries are replaced with one exchange rate equation, and the individual interest rate rules are replaced with one rule.

value of imports per country. When the model is solved, the predicted annual values of these variables for the annual countries are converted to predicted quarterly values using a simple distribution assumption. The quarterly predicted values from the trade share equations are converted to annual values by summation or averaging when this is needed.

Since the MC model is discussed in detail in Fair (1994) and on the website, it will not be discussed in detail here. The key properties of the model that are relevant for present purposes are how interest rates and indirect business tax rates affect the economy, and these properties will now be outlined.

The main U.S. short term interest rate is the three month Treasury bill rate, which is denoted R in this paper. A change in this rate affects the economy in the model in the following ways:

1. Long term U.S. interest rates follow the U.S. short term rate through standard term structure equations.

2. Interest rates appear as explanatory variables in the consumption, import, housing investment, and business fixed investment equations, all with negative coefficient estimates.

3. Interest rates have a negative effect on stock prices in the stock price equation, and stock prices appear in the consumption equations through a wealth variable, which has a positive effect on consumption. Monetary policy thus affects demand in part by affecting stock prices.

4. Interest payments of firms and the government—and thus interest income of households—change when interest rates change, and household interest income appears in the consumption, import, and housing investment equations through a disposable income variable.

5. A change in the U.S. short term interest rate leads to a change in the value of the dollar vis-a-vis the other major currencies through exchange rate equations—

an increase in the U.S. interest rate leads to an appreciation of the dollar and a decrease leads to a depreciation. A change in the value of the dollar leads to a change in U.S. import prices, which then results in a change U.S. domestically produced prices through an import price variable in the domestic price equation. For example, a depreciation of the dollar leads to a higher price of domestically produced goods, other things being equal. The change in the value of the dollar also leads to a change in the demand for U.S. exports through the trade share equations, and it leads to a change in U.S. import demand through an import price variable in the U.S. import equation. For example, a depreciation of the dollar leads to an increase in the demand for U.S. exports and a decrease in the U.S. demand for imports, other things being equal.

6. The U.S. short term interest rate appears as an explanatory variable in some of the other countries' interest rate rules, and so foreign interest rates in part follow U.S. rates.

It will be seen that the net effects of, say, a decrease in the U.S. short term interest rate on U.S. output and the price level are positive. Output increases because there is an increase in the demand for U.S. domestically produced goods, and the price level increases because of the increase in demand and the depreciation of the dollar.[6]

A change in the IBT rate in the model affects the economy in the model as follows:

1. When the IBT rate changes, this results in a change in an aggregate price index (denoted PH) that affects households. PH is a price index for household expenditures that is inclusive of indirect business taxes, and so it changes when the IBT rate changes. The price indices that are exclusive of indirect business taxes in the model do not directly change when the IBT rate changes, and so there are no direct responses to a change in the IBT rate of prices that are exclusive of indirect business taxes.

[6]The dynamics of the estimated U.S. price equation in the model are discussed in Fair (1999). An initial increase in the price level caused by changes in the explanatory variables or positive shocks leads to further increases in the price level in the future and thus to inflation. The inflation generated from these changes eventually dies out. For the most part the discussion in this paper focuses on the price level, although similar discussion would pertain to inflation. The interest rate and tax rate rules, however, use the inflation rate rather than the price level on the right hand side. See also footnote 14.

2. PH is used to deflate nominal disposable income to get real disposable income. Real disposable income is an explanatory variable in the household real expenditure equations, with estimated positive effects. Therefore, an increase in PH has a negative effect on real household expenditures through its effect on real disposable income, and vice versa for a decrease in PH.

An change in the IBT rate in the model is thus a change in real disposable income. It will be seen that the effects of, say, a decrease in the IBT rate on U.S. output and the price level are positive.

3 The Stabilization Effectiveness of Monetary Policy

Two steps will be followed to give one a sense of the size of U.S. monetary policy effects in the model. The first is a simple multiplier experiment, and the second is a set of stochastic simulation experiments.

A Multiplier Experiment

To perform the multiplier experiment the estimated U.S. interest rate rule was dropped from the model, and the U.S. short term interest rate was taken to be exogenous. (The estimated rules of the other countries in the model were retained.) The period considered is 1989:1–1994:4, 24 quarters. Before any changes were made, the estimated (historical) errors were first added to the model and taken to be exogenous. Doing this and then solving the model using the actual values of all the exogenous variables results in a perfect tracking solution. Then the U.S. short term interest rate was decreased each quarter by one percentage point from its base (actual) value and the model was solved. The difference between the predicted value for each variable and each quarter from this solution and its actual value is the estimated effect of the monetary policy change on the variable.

Selected results from this experiment are as follows:[7]

Changes from the Base Values
One percentage point decrease in R

Qtr.	Real Output	Price Level	Inflation Rate
1	0.00	0.01	0.05
2	0.03	0.03	0.08
3	0.11	0.06	0.11
4	0.19	0.09	0.14
8	0.46	0.26	0.16
12	0.50	0.41	0.14
16	0.38	0.56	0.14
20	0.20	0.69	0.12
24	0.02	0.79	0.07

The values for output and the price level are percentage deviations from the base values in percentage points, and the values for the inflation rate are differences from the base values in percentage points at an annual rate. The results show that after 8 quarters output is up .46 percent in response to the one percentage point decrease in the short term interest rate. The peak response is reached after about 12 quarters at .50 percent. The inflation rate after 8 quarters is .16 percentage points higher, which is the peak response. After 24 quarters the price level is .79 percent higher.

[7] In terms of the variables in Fair (1994), real output is the output of the firm sector (Y), the price level is the private, nonfarm price index (PF), and, as noted above, the interest rate is the three month Treasury bill rate (RS). In this paper these variables are denoted Y, P, and R, respectively. The inflation rate is the percentage change in the price level at an annual rate. The multiplier experiment reported here can be duplicated on the website, as can the multiplier experiment in Section 4.

Stochastic Simulation Experiments

The above multipliers suggest that monetary policy may not be able to completely smooth fluctuations in, say, real output without unrealistically large changes in the short term interest rate. To see if this is true, however, one needs an estimate of the likely shocks to real output that monetary policy would need to smooth, and this is where stochastic simulation comes in. Given an econometric model, these shocks can be generated by drawing errors.

Of the 365 stochastic equations in the MC model, 195 are quarterly and 170 are annual. There is an estimated error term for each of these equations for each period. Although the equations do not all have the same estimation period, the period 1976–1996 is common to almost all equations.[8] There are thus available 21 vectors of annual error terms and 84 vectors of quarterly error terms. These vectors are taken as estimates of the economic shocks, and they are drawn in the manner discussed below. Since these vectors are vectors of the historical shocks, they pick up the historical correlations of the error terms. If, for example, shocks in two consumption equations are highly positively correlated, the error terms in the two equations will tend to be high together or low together.

The period used for the variability estimates is 1989:1–1994:4, six years or 24 quarters, which is the same period used for the multiplier experiment above. Since this study is concerned with stabilization around base paths and not with positions of the base paths themselves, it does not matter much which path is chosen for the

[8]For the few equations whose estimation periods began later or ended earlier than the 1976–1996 period, zero errors were used for the missing observations.

base path. The choice here is simply to take as the base path the historical path. As noted above, if the estimated errors are added to the model and taken to be exogenous, the solution of the model using the actual values of all the exogenous variables is the perfect tracking solution. For all the stochastic simulations below the historical errors are added to the model and the draws are around these errors.

Each trial for the stochastic simulation is a dynamic deterministic simulation for 1989:1–1994:4 using a particular draw of the error terms. For each of the six years for a given trial an integer is drawn between 1 and 21 with probability 1/21 for each integer. This draw determines which of the 21 vectors of annual error terms is used for that year. The four vectors of quarterly error terms used are the four that correspond to that year. Each trial is thus based on drawing six integers. The solution of the model for this trial is an estimate of what the world economy would have been like had the particular drawn error terms actually occurred. (Remember that the drawn error terms are on top of the actual error terms for 1989:1–1994:4, which are always used.) By using the estimated error terms for the draws, the trials are consistent with the historical experience: the estimated error terms are data determined.[9] The number of trials taken is 100, so 100 world economic outcomes for 1989:1–1994:4 are available

[9] Another way of drawing error terms would be from an estimated distribution. Let $\hat{V}$ be an estimate of the 365×365 covariance matrix V of the error terms. One could, for example, assume that the error terms are multivariate normal and draw errors from the $N(\hat{\mu}_t, \hat{V})$ distribution, where $\hat{\mu}_t$ is the vector of the historical errors for t. Because of the quarterly-annual difference, $\hat{V}$ would have to be taken to be block diagonal, one quarterly block and one annual block. Even for this matrix, however, there are not enough observations to estimate all the nonzero elements, and so many other zero restrictions would have to be imposed. The advantage of drawing the historical error vectors is that no distributional assumption has to be made and no zero restrictions have to be imposed.

for analysis.[10]

Let y_t^j be the predicted value of endogenous variable y for quarter or year t on trial j, and let y_t^* be the base path (actual) value. How best to summarize the 100×24 or 100×6 values of y_t^j? One possibility for a variability measure is to compute the variability of y_t^j around y_t^* for each t: $(1/J)\sum_{j=1}^{J}(y_t^j - y_t^*)^2$, where J is the total number of trials.[11] The problem with this measure, however, is that there are either 24 or 6 values per variable, which makes summary difficult. A more useful measure is the following. Let L^j be:

$$L^j = \frac{1}{T}\sum_{i=1}^{T}(y_t^j - y_t^*)^2 \tag{1}$$

where T is the length of the simulation period (24 or 6 in the present case). Then the measure is

$$L = \sqrt{\frac{1}{J}\sum_{j=1}^{J} L^j} \tag{2}$$

L is a measure of the deviation of the variable from its base values over the whole period, and because the square root is taken, it is in units of the standard deviation of the variable.[12]

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[10]The solution of the MC model, which is explained in Fair (1994), is a somewhat involved task, and trials are costly in terms of computer time. For a simulation period of 24 quarters, 100 trials takes about 21 minutes on a Pentium Pro 200 computer. No solution failures on any trial occurred for the stochastic simulations reported in Table 1.

[11]If y_t^* were the estimated mean of y_t, this measure would be the estimated variance of y_t. Given the J values of y_t^j, the estimated mean of y_t is $(1/J)\sum_{j=1}^{J} y_t^j$, and for a nonlinear model it is not the case that this mean equals y_t^* even as J goes to infinity. As an empirical matter, however, the difference in these two values is quite small for almost all macroeconometric models, and so it is approximately the case that the above measure of variability is the estimated variance.

[12]L is, of course, not an estimated standard deviation. Aside from the fact that for a nonlinear model the mean of y_t is not y_t^*, L^j is an average across a number of quarters or years, and variances are not in general constant across time. L is just a summary measure of variability.

Table 1
Values of L

Variable	Stochastic Simulation 1	2	3	4	5	6
Y: Real Output	2.08	1.81	1.67	1.77	1.56	1.47
P: Price Level	1.87	1.71	1.72	1.80	1.68	1.70
$\dot{P}$: Inflation Rate	1.03	1.00	0.95	1.00	0.98	0.96
R: Interest Rate	0.00	1.18	1.25	0.00	1.04	1.12
τ: IBT Rate	0.00	0.00	0.00	11.60	10.32	9.37

Sim. 1: No interest rate rule (short term interest rate exogenous.)
Sim. 2: Estimated interest rate rule.
Sim. 3: Quasi optimal interest rate rule.
Sim. 4: Sim. 1 with a quasi optimal tax rate rule added.
Sim. 5: Sim. 2 with a quasi optimal tax rate rule added.
Sim. 6: Sim. 3 with a quasi optimal tax rate rule added.

The rest of this paper is essentially a description of six stochastic simulations using the MC model. The results are reported in Table 1. This section discusses the first three simulations. Simulation 1 provides an estimate of the variability of the economy in a world in which the Fed does not change interest rates at all in response to shocks. The only policy stabilizers are the automatic fiscal policy stabilizers. This simulation is useful for comparison purposes because it allows one to see how much variability is reduced when various policy rules are added. Simulation 2 adds to the model the estimated U.S. interest rate rule, and Simulation 3 adds an interest rate rule derived by searching.

Table 1 presents values of L for five variables for the six simulations. The five variables are real output (Y), the price level (P), the inflation rate ($\dot{P}$), the short term interest rate (R), and the IBT rate (τ). For Y, P, and τ, the percent deviations,

$(y_t^j - y_t^*)/y_t^*$, were used in (1) in place of the level deviations in computing L. The units in Table 1 are all in percentage points.

For Simulation 1 in Table 1, which uses no U.S. monetary policy rule, the value of L is 2.08 percent for real output, 1.87 percent for the price level, and 1.03 percentage points for the inflation rate. L is zero for the interest rate and the IBT rate because they are kept unchanged from their base paths for all the trials.

Simulation 2 adds to the model the estimated U.S. interest rate rule. This is the rule that the Fed is estimated to have followed over the sample period (1954:1–1998:3). The estimated rule is:

Estimated Interest Rate Rule

Dependent Variable is R

Explanatory Variables	Coef.	t-stat.
constant	-15.56	-6.62
Inflation rate	.0757	4.15
Labor market tightness	15.80	6.68
Output growth	.0756	5.27
$M1$ growth lagged	.0194	3.20
$DUM \times M1$ growth lagged	.2266	9.79
R lagged once	.889	49.38
ΔR lagged once	.214	3.81
ΔR lagged twice	-.304	-5.73
SE	.486	
R^2	.970	
DW	1.92	

Estimation period: 1954:1–1998:3
Estimation technique: two stage least squares
DUM = 1 for 1979:4–1982:3; 0 otherwise

This is a "leaning against the wind equation." The short term interest rate is estimated to depend positively on the inflation rate, a labor market tightness variable, the rate of growth of output, and the lagged growth of the money supply ($M1$). The term in which the lagged growth of the money supply is multiplied by the dummy variable is designed to capture a change in Fed behavior between 1979:4 and 1982:3. The lagged values of R are an attempt to capture dynamic effects. The estimated standard error of the equation is .486 percentage points. This equation does well in the tests described in Fair (1994).

When the estimated interest rate rule is added to the model, a constraint is imposed that the interest rate never be less than one percentage point. For particular shocks the rule may call for very small values of the interest rate, including negative values, and this constraint insures that these values are never used. In practice it seems unlikely that the Fed would lower interest rates much below one percentage point, and so this constraint was imposed on the model.

Table 1 shows that the use of the estimated interest rate rule (Simulation 2)[13] lowers L by .27 percentage points for output (to 1.81), by .16 for the price level (to 1.71), and by .03 (to 1.00) for the inflation rate. The estimated rule thus has stabilizing features, as would be expected.

The value of L for the interest rate is 1.18 percentage points. If one takes the estimated interest rate rule as representing the historical behavior of the Fed, then this value of L can be considered an estimate of the variability of the interest rate that

[13] The historical errors were added to the estimated interest rate rule when it was used, but no errors were drawn for it. Adding the historical errors means that when the model inclusive of the rule is solved with no errors for any equation drawn, a perfect tracking solution results. Not drawing errors for the rule means that the Fed does not behave randomly but simply follows the rule. This is the same assumption that is used for the quasi optimal interest rate rule below.

the Fed is willing to allow. This estimate guided the choice of the interest rate rule discussed next. Rules that led to values of L for the interest rate much larger than 1.18 were not accepted.

Simulation 3 uses the following interest rate rule in place of the estimated interest rate rule:

$$R_t = R_t^* + \lambda_1 100[(Y_t - Y_t^*)/Y_t^*] + \lambda_2 100(\dot{P}_t - \dot{P}_t^*) \qquad (3)$$

where $\dot{P}_t$ is the percentage change in P_t at an annual rate. * denotes a base value. According to this rule, the interest rate differs from its base value as output and inflation differ from theirs. Different values of λ_1 and λ_2 were tried to find a pair of values that gave "good" results. Each search was itself a stochastic simulation of 100 trials. The aim was to get low values of L for output, the price level, and the inflation rate without at the same time getting values of L for the interest rate much larger than 1.18.[14] As was done for the estimated interest rate rule, if the rule called for a value of the interest rate less than one percentage point, a value of one percentage point was used. The values finally chosen for λ_1 and λ_2 were .75 and .50, respectively, and the results using these values are the Simulation 3 results in Table 1. The rule using these values will be called a "quasi optimal" rule, where "quasi" refers to the fact that although searching was done to find a good rule, no formal objective function was maximized in choosing it.[15]

[14]Experimentation was also done replacing $(\dot{P}_t - \dot{P}_t^*)$ in (3) with $[(P_t - P_t^*)/P_t^*]$—replacing the inflation rate with the price level—and the results were not sensitive to this change.

[15]Another possibility would be to use optimal control techniques to find an optimal interest rate path for each trial, which would replace using any specific rule. This could be done, for example, using the procedure discussed in Fair and Howrey (1996). This may be an interesting area for future research, but for purposes of this paper no formal optimal control problems have been solved. Given the cost of solving the MC model, the use of optimal control techniques would take considerable

Table 1 shows that for output L fell more in Simulation 3 (to 1.67) than in Simulation 2 (to 1.81). For the price level L fell about the same in the two simulations, and for the inflation rate L fell slightly more in Simulation 3 (to 0.95) than in Simulation 2 (to 1.00). The quasi optimal interest rate rule is thus more stabilizing than is the estimated interest rate rule for output, but the two rules are similar for the price level and the inflation rate. The value of L for the interest rate is 1.25 in Simulation 3, which is slightly larger than the 1.18 in Simulation 2. Using larger values of λ_1 led to further falls in L for output, but at a cost of larger values of L for the interest rate. Using larger values of λ_2 led to only modest further falls in L for the price level and the inflation rate and also at a cost of larger values of L for the interest rate.

The results thus show that the interest rate rules do not come close to offsetting all of the effects of the shocks on output, the price level, and the inflation rate. There is much left to be done, and so the next question is how much a tax rate rule might help.

4 A Tax Rate Rule

The tax rate rule that was used in Simulations 4, 5, and 6 was set up as follows. There is a constructed aggregate federal IBT rate in the model, which will be denoted τ.[16] It is the ratio of overall federal indirect business taxes to total consumption expenditures. In the regular version of the model τ is taken to be exogenous.

computer time.

[16]The notation for τ in the model on the website is $D3G$.

A Multiplier Experiment

To get an idea of the effects of τ in the model, a multiplier experiment was performed. As was done for the multiplier experiment for the interest rate, the estimated (historical) errors were first added to the model and taken to be exogenous. Then τ was decreased each quarter by 10 percent from its base (actual) value and the model was solved. The U.S. short term interest rate was kept unchanged from its base values (no interest rate rule used) for this experiment.

Selected results from this experiment are as follows:

Changes from the Base Values
Ten percent decrease in τ

Qtr.	Real Output	Price Level	Inflation Rate
1	0.05	0.00	0.02
2	0.13	0.01	0.04
3	0.20	0.03	0.06
4	0.25	0.04	0.07
8	0.36	0.11	0.05
12	0.43	0.16	0.05
16	0.44	0.22	0.07
20	0.42	0.29	0.07
24	0.39	0.36	0.07

The results show that after 8 quarters output is up .36 percent in response to the 10 percent decrease in τ. The peak response is reached after about 16 quarters at .44 percent. The inflation rate after 4 quarters is .07 percentage points higher. After 24 quarters the price level is .36 percent higher.

Although the output responses in this experiment versus the responses in the interest rate experiment in Section 3 are not too dissimilar, the price level and inflation responses are noticeably smaller in this experiment than in the other. This is because the decrease in the U.S. interest rate leads to a depreciation of the dollar, which has inflationary consequences. The decrease in the indirect business tax rate, on the other hand, has no direct effects on exchange rates.

Stochastic Simulation Experiments

Since the multiplier results show that τ has effects on the economy, a rule using τ may be useful for stabilization purposes. The following equation is used for the tax rate rule:

$$\tau_t = \tau_t^* + \lambda_3[.5((Y_{t-1} - Y_{t-1}^*)/Y_{t-1}^*) + .5((Y_{t-2} - Y_{t-2}^*)/Y_{t-2}^*)]$$
$$+ \lambda_4[.5(\dot{P}_{t-1} - \dot{P}_{t-1}^*)^2 + .5(\dot{P}_{t-2} - \dot{P}_{t-2}^*)^2] \quad (4)$$

It is not realistic to have tax rates respond contemporaneously to the economy, and so lags have been used in (4). Lags of both one and two quarters have been used to smooth tax rate changes somewhat. The rule says that the tax rate exceeds its base value as output and the inflation rate exceed their base values. Different values of λ_3 and λ_4 were tried to find a pair of values that gave "good" results. The procedure here was the same as that used above to find the quasi optimal interest rate rule. The values chosen for λ_3 and λ_4 were .125 and .125, respectively. Again, the tax rate rule using these values is only "quasi optimal" because no formal objective function has been maximized. One of the criteria used in choosing the values of λ_3 and λ_4 was to have the value of L for τ be around 10 (roughly a standard deviation of τ of around 10 percent).

Simulation 4 uses the tax rate rule but no interest rate rule. Table 1 shows that the value of L for output is lowered from 2.08 to 1.77, the value of L for the price level is lowered from 1.87 to 1.80, and the value of L for the inflation rate is lowered from 1.03 to 1.00. In terms of lowering output variability, the tax rule is better than the estimated interest rate rule and worse than the quasi optimal interest rate rule. It is worse than both interest rate rules on lowering price level variability, and it is the same as or worse than both interest rate rules on lowering inflation variability. The interest rate rules are better at lowering price level and inflation variability because, as discussed above, interest rate changes have more of an effect on the price level (and thus inflation) than do IBT rate changes. Interest rate changes have a direct effect on the value of the dollar, which IBT rate changes do not.

Using both the tax rate rule and the estimated interest rate rule (Simulation 5), the value of L for output is 1.56 (versus 1.81 using only the estimated interest rate rule), the value of L for the price level is 1.68 (versus 1.71 using only the estimated interest rate rule), and the value of L for the inflation rate is 0.98 (versus 1.00 using only the estimated interest rate rule). The value of L for output is even lower using the tax rate rule and the quasi optimal interest rate rule (Simulation 6) at 1.47 (versus 1.67 using only the quasi optimal interest rate rule). On the other hand, Simulations 5 and 6 are similar regarding the price level and the inflation rate results.

Note that the use of the tax rate rule in combination with an interest rate rule lowers slightly the value of L for the interest rate—from 1.18 to 1.04 for the estimated interest rate rule and from 1.25 to 1.12 for the quasi optimal interest rate rule. This is, of course, as expected since the tax rate rule is helping smooth the economy and so there is less for monetary policy to do.

The values of L for τ are 11.60, 10.32, and 9.37, respectively, for Simulations 4, 5, and 6. A policy question is whether these values are political acceptable. They could be lowered by lowering the values of λ_3 and λ_4, although at a cost of higher values of L for output.

5 Conclusion

Most of what this paper has to say is in Table 1. The proposed tax rate rule does help in stabilizing the economy, especially output. In general, output is more amenable to being stabilized than is the price level and the inflation rate. It is not easy to offset shocks to the price level in the model because the price level responds fairly slowly to demand changes and to changes in import prices.

The methodology of this paper requires an estimated set of shocks and the ability to do stochastic simulation. Given this, the procedure is straightforward, and it would be interesting to see how tax rate rules of the kind proposed here do in other models. The trustworthiness of the above results depends on the accuracy of the estimated distribution of the shocks, on how well the effects of interest rate changes on the economy have been captured, and on how well the effects of IBT rate changes on the economy have been captured. Even though the focus in this paper is on the United States, the use of the complete MC model has the advantage of accounting for the effects of interest rate changes on exchange rates and thus on the price of imports, imports, and exports. The MC model has been extensively tested (see Fair (1994)), and it seems to be a reasonable approximation. The present results thus seem worthy of serious consideration, although it would be useful to examine their robustness across alternative models.

Whether the kind of rule proposed here is political feasible is, of course, an open question. Note, however, that a five year budget plan is based on a set of economic values over the five years, and these are in effect the base values above. The only extra work needed for a tax rule is to vote on the values of the λ's. It is not out of the question that it could become expected by the general public that, say, gasoline tax rates are higher in good times than in bad times.

Whatever tax rate is chosen, it should not be subject to gaming considerations. If people know that a tax rate is to be raised in a month, it should not be that they can offset much of this increase before it takes place. In the case of the gasoline tax, the gaming possibilities seem limited. The most one could do would be to fill up the tank the day before the tax increase.

Finally, I realize that the timing of this paper is not great, since at the time of this writing the United States has had nearly a decade without a recession. This does not mean, however, that there will not be recessions in the future, and if there are future recessions, a tax rate rule might help mitigate them.

References

[1] Clark, Todd E., 1994, "Nominal GDP Targeting Rules: Can They Stabilize the Economy?" *Federal Reserve Bank of Kansas City Economic Review*, 3, 11-25.

[2] Croushore, Dean, and Tom Stark, 1994, "Evaluating McCallum's Rule for Monetary Policy," Federal Reserve Bank of Philadelphia, November.

[3] Fair, Ray C., 1994, *Testing Macroeconometric Models*, Cambridge, MA: Harvard University Press.

[4] _________, 1999,"Testing the NAIRU Model for the United States," February.

[5] _________, and E. Philip Howrey, 1996, "Evaluating Alternative Monetary Policy Rules," *Journal of Monetary Economics*, 38, 173-193.

[6] Feldstein, Martin, and James H. Stock, 1993, "The Use of a Monetary Aggregate to Target Nominal GDP," NBER Working Paper No. 4304.

[7] Hall, Robert E., and N. Gregory Mankiw, 1993, "Nominal Income Targeting," NBER Working Paper No. 4439.

[8] Judd, John P., and Brian Motley, 1993, "Using a Nominal GDP Rule to Guide Discretionary Monetary Policy," *Federal Reserve Bank of San Francisco Economic Review*, 3, 3-11.

[9] McCallum, Bennett T., 1988, "Robustness Properties of a Rule for Monetary Policy," Carnegie-Rochester Series on Public Policy, 29, 173-204.

[10] Taylor, John B., 1979, "Estimation and Control of a Macroeconomic Model with Rational Expectations," *Econometrica*, 47, 1267-1286.

[11] _________, 1985, "What Would Nominal GDP Targeting Do to the Business Cycle?" Carnegie-Rochester Series on Public Policy, 22, 61-84.

[12] Thornton, Saranna R., 1995, "Adaptive Monetary Policy Rules Utilizing Either MZM or M2 and the Effects of Positive Bias in Money Control Errors," for presentation at the AEA Meetings, Washington D.C., January 1995.

[13] Tobin, James, 1980, "Stabilization Policy Ten Years After," *Brookings Papers on Economic Activity*, 1, 19-72.