THE POLICY RULE MIX:

A MACROECONOMIC POLICY EVALUATION

by

John B. Taylor
Stanford University

October 1997

This draft was prepared for the Robert A. Mundell Festschrift Conference, organized by Guillermo Calvo, Rudi Dornbusch, and Maury Obstfeld and held at the World Bank, Washington, D.C., October 24, 1997. The research was supported by the Center for Economic Policy Research at Stanford University.

This paper addresses the following two questions about monetary and fiscal policy rules: First, should a central bank's monetary policy rule for the interest rate react to real variables such as real GDP or the unemployment rate? Many argue that the answer to this question is no; for example, they argue that the central bank should not react by raising interest rates if real economic growth accelerates unless there is also a visible increase in inflation. Second, if for institutional, legislative, or political reasons, the central bank's monetary policy rule is restricted so that it cannot react to real variables (but only to inflation or the price level), then is it possible for the government's fiscal policy rule (e.g. automatic stabilizers) to compensate for this absence of a monetary policy reaction to real variables? In other words, is it possible to design a well-functioning mix of monetary and fiscal policy rules in which the monetary policy rule reacts only to inflation and the fiscal policy rule reacts only to real output?

Though the focus of the paper is on rules rather than one-time changes in the instruments of policy, the questions about policy mix are closely related to Robert Mundell's work on the fiscal-monetary policy mix, as exemplified by Mundell (1971), one of the most influential of Mundell's many contributions to macroeconomic policy research. The focus on policy rules is characteristic of much of modern macroeconomic policy evaluation research and contrasts in an interesting way with Mundell's early work.

The analysis of this paper assumes that the central bank targets a long run average rate of inflation and that there is no long run tradeoff between inflation and unemployment. The first section starts with a “baseline” monetary policy rule that describes the reaction of the interest rate to deviations of real GDP from potential GDP and to the deviations of rate of inflation from the target rate of inflation. It then considers the arguments for and against a monetary policy rule which reacts only to inflation, a restriction of the baseline policy rule. Considering both theoretical and empirical evidence, the case for including a reaction to real variables in the policy rule seems strong even if the goal of monetary policy is solely to target inflation. This suggests that if for some reason monetary policy cannot react to real variables, it may be advisable to have fiscal policy compensate. Since the automatic stabilizers already represent a rule-like response, the question boils down to how much that response might be changed.

Numerical simulations of a multicountry econometric model with rational expectations are used to help answer that question. The financial market linkages in the econometric model are based on the Mundell-Fleming approach to modeling exchange rates with perfect capital mobility, another way in which this paper reflects Robert Mundell's contributions.

The two questions addressed in this paper complement two other interesting policy mix questions in which the restrictions on, and compensating adjustments of, fiscal and monetary policy are reversed. These other two questions are: First, should a government's fiscal policy rule be restricted—as it would by a balanced budget amendment--so that the deficit cannot react to real variables such as real GDP and unemployment? Second, if a law like a balanced budget amendment was passed and kept the deficit from rising in recessions, then how might the monetary policy rule be adjusted to compensate for the absence of a fiscal policy reaction to real variables. These two other questions about the policy rule mix were addressed in an earlier paper (Taylor (1995)) and are reviewed in the final section of this paper. Like the earlier paper, this paper focuses on the United States but the results should apply more broadly.

1. Baseline Monetary and Fiscal Policy Rules

Consider a simple “baseline” monetary policy rule and a "baseline" fiscal policy rule of the form:

$$r = \pi + g(y - y^*) + h(\pi - \pi^*) + r^f \tag{1}$$

$$s = f(y - y^*) + s^* \tag{2}$$

where

r = short term interest rate

s = budget surplus as a percentage of GDP

π = inflation rate

y = real GDP ($100 \times \log$)

y^*= potential GDP ($100 \times \log$)

π^*= target inflation rate

and where r^f , s^*, f, g, and h are all constants (f, g, and h are non-negative). The term r^f represents the central banks estimate of the equilibrium real rate of interest. The term s^* is the structural budget surplus.

Displaying equation (1) and (2) together highlights the sense in which this paper concerns the mix of fiscal and monetary policy rules. Terms involving real output appear in both rules with coefficients g and f. Here I will consider restrictions on the parameter g and compensating changes in the parameter f. In Taylor (1995) I considered restrictions on the parameter f and compensating changes in parameter g.

Numerical examples of these types of policy rules with the parameter values f = .5, g = .5, h = .5 , r^f = 2, π^* = 2 and s^* = 3 are discussed in Taylor (1993b) and Taylor (1995). For these parameter values equations (1) and (2) describe actual U.S. monetary and fiscal policy reasonably accurately since 1987 on a quarterly average basis.

The absence of the exchange rate in equation (1) does not mean that I have a closed economy in mind; it simply means that the exchange rate has not played a major role in the formulation of U.S. monetary policy in recent years. In fact, the macroeconomic policy evaluation reported below involves simulating such policy rules in an estimated multicountry model that has exchange rates and that captures the interaction between countries.   Clarida, Gali, and Gertler (1997b) show that monetary policy rules similar to (1) also describe the behavior of Germany and Japan with the exchange rate playing a surprisingly small role.

Using the notation in equations (1) and (2) we can restate the two questions mentioned in the introduction of this paper as follows:

(1) should the parameter g = 0?

(2) if so, can the parameter f compensate for setting g = 0.

To be sure the first question is stated more starkly than necessary. A close, but less extreme, formulation of the question would simply be to ask: how large should g be?

2. The Case Against Monetary Policy Reacting to Real Variables

The central argument against a monetary policy reaction function with real variables such as $y - y^*$ is that such a reaction requires policymakers to have knowledge of potential GDP and its growth rate. Potential GDP is difficult to estimate. Both its growth rate and its level are uncertain and currently subject to an active debate. Some argue that we are in a "new economy" with real GDP well below potential GDP. Others warn that real GDP is above potential with a rise in inflation imminent. A related problem is in projecting potential GDP in the future. Conceptually potential GDP is the aggregate supply of the economy depending on available labor, capital, and technology. Even if labor supply and capital could be forecast reasonably well, total factor productivity growth is very difficult to forecast accurately. Alan Greenspan (1997) refers explicitly to uncertainty about potential growth as a disadvantage of monetary policy rules that react to deviations of real GDP from potential GDP. He refers to the "current debate between those who argue that the economy is entering a 'new era' of greatly enhanced sustainable growth and unusually high levels of resource utilization, and those who do not." and notes that policy rules like equation (1) "depend on the values of certain key variables—most crucially the equilibrium real federal funds rate and the *production potential of the economy*" (italics added).

The fact that there is a close association between the GDP gap (the deviation between real GDP and actual GDP) and other measures of utilization, including the deviation of the unemployment rate from the natural rate, provides some help in measuring the GDP gap. However, there is also great uncertainty about these other measures of capacity utilization. For example, the current level of the natural unemployment rate is the subject of as much debate as potential GDP.

If g were equal to zero, uncertainty about the level of potential GDP would not be a problem for the obvious reason that the monetary policy rule would not depend on potential GDP. Hence, if it could be established that macroeconomic performance did not deteriorate if g were zero, a policy rule with $g = 0$ would be very attractive.

The main formal theoretical rationale for lowering the value of a policy reaction coefficient like g because of uncertainty is that put forth by Brainard (1967). However, Brainard's theoretical rationale distinguishes between multiplicative and additive uncertainty. Only multiplicative uncertainty calls for a reduction in reaction coefficients. The uncertainty concerning the level of potential GDP is most likely additive. For example, the intercept coefficient in an aggregate price adjustment equation would be uncertain if potential GDP, the natural rate of unemployment, or the sustainable growth rate of real GDP were uncertain. None of these types of uncertainty seems to add multiplicative uncertainty to the policy optimization problem. If this is so then the reference to the Brainard uncertainty model as support for making g small (or setting it to zero) is incorrect.

Another argument against a monetary policy rule that reacts to real variables is that such variables are not subject to monetary control, at least not in the long run. However, such arguments confuse the goals of monetary policy with the strategy for achieving the goals. As I show in the next section, even a central bank that had the single goal of targeting inflation, with no stated goals about unemployment or real GDP, would find reacting to real variables helpful in achieving those goals.

3. The Case in Favor of Monetary Policy Reacting to Real Variables

There are several theoretical and empirical reasons why a monetary policy which reacts to real variables would improve macroeconomic performance, both in terms of more price stability and more output stability.

The argument I discuss first is also related to uncertainty, but about the "equilibrium real federal funds rate" (to use Greenspan's term) rather than the potential GDP.

Uncertainty About The Real Interest Rate

The intercept term in equation (1) represents the central bank's estimate of the real interest rate. There is, of course, much uncertainty about the level of the real interest rate. Although the parameter g does not seem to interact with r^f in equation (1), one can show that setting g = 0 can actually increase the impact of this uncertainty greatly. Hence, uncertainty about the real interest rate is a reason for not setting g to zero.

To see this I first derive a useful short-run relationship between the rate of inflation and real GDP. Assume that real GDP depends negatively on the interest rate according to the equation:

$$y - y^* = - \beta(r - \pi - r^*) \qquad (3)$$

where r^* now represents the equilibrium real rate of interest. With $r - \pi = r^*$ we have that $y = y^*$.

Substituting equation (2) into equation (3) gives

$$\pi - \pi^* = -((1+\beta g)/\beta h)(y - y^*) - (r^f - r^*)/h \tag{4}$$

Equation (4) is a negatively sloped "aggregate demand" relationship between inflation and real GDP with inflation ($\pi - \pi^*$) on the vertical axis and real GDP ($y - y^*$)on the horizontal axis. The slope of the relationship is important. It determines whether a given shock to inflation will be translated more into inflation or more into real GDP. For example, if the relationship is very flat, then a shock to inflation will cause a large decline in real GDP which in turn will tend to reduce the inflation increase and thus the variability of inflation. On the other hand if the relationship is very steep, then a shock to inflation will not have much effect on real GDP, but will result in a large and persistent swing in inflation.

Observe that the slope of this relationship depends on both g and h. Higher values of h (larger reactions of policy to inflation) flatten the relationship. Higher values of g (larger reactions of policy to real GDP) will steepen the relationship. For a given value of g, including g = 0, one can choose h to obtain any desired value for the slope. For the same value of the slope, low values of g will require low values of h.

The second term on the right hand side of equation (4) represents the effects of uncertainty about the equilibrium real interest rate. If the central bank's estimate of the equilibrium real interest rate (r^f) is not equal to the actual equilibrium real interest rate, then the inflation rate will deviate from the target. Note that the interest rate error is multiplied by 1/h. For example, if h = .5 the multiplier is 2, so the error in the inflation rate is twice as large as the error in the real interest rate estimate. How does the choice of g affect this error multiplier? The smaller is g the smaller h has to be for the same slope of the relationship between aggregate demand and inflation. For g close to zero, h would have to be very small to keep the curve from becoming too flat. Such a small value of h could cause small errors in the estimate of the equilibrium real interest rate to translate into large deviations from the inflation target.

Real Variables as Guides to Preemptive Strikes Against Inflation

The above argument in favor of reacting to real variables implicitly assumes that one of the goals of policy is to keep the fluctuations in output small. Otherwise one would not be concerned if the inflation-output relationship in equation (4) got too flat. However, there are reasons for monetary policy to react to real variables even if they are not part of the goal of policy.

The monetary policy rule in equation (1) does not have expectations of future variables in it. This may seem like a defect because policy works with a lag and it is therefore necessary to be forward looking. However, real variables such as $y - y^*$ are helpful in forecasting future inflation. There is strong time series evidence that real output "Granger-causes" inflation. Thus, an increase in real GDP above potential GDP is an indication that inflation is likely to rise and that a increase in the interest rate to *preempt* that rise in inflation would be appropriate. Similarly, a decrease in real GDP below potential GDP would signal a future fall in inflation and call for a preemptive reduction in interest rates.

Clarida, Gali and Gertler (1997a) show that equation (1) is the implication of a monetary policy rule that reacts only to expected inflation, if lagged output and inflation are sufficient statistics for forecasting future inflation. More generally, real output will appear in a reaction function (perhaps along with other variables) as long as it Granger causes inflation. Preemptive strikes—increases or decreases in the federal funds rate before there is a visible sign of an increase in inflation--can be guided by factors in addition to real output, but the strong Granger causality of output to inflation suggests that output should always be one factor.

Analogy with Money Growth Targets

A third argument in favor of real variables in the monetary policy rule comes from noting the similarity between fixed money growth rules and interest rate rules that incorporate real output. Fixed money growth rules work well when measuring the money supply accurately is possible. One of the advantages of fixed money growth rules is that they provide an automatic stabilizing effect on both real output and prices. If real output rises, the demand for money rises relative to the quantity supplied and the interest rate rises, attenuating the real output increase. Similarly, if real output falls, the interest rate automatically decreases, stimulating output. Some research has questioned whether these increases or decreases in the interest rate are large enough, but I know of no research that shows they are too large or should not occur at all.

The presence of the output variable in equation (1) for the interest rate policy rule results in exactly the same interest rate movements as the fixed money growth rule. An increase in real output causes the interest rate to rise and a decrease in real output causes the interest rate to fall. These changes in interest rates offset the fluctuation in real output and the fluctuations in inflation that they cause. By mimicking this valuable feature of money rules, an interest rate rule with real output improves macroeconomic performance.

Simulations with an Econometric Model

These arguments in favor of a policy reaction to real output are supported by calculations with estimated econometric models as in Taylor (1993a) and Bryant, Hooper, and Mann (1993). The model described in Taylor (1993a), for example, is a detailed empirical version of the simple abstract equation (3). The model includes exchange rate effects, explicit differences between long term and short term interest rates, forward looking consumption and investment behavior, and perfect capital mobility. It is fit to quarterly data. The simulations of policy rules are stochastic with the shocks to all the equations drawn from the estimated variance covariance matrix of the shocks.

To assess whether policy reaction to real output adds to the performance of the macroeconomy, one can simulate these models with two versions of policy rule (1), one with real output and the other without real output. The simulations results with my own model uniformly favor including real output in the reaction function. I focus on the variability of real output and the aggregate price level. When real output is a factor in the reaction function, both price stability and real output stability are greater (or can be made greater by adjusting the parameters) than when the policy rule is restricted to exclude real variables. In other words it would be inadvisable to ignore real output whether or not real output is an explicit goal of policy.

This finding about the superiority of rules with feedback from output is true for the seven largest industrial countries in the model, and regardless of whether the exchange rate regime involves fixed or flexible exchange rates. In the case of fixed exchange rates the policy rule is a function of a weighted average of real output and aggregate prices in each country in the exchange rate union. All countries within the union have a common short term interest rate of course. However, given the choice between fixed and flexible exchange rates, the flexible exchange rate system is preferred according to these criteria.

4. Compensating for Restrictions on the Monetary Policy Rule

The previous two sections have summarized key arguments for and against a policy rule which reacts to real variables. My assessment of these arguments is that a policy rule which reacts to real variables would improve economic performance compared with a policy rule that does not respond to real variables. Uncertainty about the economy's potential growth is a serious problem for interest rate rules such as (1) which depend on potential GDP, but because this uncertainty is additive rather than multiplicative it is unlikely to imply a very small value for the reaction coefficient.   Uncertainty about the real interest rate, the need for preemptive monetary strikes, analogies with fixed money growth rules, and simulations with empirical models all point to the optimality of reacting to real output.

However, even a strong set of economic arguments does not preclude the possibility that limitations on monetary policy might be imposed externally or even adopted internally by a central bank. For example, in an effort to convince market analysts that it is targeting inflation, the central bank might hold off on increasing interest rates when real output is above potential if there is no sign that inflation has risen. An interest rate increase in this circumstance could be thought to confuse the market which would interpret it as a sign that the central bank is actually targeting real variables.

Could the fiscal policy rule in equation (2) compensate for such a restriction by having a larger reaction to real GDP? How large would the coefficient have to be?   To see the theoretical possibilities we can modify equation (3) by adding in a fiscal variable (the deviation of the fiscal surplus from the structural surplus) to get

$$y - y^* = - \beta(r - \pi - r^*) - \delta(s - s^*) \tag{5}$$

and then substituting for both the interest rate r and the budget surplus s from the policy rule equations (1) and (2) to get:

$$\pi - \pi^* = - ((1+\beta g - \delta f)/\beta h)(y - y^*) - (r^f - r^*)/h \tag{6}$$

Equation (6), like equation (4), represents a key negative relationship between inflation and real GDP, but now with the added fiscal policy rule parameter f. The slope of the relationship in equation (6) depends on both g and f. Hence, the slope can be held constant by adjusting f to compensate for setting g equal to zero. And because f does not appear elsewhere in the equation there is no possibility of any side-effects. To the extent that equation (6) captures the effects of monetary and fiscal policy rules on economic fluctuations, it appears possible in theory to use this fiscal policy rule to offset the restriction on the monetary policy rule.

Simulations of Econometric Models

While these simple equations are useful for discussing policy issues, they do not come close to describing the full dynamic structure of the economy that is relevant for policy evaluation. A more detailed and theoretically complete model is needed. Hence, to get a better assessment of the possibility of using fiscal policy rules in conjunction with monetary policy rules, I simulated my multicountry econometric model with three scenarios:

Scenario I: Baseline monetary and fiscal policy rules (equations (1) and (2))

-- parameter values: $g = .5$ and $f = .5$

Scenario II: Restricted monetary policy rule and baseline fiscal policy rule

-- parameter values: $g = 0$ and $f = .5$

Scenario III: Restricted monetary policy rule and adjusted fiscal policy rule

- parameter values: $g = 0$ and $f = 1$

(The stochastic simulation results are still very preliminary and I only summarize the results in this draft of the paper). The stochastic simulation results indicate a deterioration of output and price stability for Scenario II compared with Scenario I, which is not surprising given the results discussed above. They also indicate that the performance of Scenario III is preferred to

Scenario II. However, with the fiscal policy parameter f = 1, the degree of output and price stability is still not as good as that in Scenario I, suggesting that a fiscal policy parameter even greater than f = 1 would be necessary to fully compensate for the restriction on monetary policy. Hence, the preliminary simulation results show that values of the fiscal reaction coefficient (f) in excess of 1 are needed to give the same amount of stability as the baseline monetary and fiscal policies. Because a parameter value of f equal than 1 is already twice as large as the current automatic stabilizers, it seems unlikely that changes in the automatic stabilizers could in reality fully compensate for such a restriction on monetary policy.

These results have some similarity with the policy rule mix analysis in Taylor (1995) which address the possibility of monetary policy compensating for a restriction on fiscal policy due to a balanced budget amendment. In that evaluation I also considered three scenarios:

Scenario A: Baseline monetary and fiscal policy rules (equations (1) and (2))

-- parameter values: g = .5 and f = .5

Scenario B: Restricted fiscal policy rule and baseline monetary policy rule

-- parameter values: g = .5 and f = 0)

Scenario C: Restricted fiscal policy rule and adjusted monetary policy rule

- parameter values: g = 1.0 and f = 0)

In this case, performance of Scenario B was worse than Scenario A. The adjustment in Scenario C improved performance relative to B, but was not enough to bring performance all the way back to Scenario A. Hence, monetary policy had to change quite a bit to offset the restriction on fiscal policy.

5. Conclusions

The main conclusions of this paper are as follows: First, a monetary policy rule in which the interest rate instrument of policy adjusts to both inflation and real GDP works better than a policy in which there is no instrument reaction to real GDP. Second, it is possible to design a nicely-performing mix of monetary and fiscal policy rules in which monetary policy has the job of reacting to inflation and fiscal policy has the job of reacting to real output. In other words, fiscal policy could adjust to compensate for a restriction on monetary policy. Third, the adjustment of the fiscal policy rule would probably be very large and therefore difficult to make in practice. Hence, although a one-on-one pairing of monetary policy with reactions to inflation and fiscal policy with reactions to real output may seem attractive, a monetary policy rule which reacts both to real output and inflation—despite the uncertainty about potential GDP and even if inflation is the only long run goal variable—makes more practical sense in the current circumstances.

REFERENCES

Brainard, William (1967), "Uncertainty and the Effects of Monetary Policy," *American Economic Review, Proceedings*, Vol. 57, pp. 411-25.

Bryant, Ralph, Peter Hooper and Catherine Mann (1993), *Evaluating Policy Regimes: New Empirical Research in Empirical Macroeconomics*, Brookings Institution, Washington, D.C.

Clarida, Richard, Jordi Gali, and Mark Gertler (1997a), “The Science of Monetary Policy,” unpublished paper, September.

Clarida, Richard, Jordi Gali, and Mark Gertler (1997b), "Monetary Policy Rules in Practice: Some International Evidence," New York University, C.V. Starr Center for Applied Economics, Economic Research Report number 97-32.

Mundell, Robert A. (1962), "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates*," Canadian Journal of Economic and Political Science,* Vol 29, pp. 475-487.

Mundell , Robert A. (1971), "The Dollar and the Policy Mix: 1971," *Essays in International Finance, No. 85,* International Finance Section, Princeton University.

Rodriguez, Carlos A. (1978), "A Simple Keynesian Model of Inflation and Unemployment with Rational Expectations," *Weltwirtschaftliches Archiv*. Vol 114, No.1.

Taylor, John B. (1993a), *Macroeconomic Policy in a World Economy,* W.W. Norton, New York.

Taylor, John B. (1993b), "Discretion Versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 39, pp 195-214.

Taylor, John B. (1995), “Monetary Policy Implications of Greater Fiscal Discipline,” in *Budget Deficits and Debt: Issues and Options*, Federal Reserve Bank of Kansas City.