Evaluating McCallum's Rule For Monetary Policy

*Dean Croushore and Tom Stark**

Some economists have proposed that the Federal Reserve follow a rigid rule for conducting monetary policy. A policy rule is a formula that tells the Fed how to set monetary policy. For example, in 1959 Milton Friedman argued that the Fed should increase the money supply a constant 4 percent each year to eliminate inflation and avoid destabilizing the economy. More recently, other economists have identified an additional benefit: a rule can eliminate the inflationary bias that could occur when discretionary monetary policy is used. Under a discretionary policy, decisions are made on a case-by-case basis.

But economists don't agree on how the economy works or on how monetary policy affects the economy. This lack of consensus makes the construction of a policy rule very difficult. A rule that works well in one model of the economy may not work well in others. But do different beliefs about the economy necessarily imply that no rule works in all reasonable models of the economy? Or is it possible to find a rule to guide monetary policy that works fairly well for many different models?

In a series of recent papers, Bennett McCallum of Carnegie-Mellon University proposed a rule that seems to work well in a variety of models. McCallum's rule targets nominal GDP (the dollar value of output in the economy) by setting the growth rate of the money supply (more precisely, the monetary base, which con-

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sists of bank reserves plus currency in circulation). The rule would allow the economy to expand at its normal pace and also eliminate inflation.

According to the rule, monetary policy must adjust whenever nominal GDP differs from its target. For example, when nominal GDP is below target, the Fed should stimulate the economy by increasing money growth. Eventually nominal GDP will grow faster and return to its target level.

How well does McCallum's rule work? In addition to McCallum, John Judd and Brian Motley at the San Francisco Fed have done research on McCallum's rule, as have Gregory Hess, David Small, and Flint Brayton at the Federal Reserve Board of Governors. These studies, which follow the same procedures we use later in this article, show that the rule may work well in very different economic models, though the Hess-Small-Brayton study finds some problems with it. Most of the studies suggest that if the rule had been in place historically instead of the discretionary policy the Fed actually followed, inflation would have been significantly lower and real output about the same as actually occurred. In one article, McCallum even suggests that using the rule could have prevented the Great Depression! But all of these studies draw upon economic models designed solely for the purpose of evaluating the rule.

The main purpose of this article is to expand the set of economic models on which McCallum's rule has been tested. In particular, we examine economic models developed for purposes other than testing McCallum's rule. If the rule does well in these models, such evidence will be more convincing than finding that the rule works well in models designed specifically to test it.

The most important criticism of the research on McCallum's rule is based on the work of University of Chicago economist Robert Lucas. Lucas argues that people's behavior is likely to be different when there is a change in policy, such as the change from discretion to a rule. Consequently, the results of all these studies, including ours, must be taken with a grain of salt: we can never be sure about the effects of a major policy change like this, because we don't know how people's behavior will change. All the studies on McCallum's rule, including this one, assume that the equations that describe people's behavior remain unchanged when policy changes. Unfortunately, no reasonable models of monetary policy yet exist that can deal fully with behavioral changes in response to policy changes, though there is much research under way.

EVALUATING THE BENEFITS AND COSTS OF MCCALLUM'S RULE

Why do economists think a rule for monetary policy is a good thing? Some economists, like Milton Friedman, think that when the Fed follows a discretionary policy it tends to react too slowly. For example, when a recession starts, the Fed may increase the growth rate of the money supply to increase economic activity. But monetary policy takes effect with a long and variable lag, so by the time the faster money growth has an effect, the economy may already be recovering, and the increased growth just leads to too much stimulus and higher inflation.

More recently, economists, including McCallum, have suggested that when monetary policy is conducted without a formal rule, policymakers have a tendency to pursue an inflationary monetary policy.[1] But if they were bound to following a rule, inflation would be lower.

What types of rules are reasonable? One type of rule would have the Fed set monetary policy without regard to economic conditions.

[1]For a useful summary of this issue, see the 1985 article by Herb Taylor in this *Business Review*.

Friedman's 4 percent money-growth rule is an example of such a nonactivist rule. But it is also possible to design rules that permit the Fed to respond to economic conditions. Activist rules include a rule that uses the federal funds interest rate, suggested by John Taylor of Stanford University; a rule that uses forecasts of future nominal income, developed by Robert Hall of Stanford University and Gregory Mankiw of Harvard University; and a rule that uses the M2 money stock to target nominal GDP, proposed by Martin Feldstein of the National Bureau of Economic Research and James Stock of Harvard University. We will evaluate McCallum's rule because it is the most widely known activist rule, but our techniques could be used to evaluate any of these other rules.

What are the potential benefits of setting monetary policy using McCallum's rule? Because the rule is designed to give better long-run performance than the discretionary monetary policy that was actually followed over time, we expect the rule's biggest impact to be a lower average simulated inflation rate than the actual average inflation rate. Using the rule should drive inflation to zero. The rule may also reduce short-run variability in the economy by forcing the Fed to respond to economic conditions in a systematic, rather than discretionary, manner.

Following the rule also has several potential costs. Our main concern is that the rule may generate economic instability. Instability occurs if the rule makes monetary policy respond too much, pushing the economy in one direction in one quarter, then the opposite direction in the next. This type of instability leads to explosive fluctuations in the key macroeconomic variables, which is clearly bad for the economy.

A second potential problem with following a rule is policymakers' loss of discretion. Policymakers often claim that the economy faces many unique circumstances and that only their expertise and judgment produce the right decisions. Thus they prefer the flexibility of exercising discretion rather than following a rule.

To examine the benefits and costs to the economy of having monetary policy guided by McCallum's rule, we proceed in the following way. First, we choose several economic models, which are simply sets of equations that describe the relationships among major economic variables. It's common to allow for the possibility that the equations cannot account for all the potential ways in which the variables may be related. Therefore, each equation may be affected by random influences that, from time to time, will cause it to fail to explain the movements that we observe in economic variables like real GDP and the price level. In keeping with tradition, we call these random influences economic shocks. For example, oil price increases during the mid-1970s resulted in unexpectedly higher inflation, and economists viewed these increased prices as shocks to the equation that explains inflation in many macroeconomic models.

By letting a computer pick random shocks to attach to each equation in a model over the period 1963-93, we simulate how the economy would have behaved over this period if McCallum's rule had determined monetary policy.[2] The computer then solves the equations of the model and generates simulated values for real GDP and the price level over time.

There's one problem with this procedure: the computer may pick an unrealistic set of shocks over time. If it does so, our simulated values of how the economy would have performed with McCallum's rule will not be comparable with the actual historical values of real GDP and the price level. To guard against that

[2]Our models use quarterly data, so the computer picks four shocks each year. The shocks are chosen so that they are as variable, on average, as the actual shocks to the economy.

possibility we simulate each model 500 times. Each time, we allow the computer to choose a different set of shocks, and corresponding to each of these, we generate a simulated path of real GDP and the price level.

Finally, we use the simulation results of each model to examine how the economy would have behaved over the period 1963–93 if McCallum's rule had actually been guiding monetary policy. To do that, we use our 500 simulations to construct ranges of simulated values for real GDP and the price level, in each model, ignoring the largest and smallest 5 percent of the 500 simulated values at each date. We compare these ranges to the actual values of real GDP and the price level.

The key element of simulations with McCallum's rule is the monetary response factor, which determines how much money growth must change when nominal GDP deviates from its target. If the monetary response factor is large, money growth will respond a lot when nominal GDP is off target by a given amount. A smaller monetary response factor will mean a smaller policy change. Having a large monetary response factor is not necessarily a good idea. Our research suggests that if the monetary response factor is too large, it will induce an explosive reaction, or instability, in the economy. When nominal GDP is off target, monetary policy has too strong an effect, and the economy responds by moving too far in the opposite direction. On the other hand, a monetary response factor that is too small means that policy doesn't affect the economy much. There seems to be a range of ideal values for the monetary response factor. (See *Technical Details on McCallum's Rule.*)

THE MODELS

We'll examine three macroeconomic models to evaluate McCallum's rule.[3]

Keynesian Model. Ben Friedman of Harvard University developed a Keynesian model of the economy in the 1970s. In the model, four equations determine the main macroeconomic variables: (1) real GDP growth depends on the growth of government expenditures and on changes in the long-term interest rate and import prices; (2) inflation depends on real GDP growth and changes in import prices; (3) money demand growth depends on real GDP growth and the change in the short-term interest rate; and (4) the long-term interest rate is related to the short-term interest rate. In the absence of shocks, real GDP eventually returns to a normal level, called potential GDP, that does not depend on monetary policy.[4]

McCallum's research suggests using a monetary response factor of 0.25, because that value worked well in his studies. This means that the Fed should increase the growth of the money supply by 0.25 percent for every 1 percent that nominal GDP falls below its target. We simulate the model 500 different times, each time using a different set of randomly determined shocks to the equations of the model over the period 1963-93 (Figure 1). For real GDP, we plot (on a logarithmic scale) the actual value of real GDP over this period, the level of potential GDP, the middle value of the 500 simulations at each date, and upper and lower bounds showing the range in which real GDP lies across the 500 simulations, excluding the largest and smallest 5 percent of the simulations (this gives you an idea of how much variability there is across different simulations).[5]

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[3]The technical details of all the models, our simulation procedure, and more results beyond those presented in this article may be found in our 1994 working paper.

[4]For consistency, we use the same potential GDP assumptions in all three models, even though that requires us to modify Friedman's model slightly. We use the potential GDP series developed at the Federal Reserve Board for use in the P* model.

[5]The logarithmic scale is used so that when a variable grows at a constant rate, the figure shows a straight line.

Technical Details on McCallum's Rule

McCallum's rule contains three major parts: (1) the target for current growth of nominal GDP; (2) a moving-average adjustment for changes in velocity (that is, changes in money demand relative to nominal GDP); and (3) the difference between the target and actual nominal GDP. An equation representing these factors is:

$$\dot{B} = (\dot{P}^* + \dot{Y}^*) - \dot{V} + \lambda\,(X^* - X)/X^*,$$

where B is the monetary base (bank reserves + currency), $\dot{P}^*$ is the target inflation rate, Y^* is the level of potential real GDP, V is the lagged 16-quarter moving average of the velocity of the monetary base, which equals nominal GDP/monetary base, X is last quarter's level of nominal GDP, X^* is last quarter's target for nominal GDP, and λ is the monetary response factor. A dot (·) over a variable indicates the growth rate of that variable.

The first part of the rule, $(\dot{P}^* + \dot{Y}^*)$, is the current targeted growth rate for nominal GDP (equal to potential real GDP growth plus the desired inflation rate).[a] This part of the equation says that money growth should equal the targeted growth of nominal GDP, other things being equal. The second part of the rule, $-\dot{V}$, allows an adjustment for changes in money demand. If the relationship between the monetary base and nominal GDP changes, for example, because of new financial instruments, the growth rate of the monetary base will be adjusted accordingly. The last part of the rule, $\lambda(X^* - X)/X^*$, represents proportional feedback to the growth rate of the monetary base from the proportionate gap between nominal GDP and its targeted level.

Here's an example of how the rule might work in practice. The rule is expressed in quarterly terms, but to make the example clearer, we'll change everything into annual growth rates and multiply the monetary response factor by 4. In March 1994, suppose the target inflation rate is $\dot{P}^* = 3$ percent, potential GDP is growing at $\dot{Y}^* = 2.5$ percent, average velocity growth over the past four years was $\dot{V} = -4$ percent, the nominal GDP gap is 0.2 percent, and the monetary response factor is $\lambda = 0.25 \times 4 = 1$, then McCallum's rule suggests a monetary-base growth rate of (3% + 2.5%) - (-4%) + (1 x 0.2%) = 9.7%. Over the previous year, the monetary base had been growing about 11 percent, so McCallum's rule suggested that monetary policy needed to be tightened somewhat.

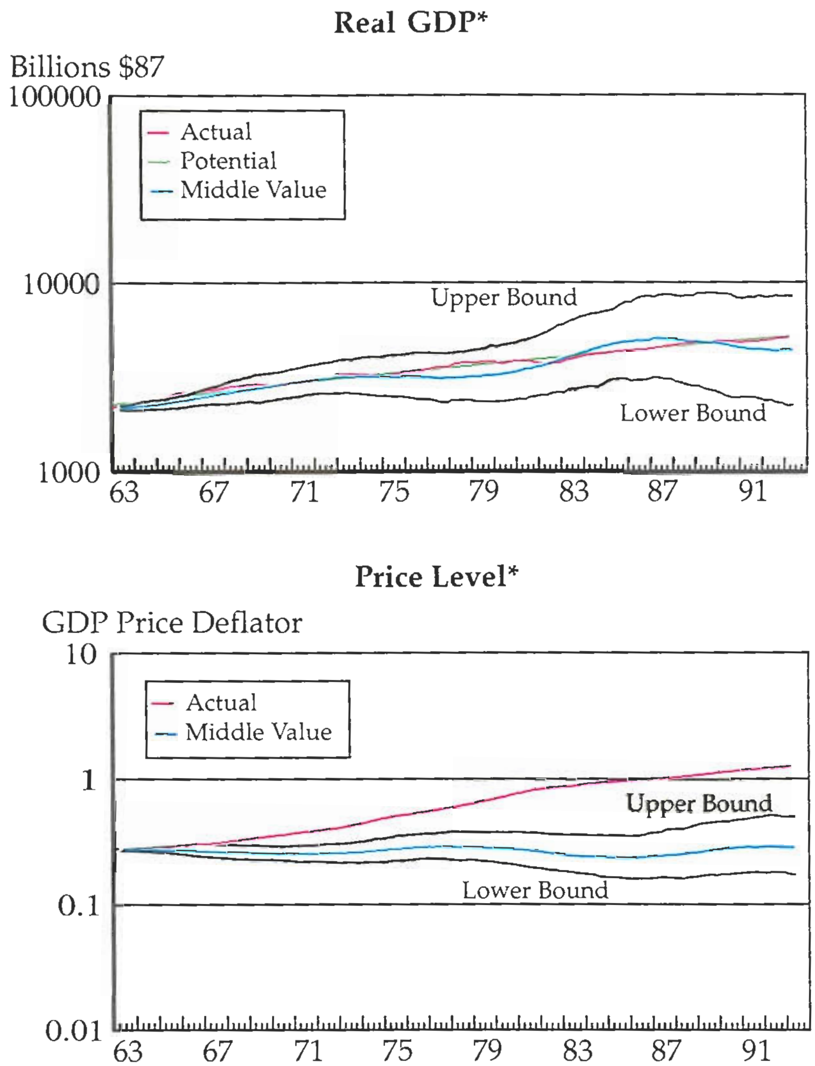
[a]No one knows the exact growth rate of potential real GDP, but many economists estimate that potential real GDP growth is about 2.5 percent. If McCallum's rule is set up with an incorrect growth rate of potential real GDP, a small amount of inflation or deflation could result, since we'd be targeting nominal GDP slightly too high or too low. But such an error is likely to be small.

From the figure you can see that while real GDP appears to be near its potential level, on average, in the simulations, there are large fluctuations above and below potential GDP. These movements correspond to periods of high unemployment, when output is below its potential level, and low unemployment, when output is above its potential level. These fluctuations get larger as time passes, which suggests that there's a problem with using the rule to set monetary policy: it seems to introduce instability into the economy.

The bottom panel of the figure shows the price level over time. As you can see, the rule helps reduce the price level relative to its actual value, which means inflation is much lower on average in the simulations than it was historically. But again, there's a problem of instability as time goes on. We'll discuss this problem in more detail shortly.

FIGURE 1

Keynesian Model Simulations



*Plotted on a log scale

PSTAR+. Herb Taylor at the Federal Reserve Bank of Philadelphia developed the PSTAR+ model in the late 1980s for use in aiding monetary policy decisions. The model is a hybrid between a Keynesian model of the economy, in which changes in short-term interest rates affect output in the short run, and a monetarist model, in which the money supply determines inflation in the long run.

Robert Laurent at the Federal Reserve Bank of Chicago studied the short-run effect of interest rates on output and found that the difference between short-term and long-term interest rates is an important factor affecting output. The long-run effect of the money supply on inflation is based on the P* (pronounced P-star) model developed by Jeffrey Hallman, Richard Porter, and David Small, staff economists at the Board of Governors of the Federal Reserve System. The P* model predicts future inflation using the monetarist theory that, in the long run, the price level is proportional to the money supply.

In addition to equations representing these ideas, the model includes an equation that determines the relationship between the short-term interest rate and the money supply and an equation that determines the long-term interest rate. In the original model, the Fed used changes in the federal funds rate when it wanted to change monetary policy. We modify this slightly to accommodate McCallum's rule, so that the Fed uses changes in the monetary base, which in turn affect the federal funds rate. When the Fed increases growth of the monetary base, the federal funds rate declines initially. This decline in the short-term interest rate increases the spread between long-term and short-term interest rates, stimulating the economy to produce more output. It also increases money growth, which will lead to higher inflation in the future.

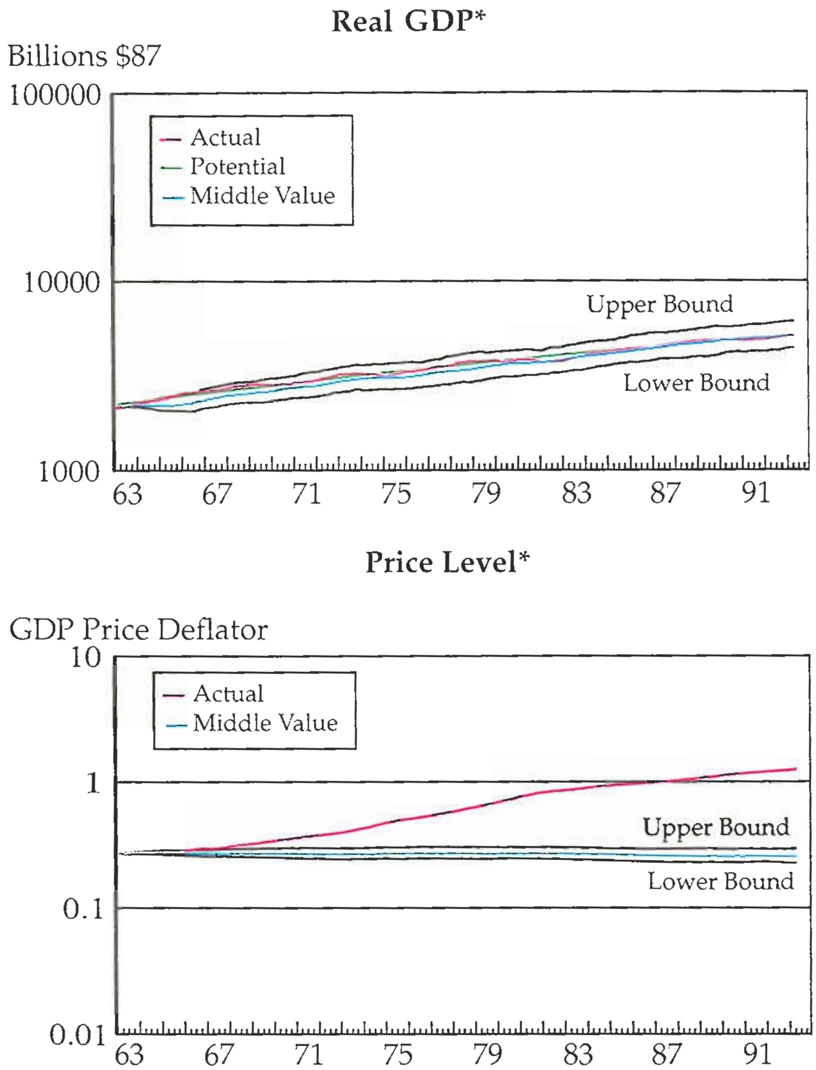
The 500 simulations of this model with a monetary response factor of 0.25 show that McCallum's rule works quite well in stabilizing both real GDP and the price level (Figure 2). The middle path for real output in the economy is quite close to its potential level. And there is little variability along that path, compared with the case in the Keynesian model, as the simulations lie in a quite narrow range. The price level is also stabilized quite well. Inflation is close to zero as a result of using McCallum's rule. And unlike the Keynesian model, there's no sign of instability over time.

Rational Expectations Model. John Taylor of Stanford University developed our third model in 1979. This model assumes that people's expectations about inflation, which affect the demand for output in the economy, are formed using the model itself. The rate of inflation affects the supply of output in the economy because workers are assumed to be locked into fixed nominal wages (for several years) through negotiations with their employers. As a result, higher inflation means firms pay workers less in real terms, so they will hire more workers, earn higher profits, and increase output.

In this model, people's demand for output increases when the Fed increases the growth rate of the money supply, leading to higher output in the short run. In the long run, output returns to its potential level and the inflation rate rises.

FIGURE 2

PSTAR+ Model Simulations



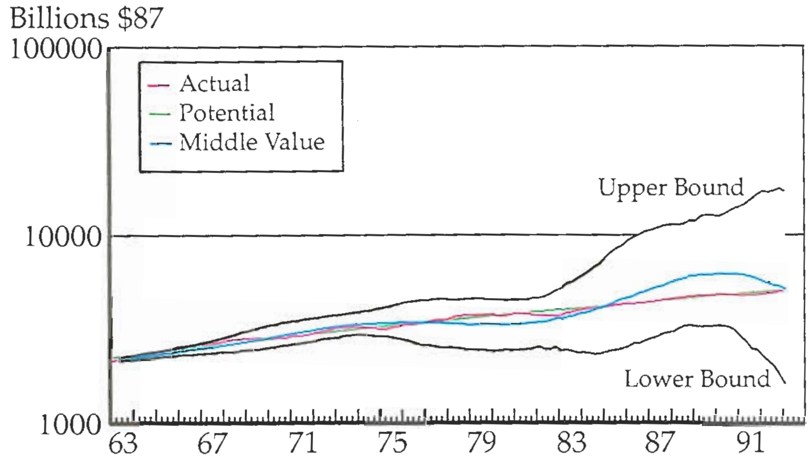
*Plotted on a log scale

Simulations of the model with a monetary response factor of 0.25 (Figure 3) are similar in many ways to those of the Keynesian model. For real GDP, the middle value of the simulations varies around the level of potential real GDP, but with much greater variability than the economy actually had. As time passes, the range of real GDP encompassed by 95 percent

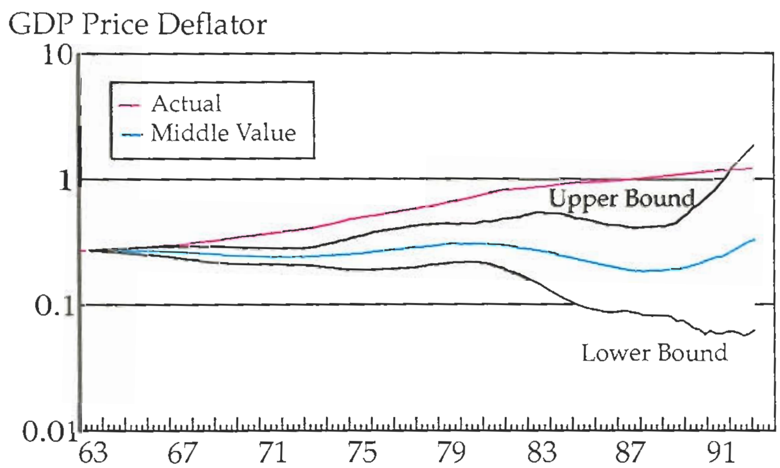
FIGURE 3

Rational Expectations Model Simulations

Real GDP*



Price Level*



*Plotted on a log scale

of the simulations gets larger, suggesting a problem of instability. The fact that the middle value and upper and lower bounds show waves also suggests an instability problem. The simulated price level also seems to suffer from instability, but average inflation is much lower than it was historically.

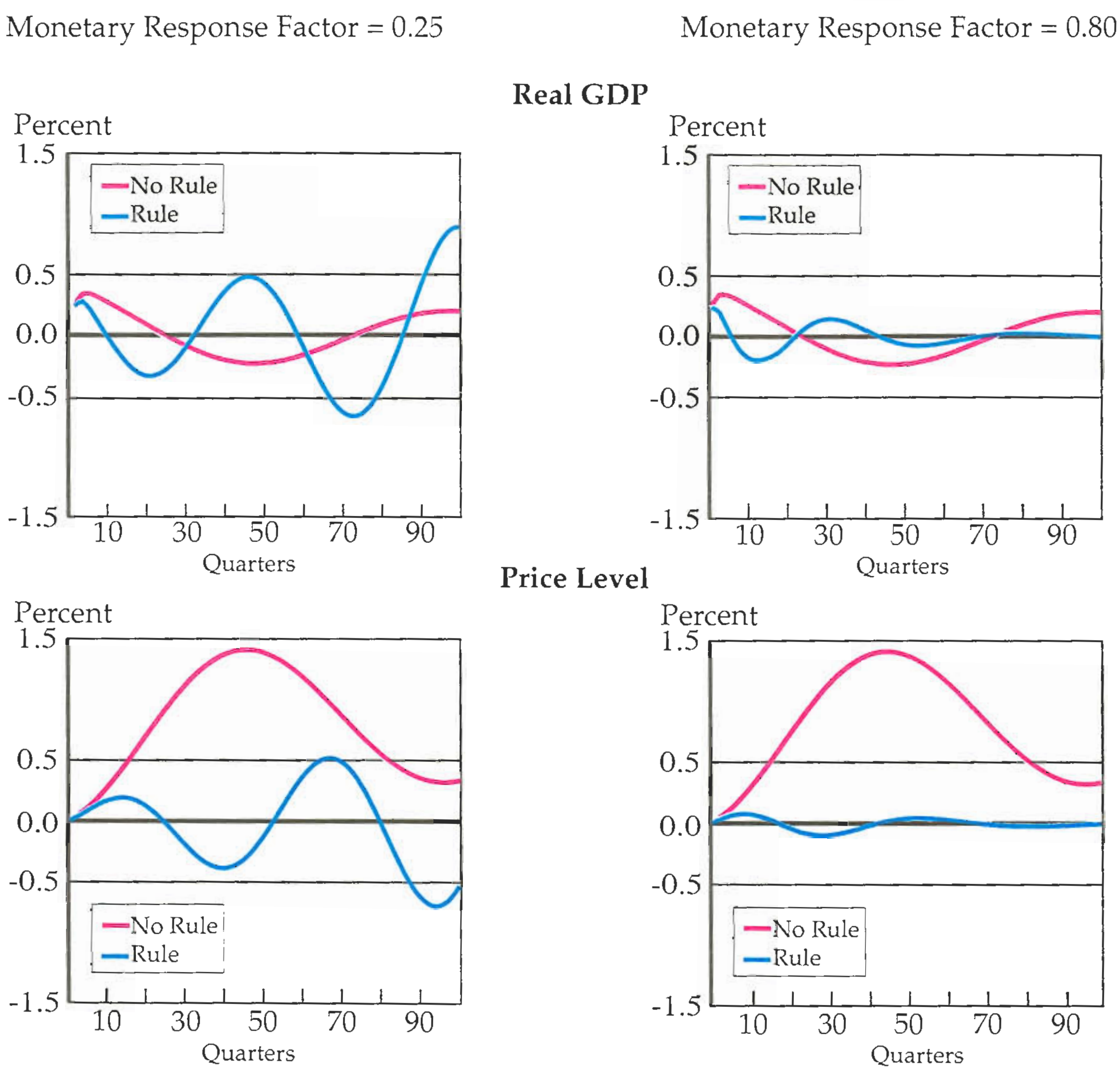
Stability Issues. In all three models, using McCallum's rule seems to be useful, on average. The average level of real output seems to be at about its potential level, while the price level is much lower in the simulations than it was historically. However, only in the PSTAR+ model were both real GDP and the price level stable. In both the Keynesian and the rational expectations models, McCallum's rule seems to introduce instability.

We investigate this matter further by conducting some additional simulations with different values of the monetary response factor. The Keynesian model requires a much larger policy response; the monetary response factor should be about 0.80 instead of 0.25. Such a large value of the monetary response factor means that nominal GDP hits its target very closely. Both real output and the price level are stabilized quite well, and the range of the simulations is quite narrow. This result is perhaps not surprising, since Keynesian models are designed to give government stabilization policies a strong role. If the monetary response factor is low, the range of the simulations becomes larger over time, and the economy is unstable.

We demonstrate the results of our search for better values of the monetary response factor by isolating the economy's response to a particular shock. Suppose there's a spending shock that raises people's demand for goods and services. We look at what happens in the Keynesian model to real GDP and the price level over the 100 quarters following the shock when the monetary response factor is 0.25 and when it is 0.80, compared with the economy's response when McCallum's rule isn't used (Figure 4). In the absence of McCallum's rule, the shock immediately increases real GDP, as firms increase their production to accommodate higher demand. Over time, in the absence of McCallum's rule, output returns to its potential level, but the price level begins to rise. With McCallum's rule and a monetary response factor of 0.25, the figure shows instability in real GDP: it declines more than it would have without the rule, then it rises even more, then it declines even more, and so on. However, when

FIGURE 4

The Proportionate Response of Real GDP and The Price Level to a Spending Shock



the monetary response factor is set to 0.80, not only is the price level stabilized immediately, but real GDP is much more stable. Unfortunately, when the monetary response factor is 0.80, both the PSTAR+ model and the rational expectations model are unstable.

FURTHER ISSUES

Since the size of the monetary response factor is critical in determining whether McCallum's rule leads to instability, is there anything we can do to modify the rule to guarantee stability? One possibility is to argue that certain models are poor representations of the economy. If so, we should eliminate them from consideration in deciding on a rule for monetary policy. But macroeconomists remain divided, and none of these models can be easily eliminated from contention.

Another potential way to eliminate instability is to allow the rule to depend on additional factors. As the rule is currently structured, changes in the monetary base are made proportionally in response to deviations of nominal GDP from its target. But A.W. Phillips long ago recognized that proportional policy responses could be destabilizing and suggested additional feedback based on both the long-term average of the target variable and the current change in the target variable. Incorporating these additional factors into McCallum's rule could eliminate the instability we found.

Another issue relates to the actual use of the rule. Suppose the Fed were to adopt McCallum's rule or use it as a guide to policy. Over time, we would be able to see how the economy reacted to shocks when the rule was in use. The rule could then be refined to find the best level for the monetary response factor. The Fed could even develop a metarule—a rule for changing McCallum's rule.

Just as with all other policy changes, the Lucas critique points out an important limitation to our simulation results. We don't have a good idea of how people's behavior would change if the Fed were to implement McCallum's rule. As macroeconomists develop new theories of behavior, we may be better able to simulate the effects of using McCallum's rule.

Can McCallum's rule be sold to policymakers as a reasonable alternative to discretionary policymaking? Policymakers seem unalterably opposed to nonactivist rules like Milton Friedman's, in which a variable such as the growth rate of the money supply is set once and for all, without regard to the condition of the economy. However, McCallum's rule is an activist one—monetary policy eases during recessions and tightens during expansions. But because so many unique events affect the economy, policymakers seem unlikely to ever give up discretionary policymaking, even for an activist rule. Still, McCallum's rule may help provide some guidance to discretionary policymaking.

McCallum's rule is potentially useful for setting monetary policy. Had the rule been followed over the past 30 years, inflation would have been much lower than it actually was. But the rule can't yet be put into practice, because our research has found that different monetary response factors are necessary to prevent instability with different models.

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