Nominal GDP Targeting Rules: Can They Stabilize the Economy?

By Todd E. Clark

As the monetary aggregates have become less reliable guides for monetary policy, considerable interest has developed in identifying some other fundamental guide for policy. Many analysts argue that the best guide might be nominal gross domestic product (GDP). Some of these analysts also argue the Federal Reserve should target nominal GDP using one of several possible rules. Such a rule would specify how the Federal Reserve should adjust policy to affect a short-term interest rate in response to deviations of nominal GDP from target.

This article examines the performance of nominal GDP targeting rules using statistical simulations of the economy. The first section reviews the argument that policymakers should target nominal GDP using a rule. The second section describes some alternative targeting rules. The third section shows how these rules would perform based on simulation analysis of models of the U.S. economy. The article concludes that policymakers cannot be certain that a simple nominal GDP targeting rule would improve economic performance.

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THE ARGUMENT FOR A NOMINAL GDP TARGETING RULE

Since the mid-1970s, the Federal Reserve has established target ranges for the monetary aggregates and has monitored growth in the aggregates relative to the targets. But in recent years, financial market innovation and deregulation have made the aggregates much less reliable policy guides. Many believe the reduced reliability of the aggregates has created a need for some other fundamental guide for policy. Some analysts also argue that nominal GDP should replace the monetary aggregates as a guide for monetary policy and that following a simple rule for targeting nominal GDP would help stabilize the economy.

The need for an alternative target variable

Targets for variables like the monetary aggregates or nominal GDP, it is maintained, might help policymakers balance the policy goals of sustainable economic growth and price stability. With a good target variable, holding the variable on target should help stabilize real GDP in the short term and also yield inflation consistent with the long-term objective of price stability.[1]

For a number of years, the Federal Reserve

relied on targets for the monetary aggregates. The targets helped stabilize real GDP in the short term. For example, sluggish money growth was seen to signal a slowdown in real GDP growth. As a result, easing monetary policy when money growth fell below target helped moderate declines in real GDP growth. The targets for the monetary aggregates were also expected to help policymakers achieve long-term inflation objectives. Throughout most of the 1980s, for example, the Federal Reserve gradually lowered the money growth targets to guide its efforts to gradually reduce inflation.

In recent years, however, the monetary aggregates have become unreliable guides. For example, given the historical relationship between M2 growth and economic activity, the sluggish behavior of M2 in 1992 and 1993 would have been consistent with an economy in recession (Board of Governors of the Federal Reserve System). Instead, the economy grew an average of 3.3 percent per year as measured by real GDP. To many analysts, such false signals create a need for some other fundamental guide for policy.

The potential benefits of nominal GDP targeting

Nominal GDP may be a useful guide for policy because it is closely related to real GDP growth and inflation. By definition, nominal GDP equals the product of real GDP and the price level. Similarly, the growth of nominal GDP equals the sum of real GDP growth and inflation.

Over short periods, changes in nominal GDP growth give rise to similar changes in real GDP growth with little or no impact on inflation.[2] For example, nominal GDP growth slowed from 8.7 percent in the first quarter of 1990 to 2.8 percent in the first quarter of 1991. Mirroring the drop in nominal GDP growth, real GDP slowed from a 3.4 percent rate of growth to a 2.1 percent rate of decline. Inflation fell only slightly, from 5.1 percent to 4.8 percent.[3]

Over long periods, in contrast, changes in nominal GDP growth are closely linked to inflation with no impact on real GDP. Because in the long run real GDP grows at a fairly constant trend, long-run inflation will tend to equal nominal GDP growth minus the trend growth of real GDP. For example, if real GDP grows at a trend rate of 2 1/2 percent, the Federal Reserve could achieve a long-run inflation goal of 1 percent by maintaining nominal GDP growth at 3 1/2 percent.

In addition to its link to policy goals, nominal GDP has two other features that would, in principle, make it a good guide for policy.[4] First, under nominal GDP targeting, monetary policy would adjust to offset disturbances to aggregate demand. In the short run, an adverse aggregate demand disturbance, such as a drop in exports stemming from a recession in the economy of an important foreign trading partner, tends to slow real GDP growth and, accordingly, nominal GDP growth. In response to the reduction of nominal GDP growth below the targeted rate, policymakers would ease monetary policy to return nominal GDP growth to target. This policy change would stimulate aggregate demand, returning both demand and real GDP growth to predisturbance levels.

A second attractive feature of nominal GDP targeting is that it would help policymakers balance the goals of stable growth and inflation in responding to aggregate supply disturbances. In the short run, an adverse supply disturbance, such as a jump in oil prices, produces two undesirable consequences—falling real GDP growth and rising inflation. These consequences pose a dilemma. Changing monetary policy to stabilize one variable creates additional volatility in the other variable. For example, easing policy to stimulate an economy slowed by a spike in oil prices would limit the decline in real GDP growth but would exacerbate inflation. Conversely, tightening policy to stabilize inflation would exacerbate the decline in real GDP.

Nominal GDP targeting would help policymakers resolve the dilemma by placing equal emphasis on stability of both real GDP growth and

inflation. Monetary policy would be adjusted to equalize the output and inflation effects of an aggregate supply disturbance. For example, an oil price hike that caused real GDP growth to fall by 1 percent and inflation to rise by 0.5 percent would reduce nominal GDP growth by 0.5 percent. Under nominal GDP targeting, monetary policy would respond by stimulating the economy enough to raise nominal GDP growth by 0.5 percent, thus returning nominal GDP growth to its targeted rate. As a result of this policy response, real GDP growth would fall and inflation would rise by the same amount, say 0.75 percent.[5] Thus, nominal GDP targeting would balance the consequences of the supply disturbance.

The potential benefits of a rule

In implementing nominal GDP targeting, policymakers might adopt any of a variety of targeting procedures. Target ranges for nominal GDP growth might be used in the same way that target ranges for the monetary aggregates have been used in the past. Under such a procedure, policymakers would monitor the actual rate of nominal GDP growth relative to target. They would then use this information, along with other indicators, to make discretionary adjustments to policy. Alternatively, policymakers might adopt more formal procedures for targeting nominal GDP. For example, policymakers could use a simple rule, rather than discretion, in adjusting policy.[6]

Rule-based and discretion-based monetary policy differ fundamentally in that a rule dictates systematic monetary policy action, while discretion does not. A rule would specify when and by how much the Federal Reserve would adjust policy in response to deviations from target of a variable like nominal GDP. A rule ensures systematic action: under a rule, policymakers would adjust policy the same way this year in response to a deviation from target as they would two years from now. In contrast, discretion-based policy permits policymakers to make policy adjustments on a case-by-case basis.

Some analysts argue rule-based policy is superior because it will produce lower inflation than discretionary policy. Suppose, for example, policymakers announce a target for nominal GDP growth of 3.5 percent under the assumption that such a rate is consistent with a long-term inflation objective of 1 percent and an expected long-term real GDP growth rate of 2.5 percent. The systematic policy adjustments dictated by a nominal GDP targeting rule would be expected to yield nominal GDP growth of 3.5 percent over long periods. As long as real GDP grows at the expected trend rate of 2.5 percent, inflation would remain at 1 percent.

In contrast, the nonsystematic policy adjustments permitted by discretionary policy could result in an average nominal GDP growth rate that exceeds the target rate. Consequently, discretionary policy might yield higher inflation than desired. Discretionary policy may suffer an inflationary bias because it gives policymakers the option to depart occasionally from announced targets.[7] For example, policymakers may decide to boost nominal GDP growth above target when an aggregate supply disturbance reduces growth or causes a recession. Such discretionary shifts to easier policy might not only push nominal GDP growth above target but, if maintained, might also result in higher inflation.

SOME SIMPLE NOMINAL GDP TARGETING PROCEDURES

Advocates of rules for targeting nominal GDP have proposed a number of specific rules. Typically, these rules call for adjusting a short-term interest rate, such as the federal funds rate, to keep nominal GDP on target.[8] While policymakers have no direct control over nominal GDP, they do have great influence over short-term interest rates. Through open market operations, for example, policymakers can increase the degree of pressure on reserve positions, thereby causing the federal funds rate to rise.

The proposed rules for targeting nominal GDP differ, in part, as to when policymakers would react

to deviations of nominal GDP from target. One rule dictates that monetary policy would change when actual nominal GDP is *observed* to deviate from target. Another rule dictates that policy would change when *projected future* nominal GDP deviates from target. This section examines these two rules for targeting nominal GDP—a lagged adjustment rule and a forecast adjustment rule.[9]

Lagged adjustment. Under the lagged adjustment rule, policymakers would adjust a short-term interest rate, such as the federal funds rate, after observing a deviation of nominal GDP growth from target. Policymakers would raise the funds rate if nominal GDP growth last quarter exceeded the targeted growth rate. Conversely, policymakers would lower the funds rate if nominal GDP growth last quarter was below the targeted rate. The rule stipulates that policymakers adjust the current interest rate systematically by x percent whenever last quarter's nominal GDP growth rate (annualized) deviated from target by one percentage point.[10]

Advocates of this rule have set the adjustment parameter x at a variety of values. Most recently, Judd and Motley (1993) suggested a value of 0.20. At this level, whenever nominal GDP growth (annualized) exceeds target by one percentage point, policymakers would raise the short-term interest rate by 0.20 percent, or 20 basis points. In a previous study, Judd and Motley (1992) advocated a lower adjustment rate x of 0.125. At this level, for every one-percentage-point gap between actual and target GDP growth (annualized), policymakers would adjust the interest rate by 0.125 percent, or 12.5 basis points.[11]

Because the lagged adjustment rule calls for adjusting an interest rate only after nominal GDP deviates from target, it may result in unnecessarily protracted deviations of nominal GDP from target. These deviations would occur because the rule ignores delays in the effects on nominal GDP of changes in monetary policy.[12] From the time policymakers adjust a short-term interest rate, two to three quarters may pass before nominal GDP responds. Many firms, for example, commit well in advance to plans for spending on plants and equipment. While a change in the interest rate might quickly affect plans for future spending, a number of months could pass before any change in plans affects actual spending.

Forecast adjustment. An alternative rule which accounts for the delays in the effects of monetary policy may better stabilize nominal GDP growth at the targeted rate. Under this alternative forecast adjustment rule, policymakers look forward, recognizing that an adjustment in current monetary policy probably will not affect nominal GDP until two to three quarters in the future. Using forecasts of future nominal GDP growth, this alternative rule adjusts current monetary policy to try to offset expected future deviations of nominal GDP from target.

Under the forecast adjustment rule, policymakers would adjust a current short-term interest rate until forecasted future growth in nominal GDP equals the targeted rate. If, at the current interest rate level, forecasts indicate nominal growth next year will exceed the targeted rate, policymakers would raise the short-term interest rate. The increase in the interest rate would be expected to slow future growth in nominal GDP and, as a result, reduce forecasted nominal GDP growth. Policymakers would raise the interest rate enough that, based on the higher rate, the forecast for future growth of nominal GDP equals the targeted rate.[13] Conversely, if forecasts indicate nominal GDP growth next year will be below target, policymakers would reduce the short-term interest rate enough to raise forecasts to target.

Advocates of the rule have proposed a variety of forecast procedures. Some suggest the Federal Reserve use its own forecasts for nominal GDP growth in setting policy. These forecasts might be the consensus of Federal Open Market Committee members or the view of the staff of the Board of Governors.[14] In this version of the forecast adjustment rule, policymakers would rely on their own projection for the next year in adjusting a current interest rate to keep projected nominal GDP growth on target. In contrast, Hall and Mankiw (1993) suggest the Federal Reserve use a consensus prediction of

private forecasters, such as the Blue Chip consensus, in setting policy.[15] In this version of the rule, policymakers would adjust a current interest rate until the consensus private forecast for next year equals the targeted nominal GDP growth rate.

Both rules have merits. In principle, the forecast rule would prove superior to the lagged adjustment rule at stabilizing nominal GDP growth. The forecast rule adjusts policy now to prevent predicted future deviations of nominal GDP from target. For example, suppose current forecasts indicate U.S. exports will decline next year and, as a result, the projected growth of next year's nominal GDP is below the targeted rate. The forecast adjustment rule dictates that policymakers reduce a short-term interest rate now, by enough to spur next year's nominal GDP growth rate to exactly offset the predicted effect of the fall in exports. In contrast, the lagged adjustment rule would adjust monetary policy only after nominal GDP actually deviates from target. Given this delayed reaction of policy and the lagged effects of policy changes, several quarters may pass before monetary policy succeeds at spurring nominal GDP back toward target.

In practice, however, forecasters make errors in predicting future movements in nominal GDP. If forecast errors are large and frequent, the lagged adjustment rule may better stabilize nominal GDP. A simple example illustrates how, in practice, the lagged adjustment rule might prove superior. Suppose forecasts call for next year's nominal GDP growth rate to fall 1 percent below target due to a sharp deterioration in exports. Under the forecast rule, policymakers would reduce the current interest rate to spur next year's nominal GDP growth rate enough to offset this disturbance. If, however, forecasters proved to be wrong and the projected deterioration in exports failed to occur, the change in monetary policy would push nominal GDP growth above the targeted rate. Due to the forecast error, the forecast adjustment rule would create a deviation of nominal GDP from target.

Because analysts disagree about the magnitude of forecast errors, they disagree about which rule would better stabilize nominal GDP. Some analysts argue forecasts are sufficiently accurate that the forecast rule would better stabilize nominal GDP. Hall and Mankiw (1993), for example, show forecasts have "substantial" predictive power for actual nominal GDP growth and conclude the forecast rule "makes sense." Others argue forecast errors are so large that the lagged adjustment rule would better stabilize nominal GDP. Meltzer (1987), for example, shows forecast errors are large enough to prevent forecasters from distinguishing between recession and boom. He concludes "policies based on forecasts are unlikely to stabilize the economy" and suggests a lagged adjustment rule.

SIMULATION EVIDENCE

While there is reason to believe simple nominal GDP targeting rules might be good policy-setting procedures, policymakers have no experience with such rules. As a result, direct evidence on their performance is not available. Instead, statistical simulations can provide indirect evidence on how well the proposed rules for targeting nominal GDP might perform.

The statistical simulations presented here measure the performance of the economy under each of the two policy rules.[16] As detailed in the appendix, the simulations use the policy rules to create counterfactual data on real GDP growth and inflation. The data are counterfactual because they are generated from a model in which monetary policy is guided by one of the nominal GDP targeting rules.

The performance of each rule is gauged by comparing volatility in counterfactual, rule-guided data to volatility in historical data.[17] If, for example, real GDP growth and inflation volatility prove to be lower in the counterfactual data than in historical data, the simulations will provide indirect evidence that the rules would be good policies.

This section presents simulations of the forecast adjustment and lagged adjustment rules for

targeting nominal GDP. The simulations yield two important findings. First, some of the simulation results contradict the results of earlier studies. Second, some of the simulation results differ sharply from most analysts' and policymakers' prior expectations about successful policies. These findings suggest simulation analysis cannot definitively determine whether the simple nominal GDP targeting rules will improve economic performance.

The models

To ensure that the simulation results do not depend on the specific model of the economy used in the analysis, simulations are conducted with two different models. The first model, detailed in the appendix, imposes little structure on the economy and may be viewed as an atheoretical model. It relates current values of real GDP growth, inflation, M2 growth, and a short-term nominal interest rate to previous values. This model is similar to atheoretical models used in other studies (such as Judd and Motley 1992, 1993). It differs from some atheoretical models in two minor respects. The atheoretical model used here features the level of the interest rate rather than the change in the interest rate.[18] And, the model imposes no restrictions on the relationships between the current values of each variable in the model and previous values, whereas some other studies impose restrictions by eliminating particular variables from certain equations of the model.

The second model, also detailed in the appendix, assumes a textbook aggregate supply/aggregate demand structure to the economy.[19] The aggregate supply equation, a Phillips curve, relates inflation to expected inflation and the gap between actual and potential real GDP. The aggregate demand equation relates real GDP growth to a short-term real interest rate. This structural model is also similar to models used in other studies. It differs slightly from some other models, however, in that monetary policy affects aggregate demand directly rather than indirectly.[20] In the structural model used in this article, policy adjustments to the interest rate affect real GDP growth directly. In other studies (Judd and Motley 1992, 1993), policy adjustments to the interest rate affect real GDP growth indirectly through their influence on money growth.

Evidence on the forecast adjustment rule

Statistical simulations are first used to evaluate the forecast adjustment rule. As detailed in the appendix, the forecast rule examined in these simulations relies on forecasts of nominal GDP from an equation that relates nominal GDP growth to lagged values of nominal GDP growth and a short-term interest rate. The specification of the equation is derived from historical estimates of the relationship between nominal GDP growth and lagged values of nominal GDP growth and the interest rate.

Simulations using the forecast adjustment rule indicate the rule will significantly stabilize both real GDP growth and inflation (Table 1). The atheoretical model simulations show that using the forecast adjustment rule to keep nominal GDP growth on target can be expected to reduce volatility in both real GDP growth and inflation by about 8.5 percent relative to historical levels. Simulations of the structural model indicate the forecast adjustment rule will yield smaller but still sizable benefits. According to these simulations, both real GDP growth and inflation variability will fall about 5 percent. Thus, at least on the surface, the forecast adjustment rule appears to hold promise for the conduct of monetary policy.

Evidence on the lagged adjustment rule

As was the case with the forecast adjustment rule, statistical simulations of both the atheoretical and structural models are used to evaluate the lagged adjustment rule. Following the recent work of Judd and Motley (1993), the version of the lagged adjustment rule first examined in these simulations sets the adjustment parameter x at 0.20. At this level,

Table 1

Economic Performance Under the Forecast Adjustment Rule

Percentage Reduction in Volatility

	Atheoretical model
Real GDP growth	8.6
Inflation	8.4
	Structural model
Real GDP growth	4.9
Inflation	5.5

Note: Positive entries indicate reductions in volatility relative to historical volatility.

policymakers adjust a short-term interest rate 20 basis points for every one-percentage-point gap between actual and targeted nominal GDP growth.

Simulations with this version of the lagged adjustment rule suggest the rule will fail to stabilize the economy (Table 2, column 1). The policy rule will raise the volatility of both real GDP growth and inflation substantially above historical levels. The atheoretical model simulations indicate that, under the rule, real GDP growth volatility will soar 13.7 percent above the historical level. And, inflation variability will rise 3.2 percent. The structural model simulations indicate comparably adverse consequences of lagged adjustment. The volatility of real GDP growth will rise 6.4 percent above the historical level, and the volatility of inflation will rise 13.9 percent.

While the lagged adjustment rule fails when the adjustment parameter x is set at 0.20, the rule may well succeed at stabilizing the economy when x takes on different values. The rule may, for example, succeed when the adjustment parameter x equals the value of 0.125 first advocated by Judd and Motley (1992). At this level, policymakers change a short-term interest rate 12.5 basis points for every one-percentage-point difference between actual and targeted nominal GDP growth.

Simulations using this version of the lagged adjustment rule indicate the rule might succeed at stabilizing the economy (Table 2, column 2). The atheoretical model simulations indicate this version of the rule will reduce volatility in real GDP growth by 2.9 percent and volatility in inflation by 5.5 percent. In contrast, simulations under the structural model indicate this specification of the lagged adjustment rule will perform slightly worse than historical policy. According to the structural model simulations, the rule will raise real GDP variability by 0.6 percent and inflation variability by 4.0 percent. Together, the favorable atheoretical model results and the unfavorable structural model results suggest at least the possibility that this version of the rule might stabilize the economy.

These simulations show clearly that the lagged adjustment rule performs better when the adjustment parameter x is set at the lower value of 0.125

Table 2

Economic Performance Under the Lagged Adjustment Rule

Percentage Reduction in Volatility

	Adjustment percent $x = .20$	Adjustment percent $x = .125$	Adjustment percent $x = 0$ (constant rate)
	Atheoretical model		
Real GDP growth	-13.7	2.9	12.1
Inflation	-3.2	5.5	12.0
	Structural model		
Real GDP growth	-6.4	-.6	4.5
Inflation	-13.9	-4.0	13.3

Note: Positive entries indicate reductions in volatility relative to historical volatility. Conversely, negative entries indicate increases in volatility.

rather than 0.20. According to the atheoretical model simulations, for example, the volatility of real GDP growth falls 2.9 percent from the historical level when the adjustment parameter is set at 0.125, but rises 13.7 percent when the parameter is set at 0.20.

The improvement in the performance of the lagged adjustment rule associated with the reduction of the adjustment parameter suggests the rule may perform even better if the adjustment rate is reduced further. Additional simulations confirm this speculation. Simulations using versions of the lagged adjustment rule that set the adjustment parameter x at a number of different values indicate the rule best stabilizes the economy when x is reduced all the way to zero. At this level, policymakers do not adjust the interest rate at all when nominal GDP growth deviates from target. They instead maintain a constant interest rate.

Under the constant interest rate policy, the volatility of real GDP growth and inflation is greatly reduced (Table 2, column 3).[21] The atheoretical model simulations indicate the constant-rate policy will reduce variability in both real GDP growth and inflation by about 12 percent relative to historical policy. The structural model simulations show the constant-rate policy will reduce real GDP growth volatility by 4.5 percent and inflation variability by about 13 percent. These reductions in volatility are even greater than those achieved under the forecast adjustment rule.

Lessons from the simulation evidence

On the surface, the simulation results suggest a simple rule for targeting nominal GDP might perform well, stabilizing both real GDP growth and

inflation. For example, evidence suggests the forecast adjustment rule would reduce volatility of real GDP growth and inflation and that, with a sufficiently low adjustment parameter, the lagged adjustment rule would also reduce volatility. Considered carefully, however, the simulation results are not convincing. Some of the simulation results differ sharply from those of previous studies. Moreover, other simulation results run strongly contrary to most analysts' and policymakers' expectations. These findings suggest simulation analysis does not provide convincing evidence for a nominal GDP targeting rule.

Differences from previous studies. The forecast adjustment rule results contradict those of Hall and Mankiw (1993). This article finds the forecast adjustment rule succeeds at reducing volatility in real GDP growth and inflation. In contrast, Hall and Mankiw (1993) concluded the forecast adjustment rule fails.[22] In their analysis the rule produces more volatility than historical policy has produced, especially in real GDP growth.[23]

In addition, the results for the version of the lagged adjustment rule that sets the adjustment parameter x at 0.20 differ from the results of Judd and Motley (1993). This article finds that when the parameter x equals 0.20, the lagged adjustment rule fails. The rule raises real GDP growth and inflation volatility significantly above historical levels. In contrast, Judd and Motley (1993) concluded the policy succeeds. In their analysis the rule reduces inflation volatility, while leaving real GDP growth volatility near the historical level. Since the models used by Judd and Motley differ only slightly from those used in this article, these differences in results suggest conclusions about rules drawn from simulation evidence are very sensitive to slight differences in models.[24]

A difference from expectations. The result that the constant-rate policy best stabilizes the economy is at sharp odds with most analysts' and policymakers' expectations. Most believe stabilizing real GDP growth and inflation would require significant volatility in the interest rate (for example, Hall and Mankiw). Accordingly, most would expect the constant interest rate version of the lagged adjustment rule to fail at stabilizing the economy.

The expected failure of the constant-rate policy rule is supported by economic theory.[25] Theory suggests pegging an interest rate will reduce policymakers' control of inflation and tend to lead to excessive inflation. When monetary policy pegs an interest rate, it must accommodate every increase in the demand for money. An increase in money demand will tend to push up the interest rate, so monetary policy must increase the supply of money to keep the interest rate at the pegged level. Because increases in the supply of money lead to increases in the price level, there is nothing to tie down the price level (Friedman; Blanchard and Fischer). Interest rate pegging therefore reduces policymakers' control of inflation.

CONCLUSIONS

Some analysts argue monetary policy should follow a simple nominal GDP targeting rule. They point to the general benefits of targets and to the specific advantages of nominal GDP targets and rules for policy. A number of alternative nominal GDP targeting rules have been proposed. These rules include adjusting an interest rate so that forecasted nominal GDP growth always equals the targeted rate, and adjusting a current interest rate in response to last quarter's gap between actual and targeted nominal GDP growth.

Simulations of models of the economy with nominal GDP targeting rules yield two troubling findings. First, some pieces of the simulation evidence contradict the results of earlier studies which used slightly different models. Second, some pieces of the simulation evidence differ sharply with most analysts' and policymakers' prior expectations about successful policies. These findings show that, based on simulation analysis, policymakers cannot be certain a simple nominal GDP targeting rule will improve economic performance.

APPENDIX

This appendix details the specifications of the atheoretical and structural models, the specification of the forecast adjustment rule, and the simulation procedure.

The atheoretical model

The atheoretical model takes the form of a vector autoregression (VAR), augmented to include an error correction term. The VAR variables consist of real GDP growth, inflation as measured by the growth rate of the GDP implicit price deflator, M2 growth, and the 3-month T-bill rate. The error correction term equals the log level of M2 velocity. Four lags of each variable are included in the VAR. The residuals of each VAR equation represent the model shocks.

While this model imposes few restrictions on the data, it lacks a theoretical structure. None of the model's equations or disturbance terms can be directly interpreted as aggregate supply or aggregate demand forms. The only structure imposed on the model is the assumption that the interest rate equation of the VAR represents historical policy (following Feldstein and Stock). Monetary policy may be viewed as setting the interest rate according to a rule given by the deterministic component of the equation, with discretionary changes in policy given by the residual.

The structural model

The structural model takes a textbook aggregate supply/aggregate demand form, with equations for aggregate demand, aggregate supply, and historical monetary policy.[26] The aggregate demand function relates current real GDP growth to lagged values of growth, lagged values of the real short-term interest rate, and a demand disturbance:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta Y_{t-1} + \alpha_2 \Delta Y_{t-2} + \alpha_3 (i_{t-2} - \pi^e_{t-2}) + \alpha_4 (i_{t-4} - \pi^e_{t-4}) + \alpha_5 (i_{t-8} - \pi^e_{t-8}) + \varepsilon^d_t,$$

where ΔY denotes real GDP growth, i represents the 3-month T-bill rate, π^e denotes the expected rate of inflation, and ε^d is a demand shock. Expected inflation equals the inflation rate predicted by a relationship between actual inflation and lagged values of inflation and the interest rate:

$$\pi^e_t = \delta_0 + \sum_{j=1}^{4} \delta_j i_{t-j} + \sum_{j=1}^{4} \delta_{j+4} \pi_{t-j}.$$

The aggregate supply function relates actual inflation to expected inflation, the gap between the levels of actual and potential real GDP, and a supply disturbance:

$$\pi_t = \pi^e_t + .02 (Y_t - YP_t) + \varepsilon^s_t,$$

where Y and YP indicate the levels of, respectively, actual and potential real GDP, and ε^s is a supply shock. Potential output is measured as the smooth trend in actual real GDP.[27] The Phillips curve slope is set at 0.02 to be consistent

with previous studies (such as Judd and Motley 1992, 1993).

The historical policy equation relates the current interest rate to lagged values of the interest rate, real GDP growth, inflation, and a discretionary disturbance:

$$i_t = \beta_0 + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \sum_{j=1}^{4} \beta_{j+2} i_{t-j} + \sum_{j=1}^{3} \beta_{j+6} \pi_{t-j} + \varepsilon_t^{pol},$$

where ε^{pol} is a discretionary change in monetary policy. Monetary policy may be viewed as setting the interest rate according to a rule given by the deterministic component of the equation, with discretionary changes in policy given by the residual ε^{pol}.

The model parameters

The parameters of the atheoretical and structural models are estimated using quarterly data from 1959 to 1988. Ending the sample period in 1988 is a matter of convenience: 1959-88 parameter estimates produce more stable simulations than 1959-93 estimates. The instability induced by extending the sample period may be associated with the recent upward trend in M2 velocity.

Specification of the forecast adjustment rule

The forecast rule is based upon a simple regression relationship between the interest rate and nominal GDP growth, fit with 1959-88 data:

$$\Delta X_t = \varphi_0 + \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \varphi_3 i_{t-2} + \varphi_4 i_{t-3} + \varphi_5 i_{t-4} + \varepsilon_t,$$

where ΔX denotes nominal GDP growth and ε represents the error in forecasting current nominal GDP growth from previous values of nominal GDP growth and the interest rate. According to this relationship, movements in the current interest rate do not affect growth until two quarters in the future. So the forecast rule adjusts the current interest rate to keep nominal growth two quarters hence on target.

The adjustment rule simplifies to a relationship between the current interest rate and lagged values of the interest rate and nominal GDP growth. The rule specification assumes the Federal Reserve has only lagged information on growth and inflation when it must decide to adjust the current interest rate. The parameters of the rule are derived by using the estimated nominal GDP growth equation to compute the forecasted growth rate two periods in the future as a function of the current interest rate and the lagged interest rates and growth rates, setting that forecast equal to the target growth rate, and then solving for the current interest rate.

Simulation procedure

The basic simulation procedure consists of two steps, the second of which is performed twice. The first step is to generate random shocks for 1989-98 from the same statistical distribution as the actual shocks observed for the selected model.[28] The second step is to pass

the simulated shocks through the selected model to create artificial data on real GDP growth, inflation, and the interest rate for 1989-98. Following Feldstein and Stock (1993), on one pass of this step the historical policy equation is used as the policy rule to construct artificial historical data. On the other pass one of the policy rules is imposed in lieu of the historical policy equation, to construct the counterfactual data which would be observed if the rule were imposed.[29]

The ten years of artificial data are then used to compare the volatility of the economy under the policy rule to volatility under historical policy. To gauge the average effects of the policy change, this comparison is made for each of 1,000 simulated 1989-98 data sets (again, following Feldstein and Stock). Tables 1 and 2 report the median (over the 1,000 data sets) percentage changes—from historical policy to the rule—in the standard deviations of growth and inflation.

ENDNOTES

[1] Because of difficulties in measuring the aggregate price level, price stability does not necessarily correspond to a 0 percent rate of inflation in measures of the aggregate price level (Kahn). Price stability is achieved when inflation is sufficiently low and stable that it is not a factor in the decisions made by households and firms.

[2] Tobin, an early advocate of nominal GDP targeting, pointed out the short-run relationship between nominal GDP growth and real GDP growth in 1980.

[3] In this example, nominal GDP growth differs slightly from the sum of real GDP growth and inflation because of rounding error in the data.

[4] This simple discussion abstracts from concerns which some analysts raise in detailed analyses. While under one mathematical model of the economy nominal GDP would be a better target than the monetary aggregates, under another reasonable model the aggregates would be superior (Bean; West).

[5] A simple model of aggregate supply and aggregate demand shows that the precise amount by which real GDP falls and inflation rises depends on the slope of the aggregate supply curve.

[6] In response to supporters of discretionary policy, some advocates of rules stress that the procedures they propose and study need not be used as strict rules. These rule proponents point out that the policy decisions dictated by a rule might simply be used as a baseline path around which discretionary policy decisions could be oriented (Judd and Motley 1992, 1993; McCallum 1993; Taylor). Under this strategy a rule would probably affect policy decisions, but permit discretionary policy changes.

[7] More formally, the inflationary bias in discretionary policy stems from a problem known as time inconsistency (Kydland and Prescott; Barro and Gordon). The simple discussion here abstracts from the important role that expectations of future events, such as policy adjustments, play in the problem of time inconsistency.

[8] Some analysts argue for rules that adjust another instrument of monetary policy, the monetary base, to keep nominal GDP on target (McCallum 1987, 1988). Interest rate-based rules offer the advantage that they involve little change from the Fed's current policy-setting practices. Currently, when policymakers wish to change the stance of monetary policy, they typically do so by adjusting short-term nominal interest rates.

[9] Hall and Mankiw (1993) suggest a closely related type of rule, under which policymakers would adjust the interest rate in response to not only the gap between actual and targeted nominal GDP growth but also to the gap between actual and

potential real GDP levels. Such a hybrid procedure offers the advantage that if nominal GDP growth exceeds target but the real GDP level falls below potential, policymakers would adjust policy less aggressively than they would under the simpler growth rules. When simulated using the models and procedures of this article, hybrid rules fail, raising volatility in both real GDP growth and inflation above historical levels. This finding conflicts with the results of Hall and Mankiw (1993).

[10] This rule takes the mathematical form

$$\Delta i_t = x\,(\Delta GDP_{t-1} - \Delta GDP^*)\,,$$

where Δi_t indicates the change in the interest rate, ΔGDP_{t-1} denotes last period's nominal GDP growth rate (annualized), and ΔGDP^* equals the target growth rate.

[11] For a one-percentage-point gap between actual and targeted GDP growth on a *quarterly* basis, which corresponds to a four-percentage-point gap on an *annual* basis, policymakers adjust the interest rate 50 basis points. Since Judd and Motley (1992) specified the policy rule in terms of GDP growth on a quarterly basis, they set the adjustment rate to 0.50. Since this article (following Judd and Motley 1993) specifies the rule in terms of GDP growth on an annual basis, it sets the corresponding adjustment parameter x at 0.125.

[12] Delays in the reporting of nominal GDP may result in additional, but much smaller, disadvantages to the lagged adjustment rule. The U.S. Commerce Department typically provides a preliminary estimate of a quarter's nominal GDP three to four weeks after the end of the quarter. Under the lagged adjustment rule, this reporting delay would add roughly another month to the two to three quarters which would pass before a change in monetary policy would be made in response to a deviation of nominal GDP from target. Moreover, because the preliminary estimate of nominal GDP is typically revised later, measurement error may create unnecessary volatility in the economy. If, for example, nominal GDP growth proves to be at the target rate but the preliminary estimate was above target, changing monetary policy in response to the preliminary estimate would create unnecessary volatility. In simulation analysis, however, the additional volatility created by data revisions appears to be small (Judd and Motley 1993).

[13] This rule has no simple mathematical form. Based upon the model used to forecast nominal GDP growth, the rule relates the current interest rate to values of a variety of variables, such as past interest rates and past inflation, which are used to forecast future nominal GDP growth. The appendix explains the precise form of the forecast adjustment rule used in this article.

[14] The Federal Reserve presents projections for nominal GDP growth in its semiannual report to Congress on the Full Employment and Balanced Growth Act of 1978. Projections made by the Federal Open Market Committee for 1993 and 1994, for example, are published in *1993 Monetary Policy Objectives: Midyear Review.*

[15] Hall and Mankiw (1993) prefer this specification of the forecast rule because it eliminates the possibility of policymakers' discretion affecting monetary policy and therefore eliminates the possibility of an inflationary bias in policy. If the rule were to use Federal Reserve forecasts, policy actions might be affected by the judgments of policymakers naturally embedded in the forecast. Policymakers' discretion might enter, for example, in predicting the effects of a change in monetary policy during a time of unprecedented financial innovation. The forecasting model projects the effects of the policy change from existing economic theory and historical economic fluctuations; the forecasters, who in this case would be policymakers, would adjust the model projection based on their judgment of the effects of the ongoing innovation.

[16] For each of the rules, the target nominal GDP growth rate equals the historical average growth rate. This article abstracts from the possibility that a rule would improve upon historical policy by preventing the Federal Reserve from systematically exceeding a targeted rate of growth. This analysis simply presumes the historical average nominal GDP growth rate to represent the historical target rate. To the extent that historical policy actually overshot its underlying target, this analysis will understate any benefits associated with a policy rule which ensures average growth near the target.

[17] Following Feldstein and Stock (1993), historical volatility is measured from estimates of how the economy would respond to the artificial disturbances if policymakers adjusted the interest rate as they appear to have adjusted it historically. As detailed in the appendix, historical policy is represented by the estimated historical relationship between the interest rate and other variables such as inflation. This historical policy for adjusting the interest rate is combined with a model of the economy and used to generate artificial data on real GDP growth, inflation, and the interest rate. These generated data measure how the economy would respond to the same artificial disturbances affecting the rule-guided economy if policy were directed as it has been historically. Volatility under the policy rules is compared to volatility in these counterfactual, historical policy-guided data.

[18] The levels specification reflects the presumption that, over the 1959-88 period, the short-term nominal interest rate is stationary, consistent with the stationarity of velocity reported, for example, by Hallman, Porter, and Small (1991).

[19] As in Mankiw (1992), for example, the model features an aggregate supply function which is positively sloped in the short run and vertical in the long run and an aggregate demand function which is importantly affected by monetary policy.

[20] In a textbook IS/LM model of aggregate demand, the aggregate demand function specified in this article's structural model corresponds to the IS curve. This specification assumes that monetary policy allows the money supply to adjust in keeping the interest rate at a desired level. Other studies (such as Judd and Motley 1992, 1993) specify an aggregate demand function which corresponds to a combination of the IS and LM curves, with the restriction that changes in expected inflation have no impact on aggregate demand.

[21] The policy rule simulations set the interest rate constant at the average level produced by the historical policy simulations.

[22] These statements apply to their "conservative assumptions" results, in which the shocks to aggregate demand are the same as those observed historically despite the change in policy-setting procedures. The rule performs much better under their alternative, highly optimistic assumption that the forecast adjustment rule eliminates all shocks to aggregate demand and deviations of nominal GDP growth from target.

[23] The tables of results reported by Hall and Mankiw (1993) show that the rule significantly raises inflation volatility above the historical level when, as in this analysis, volatility is measured by the standard deviation of inflation (the variability of inflation about the historical mean rate of inflation). In their discussion of the results, however, Hall and Mankiw concluded that the rule reduces inflation volatility below the historical level. That statement is only true when the historical volatility of inflation is measured by the root-mean-squared deviation of inflation, which is the variation of inflation about zero. The comparison made by Hall and Mankiw gives an unfair advantage to the rule, which they designed to achieve average inflation of zero, unless it is assumed that policymakers' historical inflation goal was very different from the historical average inflation rate.

[24] Simulations of a structural model patterned after that of Judd and Motley (1992, 1993) yield results qualitatively similar to theirs. The lagged adjustment rule significantly reduces inflation volatility with little effect on real GDP growth volatility. Using their structural model, when the adjustment parameter x is set at 0.20, the lagged adjustment rule reduces inflation volatility by about 7 percent while raising real GDP growth volatility about 1.5 percent. When x is set at 0.125, the rule reduces inflation volatility by about 4 percent while having no effect on real GDP growth volatility.

[25] While pegging an interest rate is widely viewed as an inferior policy, under some circumstances pegging an interest rate can be a superior policy. In an economy that has stable money demand but is subject to disturbances in the textbook "IS" curve, pegging an interest rate stabilizes the economy (Poole).

[26] The precise form of the aggregate demand function was derived by eliminating statistically insignificant variables in a more general regression of real GDP growth on lags of growth and lags of the real interest rate. The inflation expectations equation was derived by eliminating statistically insignificant lags in various regressions of inflation on lagged values of inflation and other variables such as growth, the interest rate, and the output gap. The policy equation specification was obtained by eliminating statistically insignificant lags in different regressions of the interest rate on lagged values of the interest rate and other variables.

[27] The trend is estimated with the Hodrick and Prescott (1980) filter.

[28] Overall results differ very little when the models are instead simulated over 1960-98, using a variety of initial conditions. The artificial shocks are drawn from a normal distribution with the variance-covariance matrix equal to that of the historical estimates of the model shocks.

[29] On the pass used to construct historical data, simulated interest rate equation shocks are included in the model. These shocks represent artificial discretionary policy changes like those observed historically (as measured by the residual in the estimated historical policy equation). Consequently, the precise specification of historical policy is not crucial to the results. Estimating a model which includes an interest rate equation from historical data and then using it to create artificial data from randomly generated disturbances having the same distribution as the estimated model disturbances will yield artificial data with the same volatility as the actual, historical data. This applies regardless of the precise form of the historical interest rate equation.

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