ABD Journal, Volume 3, 2011

Monetary Policy Rule Welfare Comparisons

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Abstract

Interest rate targeting rules including inflation-only, Taylor's, and nominal gross domestic product are compared using two macro-models, a modified AD/AS model and a New Consensus Macroeconomic model. All monetary policy rules are employed in simulations covering several different possible policy scenarios and then measured for a proxy for welfare loss, RMSE, the squared deviations from the targeted values and the actual values. The same simulation process is also used to determine the impact when the targeted growth values are not the same as the market clearing, or potential growth values. The method used here is to have the two different macroeconomic simulation models subjected to those rules and then to make welfare comparisons in order to determine the welfare-saving effectiveness of the rules.

Introduction

The search for optimal monetary policy rules has a long history, and history has a tendency to repeat itself. Such is the case, for instance, with the recent excitement over targeting nominal gross domestic product (NGDP) rather than targeting a mix of inflation and real GDP growth rates as seen with the Taylor Rule, or with older methods such as targeting inflation, or targeting the price level, or money growth, etc. All of these monetary policy targeting rules have been lauded at one time or another. However, most if not all, have ultimately been dismissed over the years. For example, things change and Friedman's monetary growth rate targeting rule, which was en vogue for a while in the '70s and '80s lost its importance as the correlation between inflation and money growth weakened; however, standard inflation targeting using the *P** approach, which held prominence for a short while in the '90s still lives in current research papers in some areas around the globe (see e.g. Mujeri, Shahiduzzaman, and Islam, 2009) although not so much in the United States. And nominal gross domestic product targeting, which was heavily researched in the '80s but was ultimately dismissed in favor of the Taylor rule (Taylor, 1993) is once again gaining more adherents. But the Taylor rule seems to have had more lasting influence than any other targeting rules over the last two decades and has generated an enormous literature on its virtues and frailties. Indeed, the newest Keynesian, monetarist, DSGE, etc. models generally incorporate some version of a Taylor Rule. Still, the NGDP rule has regained interest in light of the apparent liquidity trap coupled with the zero bound interest rate problems seen recently. To better assess and understand the competing rules, two different macroeconomic simulation models, the AD/AS and the New Consensus Macroeconomic models, are subjected to those rules listed above and an attempt is made to determine society's welfare losses for each.

Simulations are used in this study and nearly all others that are involved with fiscal or monetary policy projections. Studies involved with these two important macroeconomic ideas generally pursue one of two avenues, either simulations or empirical verification. The study here uses simulations, so that all outside factors can be completely controlled and the response functions that are generated can readily be seen, free of any exogenous, uncontrolled effects.

Probably the main reason that monetary rules have been sought at all is the time-inconsistency problem, which is the result of attempting to do policy by short run discretionary focus. Friedman (1948) was the first to warn of the problems of timing discretionary policies, sighting that if the policies are not correctly timed they could do more harm than good, not only to the targeted variable but to other non-targeted variables as well. Thus, Friedman recommended a fixed nominal anchor, that is a target value established by policy-makers and that is also known by the public and which keeps the monetary authorities on track. Of course, time-inconsistency is a potential problem regardless of the targets or rules any time monetary authorities are not transparent. It has long been thought (see, for instance Kydland and Prescott, 1977) that in order to cause the least harm, central banks should publicly announce their target along with the methodologies to credibly meet that target. There are others, however, who still aver that discretionary policy works well (see, for example Christiano, Albanesi, and Chari, 2003) in that the time-inconsistency problem has no measurable impact on welfare. The study here implicitly assumes that time-inconsistency is driving the need for monetary policy rules.

Below is a short synopsis of several prominent targeting rules along with a review of some recent and seminal papers implementing those particular rules. In the models below time inconsistency problems are assumed away by having the models known and available to the public and for the monetary authorities to be credible and transparent, modeling inconsistent policymaking being be akin to adding one more source of shocks to the models.

A Brief Review of Targeting Rules

Controlling one variable

Many years ago Tinbergen (1952) showed that, assuming linearity and certainty, the number of targeted variables must have an equal number of independent tools for optimally controlling a target variable. Without a separate tool for each problem variable, the other variables tend to drift away from their planned trajectories. Because monetary policy has only one main tool, which in practice can be the use of either an aggregate money supply or a particular interest rate, Tinbergen's constraint suggests that one economic variable only can be optimally controlled with monetary policy. It is left to the central bank to consider which problem it deems the greatest in order to determine a discretionary monetary policy. Moreover, Brainard (1967) showed later that Tinbergen's policy prescription is true under certainty conditions, but not true when facing stochastic uncertainty. With so many possible and legitimate macroeconomic variables that a central bank might want to try to influence, not to mention the uncertainty being faced by monetary authorities and economic agents alike, Tinbergen's constraint often leads to a central bank changing variables that they want to influence as those variables became the problem du jour. This putting-out-fires, time-inconsistency approach has been highly criticized for being unpredictable, making long term planning nearly impossible. It has long been maintained that it is necessary for monetary authorities to pick a variable to influence and to stick with it. And historically there is only one variable that monetary theorists have agreed that central banks can truly control; inflation targeting.

Inflation targeting $i_t^* = r + \pi_t + \gamma(\pi_t - \pi^*)$

Inflation targeting is the straightforward idea of having the central bank managing a key interest rate (or money stock when money supplies had a much stronger correlation to inflation) in such a way that some level of inflation, chosen by policy-makers, will be reached. In practice, the key interest rate in the U.S. has been the federal funds rate, the nominal interest rate charged for banks to borrow from one another overnight, which is denoted i_t^* above. Asterisks represent targeted levels. Motivated by the well-known Fisher's equation, that theoretically the nominal interest rate is made up of the real rate, r, and expected inflation, π_t, inflation targeting adds another component, $\gamma(\pi_t - \pi^*)$, which ultimately determines the control. The extra component is the gap between where inflation is, π_t, and where it is targeted to be, π^*. The nominal fed funds interest rate is raised if inflation is lower than the targeted level and lowered if inflation is higher than the target. The simplicity of the rule is in having one target without having to worry about any other particular variables such as GDP growth rates, unemployment, currency exchange rates, etc.

Inflation targeting is the model that most work has been compared to; it is the antagonist against which all of the new heroic targeting schemes compare themselves. The reason is simple. Almost all central banks in the world have at one time or another announced that they are targeting inflation, ostensibly because inflation has been the one target that central banks clearly have some control of. Inflation targeting is ensconced in all the textbooks to the extent that the best selling money and banking author Frederic Mishkin (2007) devoted two full chapters to just inflation targeting in transition economies alone in when he wrote a volume on central bank strategies.

Clearly, a reason that other targeting schemes besides inflation targeting have been sought is that other macro-variables are at least as important as inflation. For instance, central banks might consider unemployment or GDP growth rates as extremely important; even more so than inflation. In such a case, fighting inflation might not be considered ideal. However, macroeconomic theory holds that the variables above are real variables that in the long run are determined by real factors. Short run monetary influences on these real variables are temporary and only possible due to have market frictions which are self-correcting. Only monetary policies that can help speed the self-correcting nature of markets are useful.

Controlling more than one variable

Taylor rule $i_t^* = r + \pi_t + \delta_0(\pi_t - \pi^*) + \delta_1(y_t - y^*)$

The Taylor rule has been very popular in monetary policy ever since its introduction in 1993 (Taylor, 1993). As can be seen above, unlike the inflation-only rule the Taylor rule is characterized by the central bank managing the federal funds rate in such a way as to simultaneously control two macro-variables, inflation and output, rather than inflation alone. At its simplest, the Taylor rule just adds an additional component to the inflation-only rule by adding the output gap, $\delta_1(y_t - y^*)$. This approach will necessarily result in a slower stabilization of inflation than the approach of targeting inflation alone (Bias, 2010). A central bank following the Taylor rule may potentially contribute to larger welfare losses due to longer and deeper inflation gaps. Still, the Taylor rule is pragmatic and attempts to mitigate both inflation and unemployment problems simultaneously and thus might improve welfare over inflation-only rules by offsetting the larger welfare losses of inflation gaps with smaller welfare-improving real GDP gaps.

Nominal GDP targeting $i_t^* = r + \pi_t + \theta[(\pi_t + y_t) - (\pi_t + y_t)^*]$

A nominal gross domestic product rule has recently become popular again after having had its heyday over thirty years ago. The rule is distinguished by its lack of specificity on impacting either inflation or output gaps that may be occurring, in direct contrast to the Taylor rule. The NGDP rule is different from the Taylor rule in that there is but one gap, the gap between how fast nominal GDP is growing versus how fast it is targeted to grow by the monetary authorities. This can be seen in the equation above as $\theta[(\pi_t + y_t) - (\pi_t + y_t)^*]$. Taylor (1985) documents that targeting nominal GDP was carefully considered by the economics fraternity during the late '70s into the mid '80s but was ultimately dismissed despite the fact that at that time the tool of choice for monetary policy was money growth rates. Indeed Taylor concluded in that same paper that nominal income targeting led to larger amplitude business cycle fluctuations and contributed to boom-bust cycles largely because operational monetary policy lags were not explicitly accounted for, much like the argument Friedman (1953) had made over thirty years earlier. As a NGDP rule theoretically allows inflation and real GDP to vary as long as they are additively equal to the targeted value for NGDP, it is unsurprising that real GDP-measured business cycles could be worsened by NGDP targeting. More recently, Mishkin (2007) dismisses NGDP targeting as well, claiming that it is similar to inflation targeting in that NGDP rules attempt to close one macro-variable gap. Thus, any problems inflation-only rules have will similarly be problems for NGDP rules.

Despite these apparent negatives the NGDP targeting rule has persisted, with a trickle of papers over the years suggesting that the NGDP rule works after all. For instance, West (1986) uses a relatively standard AD/AS model to determine the efficacy of nominal GDP targeting. He concludes that the use of such a target is largely dependent upon the AS curve modeling. West finds that the impacts are very sensitive to small changes in the calibration of the AS function in his model. Kahn (1988) imposes a nominal GNP rule to a simple AD/AS model and introduces supply and demand shocks and finds that the nominal GNP rule holds up well. Bradley and Jansen (1989) find that nominal GNP targeting is actually rather useful if the parameters of the AD/AS equations are known. Their argument against the use of the targeting procedure is simply that the equations are unknown in practice. Reinhart (1990) uses a modern Keynesian model to analyze the differences in how nominal income targeting fares against monetary growth rules. Interestingly, money growth rules are found to be more efficient under AS shocks but less efficient under AD shocks and nominal income rules are found to be better under AD shocks. Frankle and Chinn (1995) subject a relatively standard AD/AS model to supply shocks, velocity shocks, and exchange rate shocks to evaluate monetary policy discretion, monetary rule, nominal GNP rule, a price level rule, and an exchange rate rule. Findings are: nominal GNP rule dominates over the other rules. Koenig (1995) supports the use of nominal GDP targeting under both sticky wage regimes and market clearing labor markets.

Quite recently many in the blogosphere have again been extolling the virtues of NGDP targeting, notably economist bloggers David Beckworth, Scott Sumner, and Bill Woolsey, but little has yet come out in academic papers. Scott Sumner (2011) is one staunch NGDP rule advocate that has published on the topic; however, Sumner's approach is a bit different than what is modeled above as he uses futures targeting rather than contemporaneous targeting used in this study.

Other Sometimes Used Targets

Price level targeting $i_t^* = r + \pi_t + \xi(P_t - P^*)$

Although the price level targeting equation looks much like the inflation targeting equation in that only $\xi(P_t - P^*)$, the price level gap, has replaced $\gamma(\pi_t - \pi^*)$, the inflation gap, price level targeting is distinctly different from inflation targeting. Whereas inflation targeting if temporarily derailed simply moves back toward the inflation target, a price level targeting process is not so accommodating to inflation. If derailed, the price level target is still sought even if it means causing deflation to do it. Nevertheless, Kahn (2009) recently expounded on the virtues of price level targeting over inflation targeting. Kahn found that inflation targeting is more volatile than price level targeting, and attempted to show that price level targeting is less harmful to the business cycle than an inflation target. Ultimately he found that the benefits of moving to a price level targeting scheme are rather small and the cost of moving to the scheme are rather large in the short run, thus Kahn more or less acquiesced that it is difficult to make the transition to price level targeting for central banks even though in the long run there would be benefit. In another recent paper Coletti and Lalonde (2008) found that price level targeting brings about smoother inflation and interest rate movements at the expense of slightly larger average output gaps. They found overall that there is slightly more favorable stability under price level targeting regimes over the inflation regimes, where stability is measured by price and real output fluctuations against the natural rates. Price level targeting was not used in the simulations here.

McCallum rule $B_t^* = \left[(\pi_t + y_t) - V + \lambda\left(\frac{Y^* - Y}{Y^*}\right)\right]$

The McCallum rule is unlike the previous rules in that it specifies monetary base as its instrument for monetary policy rather than using the federal funds rate as seen in the other rules. The McCallum rule has been strongly impacted by new Federal Reserve policies implemented at the nadir of the recent Great Recession, namely payment of interest on reserves held by the banking system. However, for completeness, the equation can be translated as the targeted growth of the monetary base, B_t^*, is determined by the growth rates of inflation and real GDP minus the velocity (turnover rate) of the money supply plus the percentage gap of nominal GDP, represented here as Y (Croushore and Stark, 1995). Obviously, in light of the new Federal Reserve policies the formula would have to be modified to be currently useful, thus the McCallum rule was not used in the simulations here.

The Macroeconomic Models

To better assess and understand the competing monetary policy rules above, two different macroeconomic simulation models, the AD/AS and the New Consensus Macroeconomic models, were subjected to AD and AS shocks to determine society's welfare losses under differing monetary policy regimes. The macroeconomic models are described below along with the calibrations used for the simulation analyses.

The modified Dwyer AD/AS macroeconomic model

A modified Dwyer (1993) AD/AS model is used for the simulations. The strengths of the modified model are that it incorporates both monetary policy impact and shocks into both equations, and yet it is a simple model that can be used for undergraduate simulations. The modified Dwyer model consists of two equations, which together comprise AD/AS: equation (1) models GDP growth, y_t, as a function of growth momentum, βy_{t-1}, and a monetary policy component, γi_t, where i_t

represents the monetary authority's targeted nominal interest rate. The equation allows for either a demand or supply shock, ε_{AD_t} or ε_{AS_t}.

(1) $$y_t = \alpha + \beta y_{t-1} - \gamma i_t + \varepsilon_{AD_t} - 0.5(\varepsilon_{AS_t})$$

Equation (2) models inflation, π_t, as a function of inflation momentum, $\theta\pi_{t-1}$, and the same monetary authority policy interest rate, i_t, used in equation (1).

(2) $$\pi_t = \delta + \theta\pi_{t-1} - \varphi i_t + 0.5(\varepsilon_{AD_t}) + \varepsilon_{AS_t}$$

Together, equations (1) and (2) becomes the AD/AS model. By choice the two equations equally split the aggregate demand or supply shocks, ε_{AD_t} or ε_{AS_t} respectively, between them such that neither AD shocks or AS shocks has more impact than the other. The third equation to complete the model is the monetary policy equation, which is a specified rule to target nominal interest rates. Generically, the monetary policy interest rate equation is shown simply as

(3) $$i_t^* = f(r, \pi, \ldots)$$

where *r* is the real interest rate and π is the inflation rate, both at time *t*. The equation can have many looks: Taylor rule, fixed nominal rule (as the first comparison), inflation only rule, nominal GDP rule, price level rule, etc.

The new consensus macroeconomic model

The NCM model has been the standard workhorse for policy evaluation over the past decade, certainly well before Woodford's (2003) classic text. The model has had the preeminent position because of its simplicity and its apparent usefulness to monetary policy makers in that the model appends a monetary policy rule as one of the main three equations of a fairly simple macroeconomic model. The NCM model has been presented many times before, but it has several forms. Probably the most recognized NCM model of Eggertsson and Woodford (2003, 2004) is made up of three equations, two equations that model the aggregate economy and a third equation that governs the monetary policy interest rate rule. As mentioned, however, other forms of the model are sometimes used as well. For instance, Lavoie and Saccareccia (2005) present a slightly different version of the New Consensus Macroeconomic model. Their three equations are established more like the form used for the AD/AS model above, thus the model used in this analysis is a modified LS form:

(4) $$y_t = A_0 - \theta i_{t-1} + \varepsilon_{AD_t}$$

The first equation of the NCM model (equation 4) is the now-standard intertemporal IS function; that is, a dynamic time element is introduced such that shocks require a necessarily lagged interest rate response from the monetary authorities in order to guide the economy back to equilibrium. In the equation A_0 is a constant as is, but it is an important one because in this simple form the model goes back to y_t any period where interest rates are at the "normal" rate if there are no shocks to the model in that period. All other variables are defined as before.

(5) $$\pi_t = \pi_{t-1} + \delta(y_{t-1} - y^*) + \varepsilon_{AS_t}$$

The second equation of the *NCM* model (equation 5) is sometimes referred to as the New Keynesian Phillips curve or the dynamic Phillips Curve, and it brings in AS elements much like the Lucas

Supply function, which it resembles. The equation depicts current inflation as dependent on lagged inflation and the current output gap. Again, all variables are defined as before in this equation.

(6) $$i_t^* = f(r, \pi, \dots)$$

The final equation is the same generic monetary rule equation as equation (3). Again, it can be the well-known Taylor Rule for monetary policy or, as is done in many instances, the equation can be derived through the model itself, depending on the modeler's objective function.

Calibrating the Models for the Simulations

All simulations for both models assumed that the central bank targets 2% inflation and expects 3% real GDP rate of growth. Consequently, nominal GDP targets 5% as well. The real interest rate, r, is set at 2% throughout. Of course the coefficients in the AD/AS and NCM models have an enormous influence on the speed with which the economies recover from shocks. Appendix 1 has been added to show what happens to the response functions for inflation and GDP as equation (9)'s θ coefficients change from 0.5 to 1.4. Ultimately the coefficients were set at 1.0 for this set of simulations but a thorough mapping of coefficients changing AD/AS and NCM model coefficients through a range while also changing monetary rule coefficients is worth considering.

The first of the rules, the no policy response rule (see equation 7 below), is meant to be a control of sorts. The rule is to simply not respond to shocks at all, thus interest rates are held fixed irrespective of what the economy is doing. Equation (7) reflects the rule by holding interest rates constant (at 4% for the simulations). The expected necessity for this equation was that it would benchmark a model's path to equilibrium without outside interference by policymakers. That is, it would show how market price and output changes naturally bring about equilibrium. Using this benchmark would enable a model to reveal any hidden advantage in getting back to equilibrium over another model by nature of its structure or calibration rather than the model's inherent "truth." The first simulation, however, revealed a problem with that approach and in retrospect it should have been anticipated. As alluded to above, if interest rates are unchanged, the NCM model never returns to 2% inflation and 3% GDP growth rates, but instead reaches 3% GDP growth at the cost of permanently negative inflation. The NCM model actually acts much like the old monetarist models in which a low targeted and constant monetary growth would also generate negative inflation. Thus the original intent, that the no-response policy would allow for the models to be equally weighted, turned out to be impossible, at least for the model specifications used here.

The exact specifications for each of the monetary rules and the two macroeconomic models as used in the simulations are shown below. Initial inflation and real GDP values were 2.0 and 3.0 respectively.

(7) ***No policy response***: $$i_t^* = 4.0$$

(8) ***Taylor rule***: $$i_t^* = 2.0 + \pi_t + 0.5(\pi_t - 2.0) + 0.5(y_t - 3.0)$$

(9) ***NGDP rule***: $$i_t^* = 2.0 + \pi_t + 1.0[(\pi_t + y_t) - (2.0 + 3.0)^*]$$

(10) ***Inflation-only targeting***: $$i_t^* = 2.0 + \pi_t + 1.0(\pi_t - 2.0)$$

The AD/AS model:

(11) $$y_t = 1.4 + 0.8y_{t-1} - 0.2i_t + \varepsilon_{AD_t} - 0.5(\varepsilon_{AS_t})$$

(12) $$\pi_t = 0.8 + 0.8\pi_{t-1} - 0.1i_t + 0.5(\varepsilon_{AD_t}) + \varepsilon_{AS_t}$$

The NCM model:

(13) $$y_t = 3.8 - 0.2i_{t-1} + \varepsilon_{AD_t}$$

(14) $$\pi_t = \pi_{t-1} + 0.8(y_{t-1} - y^*) + \varepsilon_{AS_t}$$

Measuring Welfare Loss

In order to compare the efficiencies of the targeting rules, a standard diagnostic tool used in forecasting practice is applied here; that is, a standard root mean squared error (*RMSE*) is used as a proxy for social welfare loss. In forecasting, root mean squared error measures the average of the squared deviations between the actual and forecasted values and allows the forecaster to determine the best forecasting model by minimizing the *RMSE*. Given that deviations from long run growth paths induce welfare losses, the use of RMSE to be a proxy for welfare losses to society seems reasonable. Note that this necessarily assumes that percent deviations from inflation targets have equal welfare loss implications as similar sized percent deviations from real GDP targets. While this is seemingly a very heroic assumption, the standard Taylor rule, for instance, implicitly assumes the same thing by virtue of equal coefficients for both inflation and real GDP gaps. All other forms of welfare loss due to such important variables as unemployment, banking instability, value of the dollar, etc. are not explicitly included here. Thus, welfare loss in this study is approximated by the formula

(15) $$RMSE = \frac{1}{n}\sqrt{\sum_{t=1}^{n}(y_t - y_t^*)^2} + \frac{1}{n}\sqrt{\sum_{t=1}^{n}(\pi_t - \pi_t^*)^2}$$

where *y* and π are the actual value of the variable, either inflation or real GDP, at time *t*, and the starred variables (*) are the targeted values of the variables at time *t* by the central bank.

Simulation Observations and Insights

A summary of the simulation results can be viewed in Table 1 where root mean squared errors are reported for each of the simulations after having applied either an AD or AS shock to the models.

Responses in the modified Dwyer AD/AS macroeconomic model

The AD/AS was calibrated to have a 2% target rate of inflation and 3% target rate of real GDP growth as the benchmark. These are true for the Taylor rule and the inflation only rule. For the NGDP target this means that nominal GDP was set at 5%. Simulations were run using either 4% negative AS or AD shocks and then allowed to converge back to equilibrium based on the model and the monetary rule used. Some graphic responses are included in Appendix 2. Finally, the AD/AS model was altered to have real GDP grow at either higher (3.4%) or lower (2.6%) than the level targeted by the central bank (3%).

AD shocks to the AD/AS model. As measured by RMSE, the NGDP rule outperformed the Taylor rule in every instance, whether the model was set to converge above or below the target, when subjected to a negative AD shock. The difference was slight but consistent. On the other hand, an inflation-only target consistently had the highest (i.e. worst) RMSE compared to the other two rules.

AS shocks to the AD/AS model. When the AD/AS model was subjected to AS shocks the Taylor rule performed marginally better than the NGDP rule. The Taylor rule had a lower RMSE in two of the three instances. Again, the difference was small, and again the inflation-only rule did the poorest job of minimizing RMSE.

Responses in the new consensus macroeconomic model

As was mentioned earlier, to make apples and apples comparisons an attempt was made to calibrate the NCM model so that it would have the same growth rates as the modified AD/AS model above, that is, with targets of 2% inflation and 3% real GDP. However, it was quickly realized that the New Keynesian NCM model as shown in equation (4) does not equilibrate in a natural way without help from the monetary authorities. If the interest rate is left at its starting value in the simulations, 4%, irrespective of economic conditions, it is the nature of the model by virtue of equation (4 (and also 13)) to keep the real output level at that autonomous level. Thus, a simulation using equation (4) has a one period shock and then goes immediately back to the original growth level irrespective of the type or depth of the shock, unless monetary authorities change the interest rate. In as much as an economy is certainly likely to generate some movement toward equilibrium even without monetary input, the model, as written, seems to be particularly suited for central bank use but not for a general model of the economy. To make the model less monetary policy-specific a modification could be applied instituting a friction to more naturally get back get GDP growth to the equilibrium value regardless while forcing interest rates to be endogenously determined rather than following a rule. That is, equation (4) could be modified to get equation (16) below.

(16) $$y_t = \tau y_{t-1} + A_0 - \theta i_{t-1}$$

Adding τy_{t-1} introduces an artificial, non-policy, frictional drag on real GDP coming back to equilibrium and mimics the real world's inability to instantly recover from shocks. With the friction component added to the simulation equation it was felt that a negative shock would hold real GDP down for more than one period, as opposed to how it works with equation (4).

Table 1

y's natural growth rate	monetary rule	AD/AS model: AD shock	AD/AS model: AS shock	AD/AS model: average	New Keynesian model: AD shock	New Keynesian model: AS shock	New Keynesian model: average
y = 3.4%	Taylor rule	0.496	0.505	0.5005	0.716	0.765	0.7405
	NGDP rule	0.47	0.634	0.552	0.67	0.51	0.59
	inflation rule	0.536	0.539	0.5375	0.786	0.5	0.643
y = 3%	Taylor rule	0.435	0.687	0.561	0.8095	0.583	0.69625
	NGDP rule	0.424	0.68	0.552	0.75	0.623	0.6865
	inflation rule	0.441	0.786	0.6135	0.93	0.6485	0.78925
y = 2.6%	Taylor rule	0.674	0.904	0.789	0.987	0.773	0.88
	NGDP rule	0.609	0.936	0.7725	0.879	0.785	0.832
	inflation rule	0.686	1.033	0.8595	1.203	0.841	1.022

Table 1 **- A comparison of root mean squared errors for AD/AS and NCM (New Keynesian) model**s. Both simulation models are subjected to AD and AS shocks and measured for the resulting RMSE away from stable equilibrium. The models use the Taylor Rule, the Nominal GDP rule, or a simple inflation rule. The economy's natural growth column states whether the model was set to equilibrate at 2.6%, 3%, or 3.4% all while monetary authorities targeted a 3% rate of growth for GDP. Thus only the *y = 3%* row reflects monetary authorities targeting the actual growth rate.

However, modeling the endogenous behavior of interest rates is beyond the intent of the models and this paper. Still, some exploratory simulations were run using a form of (12) and RMSEs were found for the New Keynesian NCM model much like was done for the AD/AS model. The results were as would be expected: the NCM model gradually, asymptotically equilibrated real GDP, but inflation tended to gradually move away from the 2% targeted rate, never to move toward its targeted value. No changes in the coefficients were able to make the model equilibrate like the AD/AS model. As described earlier, this is a standard monetarist result whereby the growth of money is slowed resulting in a higher interest rate. The act of holding interest rates at the 4% level when the economy falters is akin to permanently lowering the rate of money growth. This is more realistic than the AD/AS result. In the AD/AS model if a shock occurs the model will ultimately settle to the same equilibrium if the interest rates are held constant. Although equation (12) was imposed on several preliminary runs, this approach was ultimately not used in this study because interest rates are being targeted as the Federal Reserve instrument of choice, and always react to deviations from the target and thus there are no endogenously determined interest rates in the short run. A rigorous comparison between these two types of modeling techniques might prove fruitful, but it would require a rather sophisticated model of simultaneously determined endogenous interest rates and money supplies.

AD shocks to the NCM, New Keynesian model. When the NCM, New Keynesian model was used, once again the NGDP rule outperformed the Taylor rule in every instance when subjected to a negative AD shock. Indeed the differences between the RMSEs for the Taylor rule and the NGDP rule were a bit larger than seen in the AD/AS simulations, although without more fine tuning of the calibrations to ensure that the models behave similarly, this is likely unimportant. And again, the inflation-only target consistently had the highest (worst) RMSE compared to the other two rules just as it did for the AD/AS model.

AS shocks to the NCM, New Keynesian model. When the New Keynesian model was subjected to AS shocks, the Taylor rule again performed marginally better than the NGDP rule; however, the two lower RMSEs were not the same two as occurred in the AD/AS model. Finally, the inflation-only rule once again did the poorest job of minimizing RMSE.

Summary and Conclusions

In this study AD/AS and New Keynesian NCM simulation models were subjected to AD and AS shocks in order to examine the robustness of monetary rules through a range of scenarios. Response functions for inflation and real GDP were generated in several simulations. A proxy for welfare loss was made by measuring the resulting RMSEs as defined by the inflation and output gaps for these two variables. Inflation-only, Taylor, and nominal GDP interest rate targeting rules were examined under conditions where the central bank aims at the correct targets for the nature of the simulated economy and for conditions where the targets were set correctly and also for where targets were set against the nature of the economy, either targeting GDP too low or too high for its natural path.

The results of the simulations were that the inflation-only rule nearly always performed poorly compared to the Taylor and NGDP rules, whether the shocks were AD or AS and irrespective of whether or not the monetary authorities knew the correct ‘nature’ of the economy. This result is not surprising, however, when output gaps are assumed to be equally welfare-destroying as inflation gaps, as is done here.

When the economy was subjected to an AD shock, the Taylor rule was consistently outperformed by the NGDP rule for both models regardless of the central bank’s awareness of the economy’s true nature. However, when the economy was subjected to an AS shock, the Taylor rule performed better than the NGDP rule in four of the six cases. Still, the NGDP rule averaged lower RMSEs for both AD and AS shocks than the Taylor rule in five of the six cases and better in every case than the inflation-only rule.

It would appear that the nominal GDP rule is at least worth a very close look despite Taylor’s, Mishkin’s, and others’ reservations regarding the rule. Taylor’s concern that the NGDP rule would lead to larger business cycles was not confirmed here, although as seen in Appendix 1 and is well known, using larger central bank response coefficients when targeting NGDP can induce strong cyclical behaviors.

A thorough examination of a range of model and rule coefficients along with biased targets might lead to a clear monetary rule “winner.”

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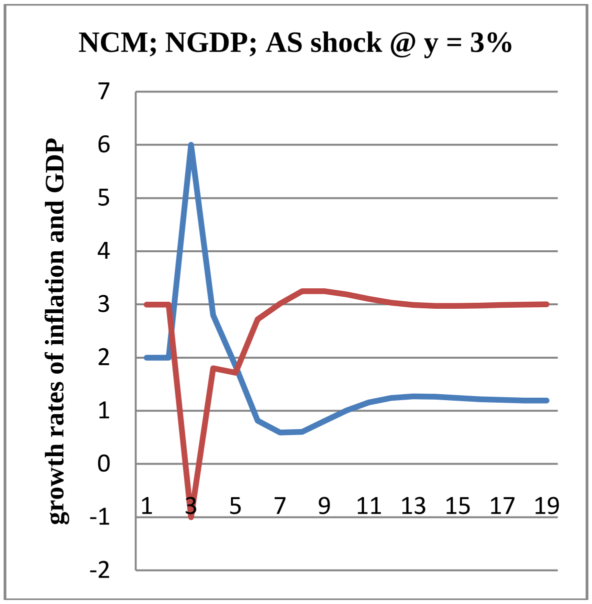
Biography

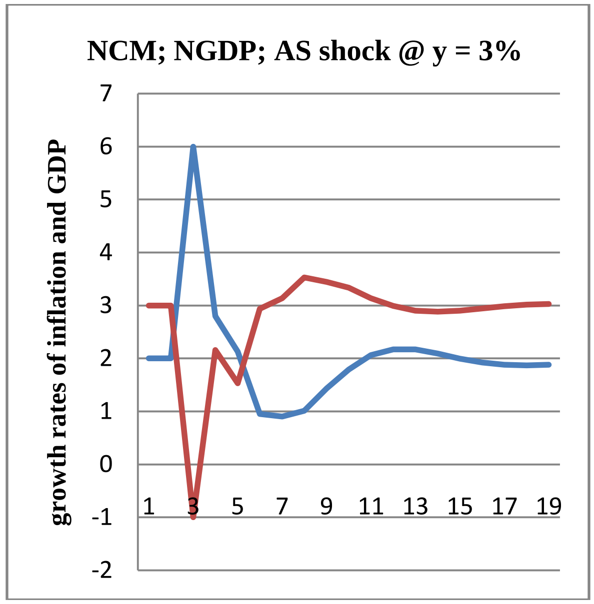
Pete Bias is Professor of Business and Economics at Florida Southern College. He earned his Ph.D. in Economics at the University of Cincinnati. He has eclectic research interests including monetary policy rules, macroeconomics, statistics, and meteors. Pete has published articles in the *Journal of Regional Science*; *Research in Business and Economics Journal*; *Journal of Business, Industry, and Economics*; *Journal of Mathematics and Statistics*; and *WGN, The Journal of the International Meteor Organization*. He has written and edited several workbooks and study guides for economics and statistics as well as a popular book on meteors.

Appendix 1

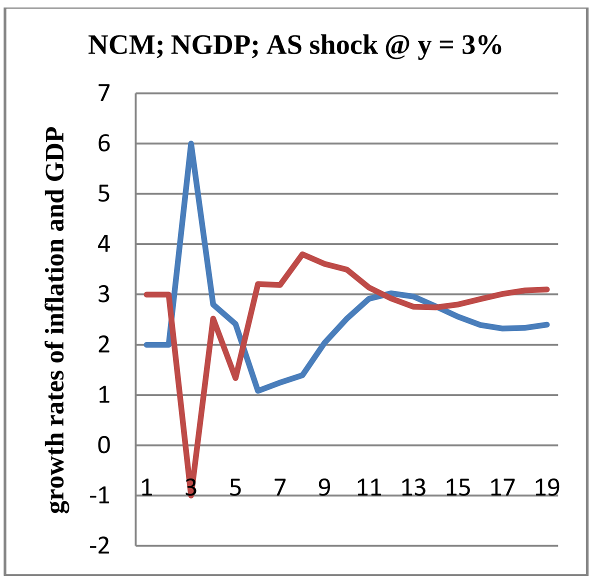
The impact of changing the θ coefficient in equation 9



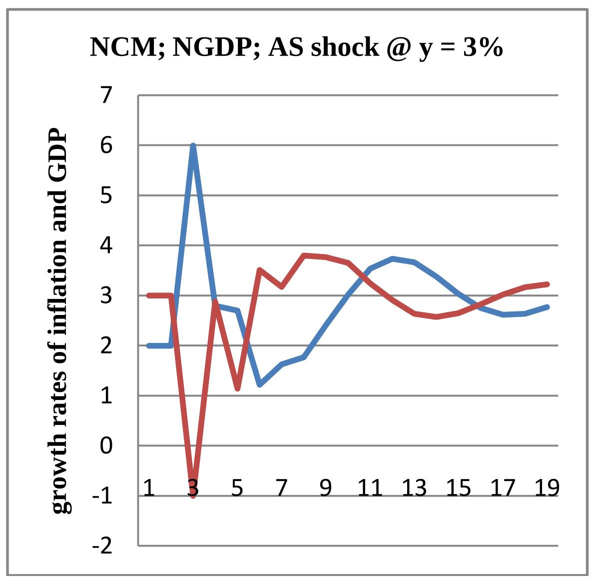
0.5 coefficient is used



0.8 coefficient is used



1.1 coefficient is used

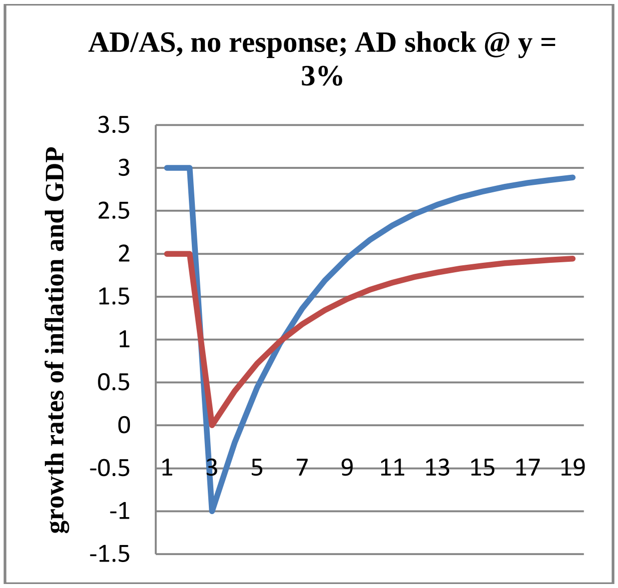


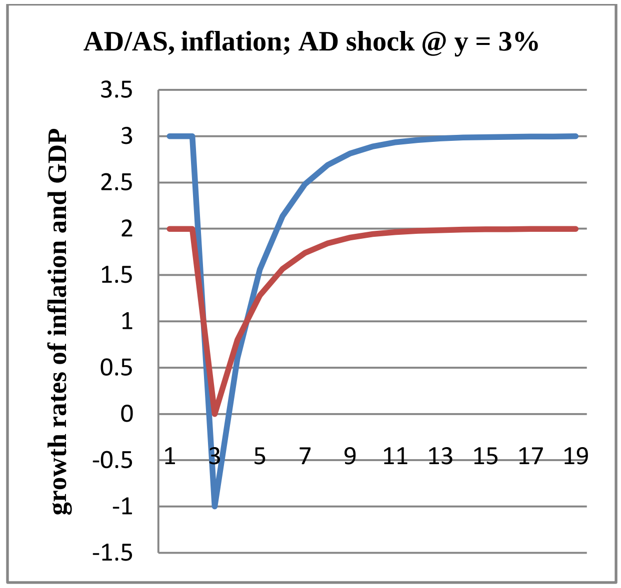
1.4 coefficient is used

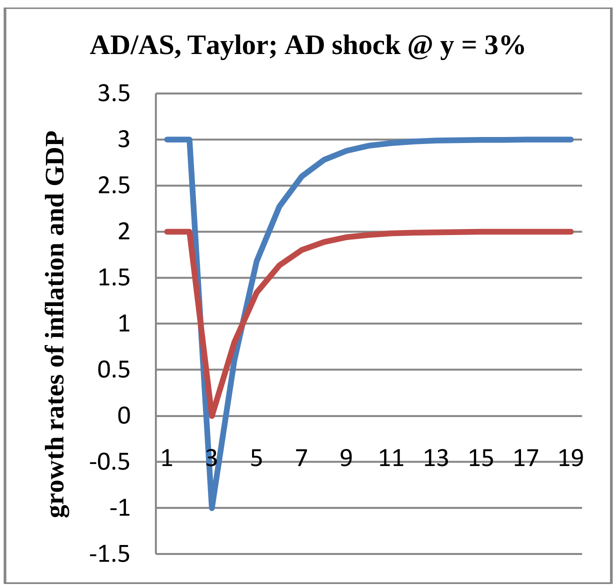
Appendix 2

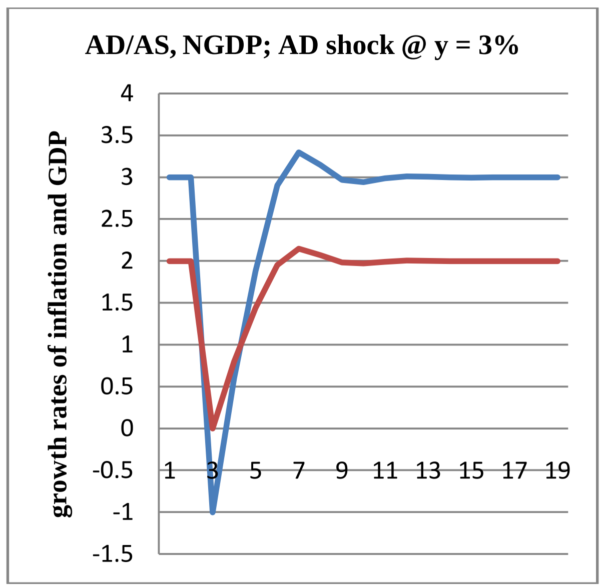
The response functions below are all derived from the simulation model and are reported for a 4% negative aggregate supply or demand shock to an AD/AS model as listed. In each case the red function shows the GDP growth rate response, while the blue function shows the inflation rate response. In all cases the model asserts a normal GDP growth rate of 3% and inflation targeted at 2% and shows the impacts of no response, inflation-only rule, Taylor rule, and NGDP rule. The RMSEs determined in this study represent the squared deviations from these inflation and GDP assertions at each period.

Responses for a 4% negative AD shock:









Responses for a 4% negative AS shock: