

Testing two types of monetary rules for Brazil

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ABSTRACT

The purpose of this paper is to verify whether, if a monetary rule had been in effect, it would have resulted in smoother non-inflationary nominal GDP paths over the period 1974.I-1992.III. Two types of rules are considered. The first is an activist rule proposed by McCallum (1987, 1988), and the second is a non-activist rule proposed by Meltzer (1987). The results of the simulations indicate that neither of the two rules performed well during the period analyzed.

Key words: rules, discretion, credibility, flexibility, simulation.

RESUMO

O objetivo desse artigo é verificar se trajetórias não inflacionárias para o PIB nominal no período 1974.I-1992.III teriam sido geradas se uma regra monetária tivesse sido adotada. Dois tipos de regras são consideradas. A primeira é uma regra ativa proposta por McCallum (1987, 1988) e a segunda é uma regra não-ativa proposta por Meltzer (1987). Os resultados da simulação indicam que nenhuma das regras mostra um bom desempenho durante o período de análise.

Palavras-chave: regra, discricção, credibilidade, flexibilidade, simulação.

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1. Introduction

The importance of a monetary rule as a precommitment mechanism can be justified by several arguments. In games involving a single policymaker and the private sector a rule would be necessary to reduce the inflationary bias resulting from the time-inconsistent behavior of the policymaker. The conduct of monetary policy according to a rule would result, on average, in less inflation than would be the case with discretionary policy making, and with the same output or employment. In this context arguments in favor of rules appear, for example, in Kydland and Prescott (1977), Barro (1990), and McCallum (1988,1989). In games in which different policymakers are in office at different points in time the political business cycle results in inflationary bias and excess volatility in the economy. As a solution in this case, Alesina (1988,1989) proposes the adoption of a “cooperative” rule by different parties enforced by an independent central bank. Sargent & Wallace (1981) and Sargent (1993), on the other hand, suggest that a rule is a mechanism that can credibly impose fiscal discipline. A rule indicates that the central bank is willing to stick firmly to a tight monetary policy, despite rising deficits, and since no monetary accommodations will be made the fiscal authority has no other choice than to adjust the budget.

Although there are many arguments that support the adoption of a rule, this is not so when it comes to empirical evidence about the performance of a particular rule or different types of rules.¹ The purpose of this paper is to analyze the possible consequences of the establishment of a monetary rule for Brazil. More precisely, the idea is to verify whether, if a monetary rule had been in effect, it would have resulted in smoother non-inflationary nominal GDP paths during the period 1974.I-1992.III.

The methodology adopted here closely follows that developed by McCallum (1988), and is used to compare his activist rule with the non-activist rule proposed by Meltzer (1987).

The second section presents the main characteristics of the two types of rules to be considered, as well as their distinctive aspects. The third section summarizes the procedure adopted to evaluate the performance of the rules. Given the absence of a consensual model to explain the behavior of the Brazilian economy, a rule will be considered adequate if it performs well according to a variety of economic models. The rules are tested using different vector autoregression (VAR)

¹ There are also strong arguments against the adoption of a rule. The adoption of a monetary rule enormously restricts the monetary authority's flexibility to respond to unexpected changes in the economy. The dilemma between flexibility and commitment, as well as the greater costs associated with the abandonment of the rule since it represents a stronger form of precommitment, are the most common arguments used in favor of other mechanisms such as for example, the establishment of an autonomous monetary authority.

systems, for the real business cycle model and for the monetary misperceptions model. The results of the simulation exercises are summarized in the fourth section. Conclusions are presented in the fifth section.

2. The Two Types of Rules²

Concerning the design of a monetary policy rule, there are two essential elements. The first is the choice of a specific target. Here the target is a path for nominal GDP growing at a prespecified rate given by the economy's long-term average rate of real output growth. For the Brazilian economy this rate corresponds to 5%. According to the natural rate hypothesis, keeping nominal GDP growth at 5% should result in approximately zero inflation given that this rate is independent of monetary policy over a long period of time. In summary, the target is given by a smooth non-inflationary target path for nominal GDP.³

The second is the choice of an instrument variable for achieving the specified target. This variable should be controlled directly by the monetary authority, so that the monetary base is a natural choice.^{4,5}

The first rule to be tested was proposed by McCallum (1987, 1988).⁶ It is given for quarterly base growth rates by

$$\Delta b_t = \alpha - (1/16)[x_{t-1} - x_{t-17} - b_{t-1} + b_{t-17}] + \lambda(x_{t-1}^* - x_{t-1}) \quad (1)$$

² A rule is a formula that will be implemented by the policymaker for several periods, and not just the current one. Therefore, an activist policy can be reflected by a rule if it is applicable for periods $t=1,2,\dots$. As observed by McCallum (1989) "it is not necessary for this definition that the calculation be conducted in a formal manner on the basis of an explicit model. Instead, the policymaker can be relying on an informal model, that is, a nonexplicit but coherent view (or perception) of the way in which the economy works" (p.239).

³ This policy proposal is closely related to the proposal for "nominal GNP targeting" advanced by Taylor (1985).

⁴ Other controllable variables, and therefore potential instruments, are reserve aggregates and the interest rate.

⁵ There are numerous articles on targets and instruments of monetary policy. For a careful review of the literature, especially the theoretical one, see Friedman (1975, 1990)

⁶ A simplified description of this rule is given in McCallum (1984), and the algebraic form implicit in this description is given in McCallum (1987).

where b_t is the log of the monetary base, x_t is the log of nominal GDP, x_t^* is the target value of x_t , λ is a non-negative parameter that must be large enough to capture adequate responsiveness of base growth misses but not excessively large in order to avoid dynamic instability. The constant term α is the long-term average rate of real output growth expressed in quarterly logarithmic units. The second term subtracts from this the average growth rate of base velocity over the previous four years (this term is intended to take care of possible changes in velocity growth resulting from regulatory and technological changes), and finally the third term adds a feedback adjustment in response to deviations of GDP from the target path (this term is intended to take account of changes in cyclical conditions).

The key characteristic of rule (1) is that it is an activist rule, that is, it incorporates policy response to the state of the economy. If the actual x_t value exceeds the target value x_t^* in some period, then in order to bring x_{t+1} closer to x_{t+1}^* the monetary authority should decrease the setting for Δb_{t+1} . On the other hand, Δb_{t+1} values should be increased when x_t falls short of x_t^* . Therefore, (1) establishes that the growth rate of the monetary base would be increased whenever the most recent value of nominal GDP is smaller than its target path, and would be reduced whenever nominal GDP is greater than its target value.

The second rule was proposed by Meltzer (1987), and it is given by:⁷

$$\Delta b_t = (1/16)[(y_{t-1} - y_{t-17}) - (x_{t-1} - x_{t-17} - b_{t-1} + b_{t-17})] \quad (2)$$

where y_t is the log of real GDP.

⁷ In fact Meltzer's rule averages over the previous three years. We also average over the previous four years, following McCallum (1988). Meltzer's rule is an inflation-target rule. Therefore, a direct criterion to consider its properties would be to compare its performance to a constant price level. McCallum (1988), however, prefers to use values for nominal GDP as the criterion. As the variable of interest is non-inflationary nominal GDP growth, the target path value (x_t^{**}) should be adjusted to real GDP predictions, future real GDP growth rates are given by the most recent four years' experience rather than a constant value. Thus the target path is expressed as follows:

$$x_t^{**} = x_{t-1}^* + (1/16)(y_{t-1} - y_{t-17})$$

Here Meltzer's rule is also analyzed using a constant nominal GDP growth rate in order to ensure that the choice of target does not result in differences between the two rules in performance terms.

A comparison between (2) and (1) immediately shows that the constant term in (1) is replaced by the average growth rate of real GDP during the previous sixteen quarters. Furthermore, the feedback term is disregarded and this makes Meltzer's rule a non-activist one. The effect of omitting the feedback term is equivalent to assuming a value of zero for λ in McCallum's rule.

3. Procedure and Data

The purpose of this section is to determine the behavior of nominal GDP if the monetary policy had been conducted according to one of the rules. The idea is to compare actual nominal GDP paths with the paths generated by simulations, with (1) and (2) in place of actual historical policy, using a variety of models. The support for the rule is based on results obtained from different models simply because there is no "correct" model to describe the structure of the Brazilian economy. The results are obtained for the real business cycle (RBC) model, the monetary misperceptions model, and three vector autoregressions.

Root-mean-square control error (RMSE) is used to measure deviations of simulated values of nominal GDP (\bar{x}_t) from the target path x_t^* . This corresponds to the square root of the mean over the simulation period of $(\bar{x}_t - x_t^*)^2$.

The data on government purchases of goods and services, monetary base, price index and interest rates are taken from several issues of *Boletim do Banco Central do Brasil*. The data on gross domestic product are from IBGE. All data are quarterly series for the period 1974.I-1992.III.

Before proceeding to estimation and simulation, we individually tested each series for unit roots. This is necessary due to problems of spurious regression (Granger & Newbold, 1974). The Dickey-Fuller regressions were estimated both excluding and including a trend term. The number of lagged terms was chosen to ensure that errors were uncorrelated. The results are summarized in Table 1.

The results indicate that the interest-rate series is stationary in first differences, and all other series are stationary only in second differences.

Ex-post simulations begin with the vector autoregression (VAR) formulations. The first VAR system considered includes three variables: $\Delta^2 b_t$, $\Delta^2 y_t$, and $\Delta^2 p_t$. The second VAR includes ΔR_t as an additional variable, and the third also includes $\Delta^2 g_t$. In order to determine the number of lags in each VAR system, a likelihood ratio test was performed with a correction to

improve small sample properties.⁸ The dynamics for the three systems seem to be completely captured by a three-lag VAR.

Table 1
Tests for a Unit Root

Variables	τ_c (a)	$\tau_{c,t}$ (b)	lags	n. observations
b_t	1.9657	-0.2183	4	70
Δb_t	-2.1066	-3.2502	3	70
$\Delta^2 b_t$	-4.0705*	-4.0282*	6	66
y_t	-1.5541	-2.6122	8	66
Δy_t	-1.8370	-2.0693	8	65
$\Delta^2 y_t$	-4.1127*	-4.0703*	8	64
p_t	2.5614	0.3923	5	69
Δp_t	1.4617	-3.0274	3	70
$\Delta^2 p_t$	-4.5489*	-4.5068*	8	64
g_t	-1.7329	-2.3254	8	66
Δg_t	-2.3251	-2.3653	8	65
$\Delta^2 g_t$	-4.6787*	-4.6327*	8	64
R_t	1.3039	-2.7454	3	71
ΔR_t	-4.4955*	-4.4611*	6	67

(a) τ_c is the t statistic associated to a Dickey-Fuller regression with constant and no trend. The asymptotic critical value for τ_c at the 5% level is -2.86.

(b) $\tau_{c,t}$ is the τ statistic associated to a Dickey-Fuller regression with constant and trend. The asymptotic critical value for $\tau_{c,t}$ at the 5% level is -3.41.

* means that the null hypothesis of non-stationarity is rejected.

⁸ This correction is due to Sims (1980,p.17). and is equal to the number of variables in each unrestricted equation in the system.

In each case parameters and residuals were estimated for the period 1974.I-1992.III.⁹ A 54-period simulation was then performed based on initial conditions pertaining to 1979.II with estimated disturbances fed into each period as estimates of the shocks that hit the economy during the period. The values for b_t were generated by policy rules (1) and (2), however, and not by the VAR equations. The simulated p_t and x_t series were then summed up to generate the simulated x_t series which was then compared to the target path.

Because the main difference between the real business cycle and monetary misperceptions models relates to the aggregate supply (or Phillips-curve) specification, the same aggregate demand specification was used in both cases. The main determinants of quantity demanded are given by real money balances and government purchases. Least-squares estimates for the sample period are as follows, with lags of some of the variables included to reflect dynamics :

$$\begin{aligned} \Delta^2 y_t = & 0.0221 - 0.1918\Delta^2 y_{t-1} - 0.6746\Delta^2 y_{t-2} - 0.0784(\Delta^2 b_t - \Delta^2 p_t) + 0.1153\Delta^2 g_t \\ & (0.006) \quad (0.080) \quad (0.084) \quad (0.036) \quad (0.052) \\ & -0.1359\Delta^2 g_{t-1} + \varepsilon_t \\ & (0.049) \end{aligned} \tag{3}$$

$$R^2 = 0.639 \quad \text{Durbin's } h : -1.0274$$

It was not considered necessary to estimate an aggregate supply equation for the RBC simulation. The reasons for this are the RBC hypothesis that real variables are exogenous with respect to nominal variables, and the assumption that fiscal measures affect output through their impact on nominal aggregate demand.¹⁰ Thus real output is taken as exogenous so that (3) only determines the price level. g_t values are also taken as exogenous. ε_t are used as estimates of shocks to aggregate demand. The simulations used (1) and (3), and (2) and (3) to generate sequences for b_t and p_t with g_t and y_t set at their actual historical values. \bar{x}_t values were then calculated as

⁹ Since the regressors are the same in each equation, the improvement in efficiency is expected to be small with joint estimation. So each equation is estimated by least squares. The results for the vector autoregression estimates are not reported but are available from the author upon request.

¹⁰ McCallum justifies this simplification by the preponderant role that RBC proponents attribute to technological shocks as the source of cyclical fluctuations.

$\bar{x}_t = \bar{p}_t + y_t$, where \bar{p}_t is the simulated series of the price level, and compared with x_t^* in order to obtain the RMSE statistic.

It is necessary, however, to consider the aggregate supply portion of the monetary misperceptions model developed by Lucas (1972, 1973). According to Barro (1977, 1978), money growth influences output only when this growth is unanticipated. Money growth surprises are measured empirically as residuals from an autoregression model of order 3.¹¹

The estimated aggregate supply equation is given by:¹²

$$\Delta^2 y_t = -0.2903 res_t + 0.1859 res_{t-1} + 0.2577 res_{t-2} - 3.7801 res_{t-3} + u_t \quad (4)$$

(0.097) (0.098) (0.101) (0.104)

$$R^2 = 0.304 \quad DW = 2.6482$$

The simulation exercise used (1), (3) and (4) or (2), (3) and (4) to generate sequences for b_t , p_t and y_t which, as in the other models, permitted calculation of the simulated nominal GDP series for comparison with the target path.

4. Results

This section discusses the results of the simulations using policy rules (1) or (2) with each of the different models. McCallum tabulates the results for four λ values: 0.0, 0.1, 0.25, and 0.5. The RMSE values are reported here, however, only for values of $\lambda = 0.25$. There are two reasons for this: the results do not differ much for different values of λ , and the results based on rule (1) with $\lambda = 0.0$ were expected to be similar to those obtained with rule (2), as is in fact the case, so there is no need to report both.

¹¹ This is a "naive" version of Barro's model. Two explanatory variables used by him are omitted here: federal expenditure relative to "normal" and a measure of lagged unemployment.

¹² Equation (4) below was also estimated including a lagged value of the dependent variable and a time trend, but they were insignificant.

Table 2
Simulation Results

	McCallum's rule $\lambda = 0.25$	Meltzer's rule
VAR1	9.9760	9.9758
VAR2	4.0882	4.0879
VAR3	0.6711	0.6708
Real Business Cycle	0.9783	0.9775
Monetary Misperceptions	1.0028	1.0042

The first and second vector autoregressions result in extremely high RMSE. The RMSE for the third VAR, the real business cycle model and the monetary misperceptions model are much smaller but still unfavorable to both policy rules. In order to have a better idea of the performance of the rules it is useful to put the values obtained in perspective. Since a large part of actual GDP values reflect inflation, the benchmark is actual nominal GDP variability about its (inflationary) trend path. The RMSE value for log of nominal GDP relative to a fitted trend line was then calculated and found to be 0.6345 for the simulation period. This is practically the same as the figure obtained with the third VAR system, and much smaller than the results obtained for the other models. This suggests that rules (1) and (2) would have provided greater fluctuations in nominal GDP than actually occurred.

5. Conclusions

From a theoretical point of view the identification of precommitment with a rule made a stronger case for rules than shortsighted policymaking. However, if the benefits of flexibility are taken into account, the case for rules over discretion becomes dubious. There is no way to decide a priori which sort of policy regime should be followed, and the only satisfactory solution is a case-by-case study.

Given the results obtained for the simulations, one can conclude that adoption of rules (1) or (2) would have resulted in poorer macroeconomic performance in Brazil. In fact the actual policy followed by the Brazilian government has provided smaller (although still large) fluctuations in nominal GDP than would have been the case if policymaking was conducted according to one of the rules.

It is obvious that many other experiments can be conducted to test the adequacy of a monetary rule. Some suggestions are: different specifications of the rules but still using the monetary base as the instrument, different specifications of the rules using the interest rate or a reserve aggregate as the instrument, and the use of more complex models to characterize the structure of the economy.

The point is that, at least in regard to the simple simulations performed here, the two specific monetary rules described would not have worked well in Brazil if they had been in effect.

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