Interest Rate Rules VS Money Growth Rules: Some Theoretical Issues and an Empirical Application for Venezuela

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Central Bank of Venezuela

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Producción editorial

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Abstract
This paper main theme is that the arguments against the use of money (i.e. money growth rate rules) in the conduct of monetary policy are not so strong, particularly for less developed economies. I analyze this topic in two ways: i) using some simple theoretical forward-looking macro models and evaluating their inflation and output variance under interest rate and monetary aggregates rules; ii) setting up models similar to the theoretical ones, but with more complex dynamics, assigning values to the parameters, and solving them for different kind of shocks under interest rate and monetary aggregates rules.

Keywords: Interest Rate Rules, Money Growth, Monetary Police, Rate Rules

JEL classification: E52

Resumen
El tema principal de este documento es que los argumentos en contra del uso de dinero (i.e. las normas de la tasa de crecimiento del dinero) en la conducción de la política monetaria no son consistentes, particularmente para economías menos desarrolladas. Yo analizo este tema de dos maneras: i) utilizando algunos macro modelos teóricos simples basados en las previsiones y evaluando su varianza de inflación y de producción bajo normas de tasa de interés y de agregados monetarios; ii) estableciendo modelos similares a los teóricos, pero con una dinámica más compleja, asignando valor a los parámetros y resolviéndolos para los distintos tipos de impacto bajo normas de tasa de interés y de agregados monetarios.

Palabras clave: Política monetaria, Reglas de crecimiento agregados monetarios, Reglas de crecimiento tasas de interés

Clasificación JEL: E52

1. INTRODUCTION

There is currently little discussion about monetary policy based on monetary aggregates. In his paper *Recent Developments in the Analysis of Monetary Policy (1999)*, Bennett McCallum, states:

> *"The nearly standard framework at the NBER and Riksbank conferences is a quantitative macroeconomic model that includes three main components. These are:*
>
> - *An IS-type relation (or set of relations) that specifies how interest rate movements affect aggregate demand and output;*
> - *A price adjustment equation (or set of equations) that specifies how inflation behaves in response to the output gap and expectations regarding future inflation; and*
> - *A monetary policy rule that specifies each period's settings of an interest-rate instrument.*
>
> *These settings typically are made in response to recent or predicted values of the economy's inflation rate and its output gap".*

Later in that paper McCallum asserts:

> *"So what is actually being assumed implicitly, by analyses that exclude* m_t (i.e. $m_t - p_t$) *from the relation 1, is that the effects of money holdings on spending are quantitatively small (indeed negligible). This is a belief with a long tradition, and I am inclined to think that it is probably justifiable, but the whole matter needs additional study".*

Another argument frequently exposed to favor an interest rate rule over a monetary aggregate rule is that the latter is more prone to monetary shocks, particularly due to unexpected fluctuations in money demand.

With respect to McCallum's assessment about the relevance of money, Meltzer (2001) and Nelson (2002) present interesting theoretical and empirical (for the US and british economy) arguments that supports the importance of the real monetary base for aggregate spending decisions.

Regarding the susceptibility of money rules to money demand shocks, Walsh (2003, p. 488), points out:

> *"Changes in the short-term interest rate that serves as the operational target for implementing monetary policy will affect aggregate spending decisions only if longer-term rates of interest are affected. While the use of an interest -rate- oriented policy reduces the importance of money demand in the transmission of policy actions to the real economy, it raises to prominence the role played by the term structure of interest rates".*

This is a very relevant issue, because the relationship between the short-term interest rate, used as operational target by the monetary authority, and longer-term interest rates may be affected by financial innovations and other shocks, just as the demand for money. Moreover, in developing countries this link may be further weakened by the presence of shallow financial markets, unstable fiscal policy, and central banks with poor track records in providing monetary stability.

In addition, Neumann and von Hagen (2002), and Ball and Sheridan (2003), have presented interesting evidence that shows that the disinflation process observed in many countries during the 90s occurred under different monetary policy arrangements, not only inflation targeting or other interest-rate oriented monetary policy strategies.

This paper main theme is that the arguments against the use of money (i.e. money growth rate rules) in the conduct of monetary policy are not so strong, particularly for less developed economies. This topic is analyzed in two ways: i) using some simple theoretical forward-looking macro models and evaluating their inflation and output variance under interest rate and monetary aggregates rules; ii) setting up models similar to the theoretical ones, but with more complex dynamics, assigning values to the parameters, and solving them for different kind of shocks under interest rate and monetary aggregates rules.

Before proceeding with the detailed analysis, it is important to clarify certain basic assumptions from the outset:

- The models developed are not derived from the solution of the dynamic optimization problem in representative agent models. Their structure, however, is very similar to the linearized versions obtained from these models. In particular, the inclusion of forward-looking variables is intended to capture some of the main features of the models based on microfoundations.

- The models are basically of short/medium-run nature, so they do not include capital accumulation relations. This follows McCallum and Nelson (1999), that contend that for monetary analyses in this time horizon, fluctuations in the stock of capital do not play a major role.

- Aggregate demand shocks may have a fiscal origin, but we assume the absence of fiscal dominance.

- The analysis does not try to determine optimal policy rules, instead it sets up *ad-hoc* simple rules that serve as benchmarks for monetary policy and may facilitate transparency and communication. The rules are, however, specified to guarantee some basic theoretical requirements: for example, in the interest rate rule the Taylor principle is maintained to ensure the existence of a determinate monetary equilibrium under rational expectations.

- It is assumed implicitly that the central bank's concern with social welfare is represented by its aim to minimize a loss function similar to the one employed in the Barro-Gordon rules Vs. discretion discussion, with inflation and output deviations from some target values as arguments: $L = (\pi_t - \pi_t^*)^2 + \lambda \tilde{y}_t^2$. This is a reasonable theoretical assumption, but again of an *ad-hoc* nature[1].
- No attempt is made to model explicitly the open economy sector. This is an exercise particularly difficult for the Venezuelan economy, that has experienced during the 90s, frequent modification of its exchange rate regime. Instead, we rely on the fact that some versions of the open economy models built on the foundations of optimizing agents and sticky prices, could be reduced to a form that is isomorphic to the typical closed economy new Keynesian model (see Walsh 2003, Chapter 11). Hence, external sector shocks are analyzed as either aggregate demand or aggregate supply shocks.

1 Woodford (2003), Chapter 6, derives a loss function similar to the *ad-hoc* one from the expected utility of the representative agent.

- In the monetary policy literature is common to distinguish between **Targeting Regimes** (i.e. Inflation Targeting), and **Instrument Rules** (i.e. the Taylor rule). Ball (1997) and Olivo (2001), however, show that there is a close relationship between the two schemes, thus we refer to them interchangeably along the analysis.

The paper is organized as follows: after this introduction, in section 2, the theoretical models are set up and solved to derive their inflation and output gap variances; section 3, builds upon these models to analyze empirically with data for Venezuela, the possible effects of different shocks under an interest-rate rule and two types of money-growth rules. Finally, some conclusions from the analysis are presented.

2. BASIC THEORETICAL MODELS

In this section, three simple AD-AS (Phillips-curve) forward-looking models are set up: one with an interest rate rule; one with a Friedman constant money growth rate; and the last with a flexible or feedback money growth rule. The models are solved for the inflation rate and the output gap using the method of undetermined coefficients, and the variances of inflation and the output gap derived assuming that the various shocks are uncorrelated.

2.1 Model with an interest rate rule

The interest rate rule model has a structure very similar to the log-linear approximation of the basic model developed by Woodford (2003, Chapter 4). The interest rate rule model includes a forward-looking aggregate demand equation in which the output gap $(\tilde{y}_t)$ responds to the long-run real interest rate. Thus in equation (2), is defined as a long-run nominal interest rate that according to the expectations theory of the interest rate can be expressed as:

$$i_t = (1/n)\sum_{i=0}^{n-1} E_t i_{t+i}^s , \qquad (1)$$

where i^s is the short-run interest rate.

Given this, the interest rate equation (3) has two components: a) the interest rate rule that the central bank follows which determines the short-term interest rate; b) a random error υ_t that reflects the imperfect control of the monetary authority over the long-run interest rate. The introduction of a random shock in the interest rate equation attempts to capture the imperfect relationship between the short-term interest rate that is adjusted by a rule and the long-term interest rate relevant in the aggregate demand equation. This shock may be as important as the shock considered in the model with a rule for a monetary aggregate that is fundamentally linked to money demand shocks. Note that the interest rate equation specification further differs from the original Taylor rule in that it includes $E_t^* \pi_{t+1}$ instead of π_t in the inflation gap term.

The model also includes an aggregate demand shock (ε_t), and an aggregate supply shock (η_t). In the interest rate equation, $\bar{r}$ stands for the long-run equilibrium real interest rate and π^* for the target inflation rate.

The third equation in the model (4) is a forward-looking Phillips curve based on staggered price adjustment of the type suggested by Calvo (1983).

The complete model is specified as follows:

$$\tilde{y}_t = E_t \tilde{y}_{t+1} - \beta(i_t - E_t \pi_{t+1}) + \varepsilon_t; \text{ AD equation}^2; \tag{2}$$

$$i_t = g_0 \tilde{y}_t + g_1 (E_t \pi_{t+1} - \pi^*) + \bar{r} + \pi^* + \upsilon_t \text{ ; Interest rate equation;} \tag{3}$$

$$\pi_t = E_t \pi_{t+1} + \gamma \tilde{y}_t + \eta_t \text{ ; AS equation.} \tag{4}$$

Solving the model for the output gap and the rate of inflation in terms of the forward-looking variables, exogenous variables, and the random shocks yields:

---

2 Note that defining $r_t \equiv i_t - E_t \pi_{t+1}$, the forward solution of this equation is:

$$\tilde{y}_t = -\beta \sum_{i=0}^{\infty} r_{t+i} + \sum_{i=0}^{\infty} \varepsilon_{t+i}$$

$$\tilde{y}_t = \frac{1}{(1+\beta g_0)} E_t \tilde{y}_{t+1} + \frac{\beta(1-g_1)}{(1+\beta g_0)} E_t \pi_{t+1} - \frac{\beta(1-g_1)}{(1+\beta g_0)} \pi^* - \frac{\beta}{(1+\beta g_0)} \bar{r} - \frac{\beta}{(1+\beta g_0)} \nu_t + \frac{1}{(1+\beta g_0)} \varepsilon_t \quad ; \tag{5}$$

$$\pi_t = \frac{\gamma}{(1+\beta g_0)} E_t \tilde{y}_{t+1} +_t [1 + \frac{\gamma\beta(1-g_1)}{(1+\beta g_0)}] E_t \pi_{t+1} - \frac{\gamma\beta(1-g_1)}{(1+\beta g_0)} \pi^* - \frac{\gamma\beta}{(1+\beta g_0)} \bar{r} - \frac{\gamma\beta}{(1+\beta g_0)} \nu_t + \frac{\gamma}{(1+\beta g_0)} \varepsilon_t + \eta_t \quad . \tag{6}$$

The following trial solutions to apply the method of undetermined coefficients are used:

$$\tilde{y}_t = \delta_0 + \delta_1 \varepsilon_t + \delta_2 \eta_t + \delta_3 \upsilon_t ; \tag{7}$$

$$\pi_t = \lambda_0 + \lambda_1 \varepsilon_t + \lambda_2 \eta_t + \lambda_3 \upsilon_t . \tag{8}$$

Next, the solutions for the output gap and inflation, and their respective variances assuming that the shocks are uncorrelated are obtained:

Solution for $\tilde{y}_t$

$$\tilde{y}_t = \frac{1}{(1+\beta g_0)} \varepsilon_t - \frac{\beta}{(1+\beta g_0)} \upsilon_t . \tag{9}$$

Variance of $\tilde{y}_t$

$$\sigma^2_{\tilde{y}} = \frac{1}{(1+\beta g_0)^2} \sigma^2_{\varepsilon} + \frac{\beta^2}{(1+\beta g_0)^2} \sigma^2_{\upsilon} . \tag{10}$$

Solution for π_t

$$\pi_t = \pi^* + \frac{1}{1-g_1} r + \frac{\gamma}{(1+\beta g_0)} \varepsilon_t + \eta_t - \frac{\gamma\beta}{(1+\beta g_0)} \upsilon_t \ . \tag{11}$$

Variance of π_t

$$\sigma_\pi^2 = \frac{\gamma^2}{(1+\beta g_0)^2} \sigma_\varepsilon^2 + \sigma_\eta^2 + \frac{(\gamma\beta)^2}{(1+\beta g_0)^2} \sigma_\upsilon^2 \ . \tag{12}$$

2.2 Models with money growth rules

In this section, two models with money growth rules are specified. In these models the forward-looking aggregate demand function responds to the growth rate of real money defined as the monetary base. Nelson (2002) discusses the empirical and theoretical evidence that supports the inclusion of the real monetary base in the aggregate demand equation. Based in arguments developed by Meltzer (2001) and Friedman-Schwartz (1963), Nelson contends that the inclusion of the long-term nominal interest rate in the money demand function in the optimizing IS-LM model allows to derive an aggregate demand function that incorporates the real monetary base. Meltzer and Friedman and Schwartz argument is based on the monetarist transmission mechanism in which money exerts its influence over a wide array of relative prices and not only on a short-run interest rate. In this sense, money is a good indicator of the long-run interest rate that is more relevant that a short-run interest rate in the aggregate demand equation (equation 13).

The first money growth rule model is based on Friedman proposal of a fixed rate of growth for the money supply. In equation (14), the rate of growth of the monetary base (μ) follows the growth rate of potential output (k), the inflation rate targeted by the monetary authority (π^*), plus a shock that captures both money demand and supply random variations (z). In the second model, the money growth rule is a feed-back rule where money growth follows the Friedman rule, but in addition responds to the output gap $(\tilde{y}_t)$ and the inflation gap$(E_t\pi_{t+1}-\pi^*)$, plus a shock that captures money demand and supply random variations (z) –equation 25–.

As in the interest rate rule model, the third equation in each model (15 and 26) is a forward-looking Phillips curve based on staggered price adjustment of the type suggested by Calvo (1983).

The detail specification of the money growth rule models and their rational expectations solutions are presented bellow.

2.2.1 Model with a fixed money growth rule

The basic equations of the model are the following:

$$\tilde{y}_t = E_t\,\tilde{y}_{t+1} + \psi(\mu_t - \pi_t) + \varepsilon_t \text{; AD equation;} \tag{13}$$

$$\mu_t = k + \pi^* + z_t \text{; Money growth rule;} \tag{14}$$

$$\pi_t = \gamma\,\tilde{y}_t + E_t\pi_{t+1} + \eta_t \text{; AS equation;} \tag{15}$$

Solving the model for the output gap and the rate of inflation in terms of the forward-looking variables, exogenous variables, and the random shocks, yields:

$$\begin{aligned}\tilde{y}_t = {} & \frac{1}{(1+\gamma\psi)}E_t\,\tilde{y}_{t+1} - \frac{\psi}{(1+\gamma\psi)}E_t\pi_{t+1} + \frac{\psi}{(1+\gamma\psi)}(\pi^*+k) \\ & + \frac{\psi}{(1+\gamma\psi)}z_t - \frac{\psi}{(1+\gamma\psi)}\eta_t + \frac{1}{(1+\gamma\psi)}\varepsilon_t\end{aligned} \quad ; \tag{16}$$

$$\pi_t = \frac{1}{(1+\gamma\psi)} E_t \tilde{y}_{t+1} + \frac{(1-\gamma\psi)}{(1+\gamma\psi)} E_t \pi_{t+1} + \frac{\gamma\psi}{(1+\gamma\psi)} (\pi^* + k)$$
$$+ \frac{\gamma\psi}{(1+\gamma\psi)} z_t + \frac{\gamma}{(1+\gamma\psi)} \varepsilon_t + \frac{(1-\gamma\psi)}{(1+\gamma\psi)} \eta_t \quad . \tag{17}$$

Using the trial solutions:

$$\tilde{y}_t = \delta_0 + \delta_1 \varepsilon_t + \delta_2 \eta_t + \delta_3 z_t \, ; \tag{18}$$

$$\pi_t = \lambda_0 + \lambda_1 \varepsilon_t + \lambda_2 \eta_t + \lambda_3 z_t \, ; \tag{19}$$

the following results for the output gap and the inflation rate and their respective variances, assuming that the shocks are uncorrelated, emerge:

Solution for $\tilde{y}_t$:

$$\tilde{y}_t = \frac{1}{1+\gamma\psi} \varepsilon_t - \frac{\psi}{1+\gamma\psi} \eta_t + \frac{\psi}{1+\gamma\psi} z_t \, . \tag{20}$$

Variance of $\tilde{y}_t$:

$$\sigma^2_{\tilde{y}} = (\frac{1}{1+\gamma\psi})^2 \sigma^2_{\varepsilon} + (\frac{\psi}{1+\gamma\psi})^2 \sigma^2_{\eta} + (\frac{\psi}{1+\gamma\psi})^2 \sigma^2_{z} \, . \tag{21}$$

Solution for π_t:

$$\pi_t = \pi^* + k + \frac{\gamma}{1+\gamma\psi} \varepsilon_t + \frac{(1-\gamma\psi)}{1+\gamma\psi} \eta_t + \frac{\gamma\psi}{1+\gamma\psi} z_t \, . \tag{22}$$

Variance of π_t:

$$\sigma_\pi^2 = (\frac{\gamma}{1+\gamma\psi})^2 \sigma_\varepsilon^2 + (\frac{1-\gamma\psi}{1+\gamma\psi})^2 \sigma_\eta^2 + (\frac{\gamma\psi}{1+\gamma\psi})^2 \sigma_z^2 \cdot \qquad (23)$$

2.2.2 Model with a flexible money growth rule

The model is specified as follows:

$$\tilde{y}_t = E_t \tilde{y}_{t+1} + \psi(\mu_t - \pi\ ) + \varepsilon_t;\ \text{AD equation}; \qquad (24)$$

$$\mu_t = k + \pi^* - h_0 \tilde{y}_t - h_1(E_t \pi_{t+1} - \pi^*) + z_t;\ \text{Money growth rule}; \qquad (25)$$

$$\pi_t = \gamma \tilde{y}_t + E_t \pi_{t+1} + \eta_t\ ;\ \text{AS equation}; \qquad (26)$$

Solving the model for the output gap and the rate of inflation in terms of the forward-looking variables, exogenous variables, and the random shocks, yields:

$$\begin{aligned}\tilde{y}_t = {} & \frac{1}{1+\psi(h_0+\gamma)} E_t \tilde{y}_{t+1} - \frac{\psi(1+h_1)}{1+\psi(h_0+\gamma)} E_t \pi_{t+1} + \frac{\psi}{1+\psi(h_0+\gamma)} k + \frac{\psi(1+h_1)}{1+\psi(h_0+\gamma)} \pi^* \\ & + \frac{\psi}{1+\psi(h_0+\gamma)} z_t - \frac{\psi}{1+\psi(h_0+\gamma)} \eta_t + \frac{1}{1+\psi(h_0+\gamma)} \varepsilon_t\end{aligned} \quad ; \qquad (27)$$

$$\begin{aligned}\pi_t = {} & \frac{\gamma}{1+\psi(h_0+\gamma)} E_t \tilde{y}_{t+1} + [1 - \frac{\gamma\psi(1+h_1)}{1+\psi(h_0+\gamma)}] E_t \pi_{t+1} + \frac{\gamma\psi}{1+\psi(h_0+\gamma)} k + \frac{\gamma\psi(1+h_1)}{1+\psi(h_0+\gamma)} \pi^* \quad ; \\ & + \frac{\gamma\psi}{1+\psi(h_0+\gamma)} z_t + \frac{\gamma}{1+\psi(h_0+\gamma)} \varepsilon_t + \frac{1+\psi h_0}{1+\psi(h_0+\gamma)} \eta_t\end{aligned} \qquad (28)$$

Using the trial solutions:

$$\tilde{y}_t = \delta_0 + \delta_1 \varepsilon_t + \delta_2 \eta_t + \delta_3 z_t\,; \tag{29}$$

$$\pi_t = \lambda_0 + \lambda_1 \varepsilon_t + \lambda_2 \eta_t + \lambda_3 z_t\,; \tag{30}$$

the following results for the output gap and the inflation rate and their respective variances (assuming that the shocks are uncorrelated) are obtained,

Solution for $\tilde{y}_t$:

$$\tilde{y}_t = \frac{1}{1+\psi(h_0+\gamma)}\varepsilon_t - \frac{\psi}{1+\psi(h_0+\gamma)}\eta_t + \frac{\psi}{1+\psi(h_0+\gamma)}z_t\,. \tag{31}$$

Variance of $\tilde{y}_t$:

$$\sigma^2_{\tilde{y}} = \left(\frac{1}{1+\psi(h_0+\gamma)}\right)^2 \sigma^2_\varepsilon + \left(\frac{\psi}{1+\psi(h_0+\gamma)}\right)^2 \sigma^2_\eta + \left(\frac{\psi}{1+\psi(h_0+\gamma)}\right)^2 \sigma^2_z\,. \tag{32}$$

Solution for π_t:

$$\pi_t = \frac{1}{1+h_1}k + \pi^* + \frac{\gamma}{1+\psi(h_0+\gamma)}\varepsilon_t + \frac{1+\psi h_0}{1+\psi(h_0+\gamma)}\eta_t + \frac{\gamma\psi}{1+\psi(h_0+\gamma)}z_t\,. \tag{33}$$

Variance of π_t:

$$\sigma^2_\pi = \left[\frac{\gamma}{1+\psi(h_0+\gamma)}\right]^2 \sigma^2_\varepsilon + \left[\frac{1+\psi h_0}{1+\psi(h_0+\gamma)}\right]^2 \sigma^2_\eta + \left[\frac{\gamma\psi}{1+\psi(h_0+\gamma)}\right]^2 \sigma^2_z\,. \tag{34}$$

2.3 Comparing variances

In this section the output and inflation variances obtained for the three models under analysis are compared.

In terms of the variance of output, the interest rate rule has the advantage over the money growth rules as it isolates output fluctuations from supply shocks (see equations 11, 21, 32). Further, compared with the Friedman rule, the interest rate rule may reduce the volatility of the output gap to aggregate demand and monetary sector shocks through the adjustment of the policy parameter g_0 that captures the response of the interest rate to the output gap. The feedback money growth rule may be also superior to the Friedman rule in terms of output gap volatility, as it also allows to reduce fluctuations by adjusting the policy parameter that captures the response of the rate of growth of money to the output gap.

In terms of the variance of inflation the money growth rules are superior to the interest rate rule in the presence of aggregate supply shocks. These shocks have a smaller effect (coefficient less than one) on inflation variations in the models with money growth rules, in contrast to a coefficient equal to one in the model with an interest rate rule (see equations 13, 23, 34).

Compared to the Friedman rule the interest rate rule and the feedback money growth rule may reduce inflation volatility due to aggregate demand shocks through the adjustment of the policy parameters g_0, h_0.

But the main issue highlighted in this analysis is that output and inflation volatility will be affected by monetary sector shocks under both kinds of monetary policy rules. The effects of this kind of shocks on the volatility of the output gap and the inflation rate, however, can be reduced under the interest rate rule and the flexible money growth rule through adjustments in the parameters g_0, h_0.

3. EVALUATION OF SHOCKS IN CALIBRATED MODELS FOR VENEZUELA

In this section calibrated versions of the models discussed previously using data from the Venezuelan economy are set up and solved. In contrast to the theoretical models that include only forward-looking and contemporaneous variables, the calibrated models have a more complex dynamic that is captured by adding several backward-looking variables. In this case, trying to get analytical solutions is more complicated hence, calibration is an attractive option. The parameters for the calibration of the aggregate demand and supply equations are obtained from econometric estimates based on quarterly data for the period 1990-2002. The policy equations parameters are chosen from values used in the literature in the case of the interest rate rule, and from evaluating successive specifications in the case of the feedback money growth rule. I then solve the models in the Eviews solver using the Gauss-Seidel iterative method[3]. I present the calibrated models below.

i) Interest rate rule model

y = 0.25 * y(-1) + 0.20 * y(+1) - 0.09 * (i(-4) - dp(-4)) + e

i = 0.5 * y + 1.5 * (dp(+1) - dpm) + r + dpm + v

dp = 0.41 * dp(-1) + 0.59 * dp(+1) + 0.085 * y(-4) + n

3 In the Gauss-Seidel algorithm, in each iteration, each equation of the model is solved for the value of its associated endogenous variable, treating all other endogenous variables as fixed. The iterative process is repeated until changes in the values of the endogenous variables between successive iterations become less than a specified tolerance (see Eviews 4 User's Guide).

ii) Fixed money growth rule model

y = .31 * y(-1) + .38 * y(+1) + 0.19 * (dm(-4) - dp(-4)) + e

dm = dpm + k + z

dp = .41 * dp(-1) + .59 * dp(+1) + 0.085 * y(-4) + n

iii) Flexible money growth rule model

y = 0.31 * y(-1) + 0.38 * y(+1) + 0.19 * (dm(-4) - dp(-4)) + e

dm = - 0.40 * y - 1.0 * (dp(+1) - dpm) + k + dpm + z

dp = 0.41 * dp(-1) + 0.59 * dp(+1) + 0.085 * y(-4) + n

Where *y* is the output gap; *i* the long-run nominal interest rate; *dp* the rate of inflation; *dpm* the target inflation rate; *e* is the aggregate demand shock; *r* is a long-run equilibrium real interest rate; *v* is a money market shock that affects the relationship between the short-run and the long-run nominal interest rate; *n* is a supply or cost shock; *dm* is the rate of growth of the monetary base; *k* is the rate of growth of natural output; *z* is a money market shock that captures random fluctuations in both money demand and money supply.

The aggregate demand equation in the interest rate rule is derived from the following OLS regression using quarterly data from 1990 to 2002:

Dependent Variable: LYG
Method: Least Squares
Date: 11/25/03 Time: 11:56
Sample (adjusted): 1992:2 2002:4
Included observations: 43 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033668	0.018931	1.778427	0.0831
LYG(-1)	0.248048	0.153977	1.610945	0.1153
LYG(1)	0.202487	0.100435	2.016099	0.0507
I(-4)-DLP(-4)	-0.091821	0.056834	-1.615608	0.1142

R-squared	0.309635	Mean dependent var	0.008362
Adjusted R-squared	0.256530	S.D. dependent var	0.044426
S.E. of regression	0.038306	Akaike info criterion	-3.598001
Sum squared resid	0.057227	Schwarz criterion	-3.434168
Log likelihood	81.35701	F-statistic	5.830617
Durbin-Watson stat	2.459533	Prob (F-statistic)	0.002163

Where LYG is the output gap measure as the difference between the logarithm of GDP and its Hodrick-Prescott trend; *I* is a short-run nominal lending rate that proxies for the long-run nominal rate due to the lack of information of the latter; *DLP* is the inflation rate measured as the first difference of the logarithm of the CPI.

Given the presence of the output gap one period ahead [LYG(1)], we tried to estimate the equation using the GMM method. The results were highly sensitive to the instruments used, and in all cases none of the coefficients of the variables were significantly different from zero at standard critical levels.

The aggregate demand equation in the money growth models is derived from the following OLS regression using quarterly data from 1990 to 2003 (first quarter):

Dependent Variable: LYG
Meted: Least Squares
Date: 11/20/03 Time: 17:02
Sample (adjusted): 1990:2 2003:1
Included observations: 52 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000697	0.006069	-0.114863	0.9090
LYG(-1)	0.307908	0.137911	2.232656	0.0303
LYG(1)	0.380361	0.107145	3.549952	0.0009
DLBM(-4)-DLP(-4)	0.194744	0.039559	4.922835	0.0000

R-squared	0.472962	Mean dependent var	0.002116
Adjusted R-squared	0.440022	S.D. dependent var	0.057918
S.E. of regressión	0.043341	Akaike info criterion	-3.365621
Sum squared resid	0.090166	Schwarz criterion	-3.215525
Log likelihood	91.50614	F-statistic	14.35835
Durbin-Watson stat	1.989039	Prob (F-statistic)	0.000001

Where DLBM is the rate of growth of the monetary base measured as the first difference of the logarithm of the monetary base.

The GMM estimation was again very sensitive to the instruments used, particularly for the coefficients of LGY(-1) and LYG(1). The results indicate, however, that the coefficients of LYG(1) and (DLBM(-4)-DLP(-4)) are significantly different from zero (*p* values close to zero), with the latter taking values around 0.28.

The aggregate supply equation, that is shared by all the models, is taken from a paper by Arreaza, *et al.*, (2002) who estimated it using the GMM method. A similar estimation is derived , however, by using OLS with the White heteroskedacity correction:

Dependent Variable: DLP
Meted: Least Squares
Date: 02/17/04 Time: 15:45
Sample (adjusted): 1991:1 2002:3
Included observations: 47 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003112	0.006767	-0.459854	0.6479
DLP(-1)	0.515437	0.093172	5.532084	0.0000
DLP(1)	0.522560	0.069900	7.475813	0.0000
LYG(-4)	0.098432	0.059642	1.650391	0.1061

R-squared	0.854392	Mean dependent var	0.081710
Adjusted R-squared	0.844233	S.D. dependent var	0.047191
S.E. of regression	0.018625	Akaike info criterion	-5.047370
Sum squared resid	0.014916	Schwarz criterion	-4.889910
Log likelihood	122.6132	F-statistic	84.10431
Durbin-Watson stat	2.583677	Prob (F-statistic)	0.000000

The models are solved for the different shocks: aggregate demand, aggregate supply, and monetary sector shocks. In each case, a one-unit shock that last for eight quarters is introduced and the impulse-response functions for the output gap and the inflation rate are studied.

3.1 Interest rate rule Vs. Friedman money growth rule

Figure 1, shows the effect of an aggregate demand shock of one unit that last eight quarters on the output gap. The continuous line (*y*-*i*) represents the evolution of the output gap under the interest rate rule and the dotted line (*y*-*m*) under the Friedman rule. There is evidently a sharper initial reaction and a more volatile response of the output gap to an aggregate demand shock under the Friedman rule. The variance of the output gap with the Friedman rule is 0.29 Vs. 0.11 with the interest rate rule.

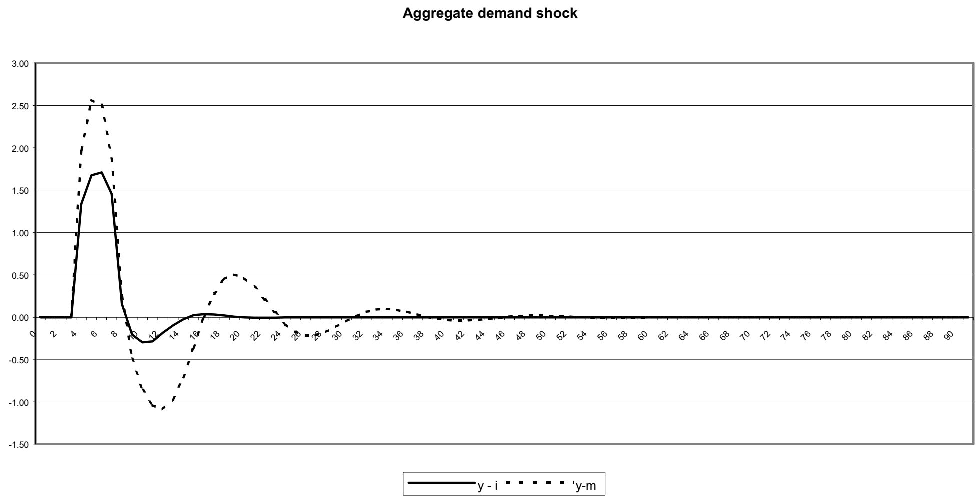


Figure 1

The effect of an aggregate demand shock on the inflation rate is shown in Figure 2. The continuous line (*dp-i*) traces the effect on inflation under the interest rate rule and the dotted line (*dp-m*) under the Friedman rule. In this case, the interest rate rule and the Friedman rule produce similar results, both in terms of the initial reaction of the inflation rate and its volatility. The variance of the interest rate rule is 0.23 against 0.25 for the Friedman rule.

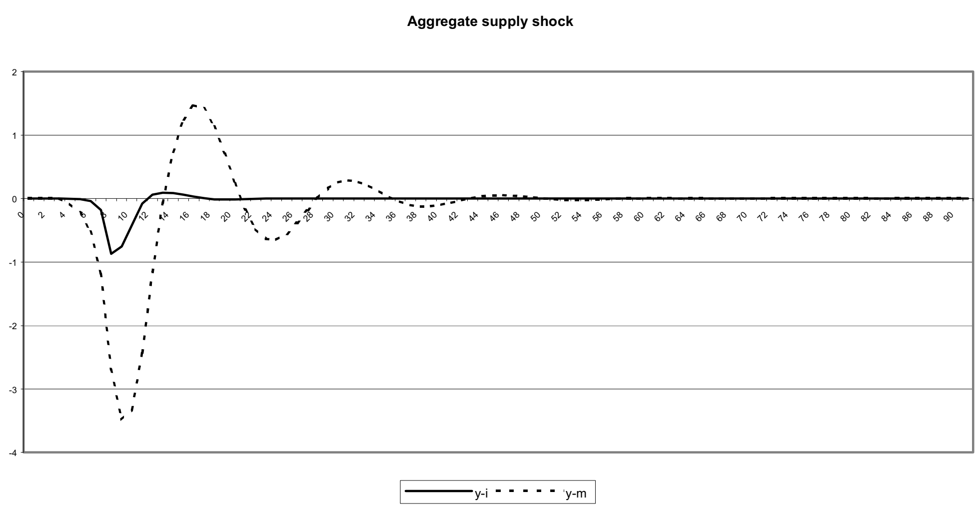


Figure 2

The effect of an aggregate supply shock of one unit for eight quarters on the output gap is illustrated in Figure 3. The Friedman rule (*y-m*) generates much more volatility with a variance of 0.53 than the interest rule (*y-i*) with a variance of 0.017.

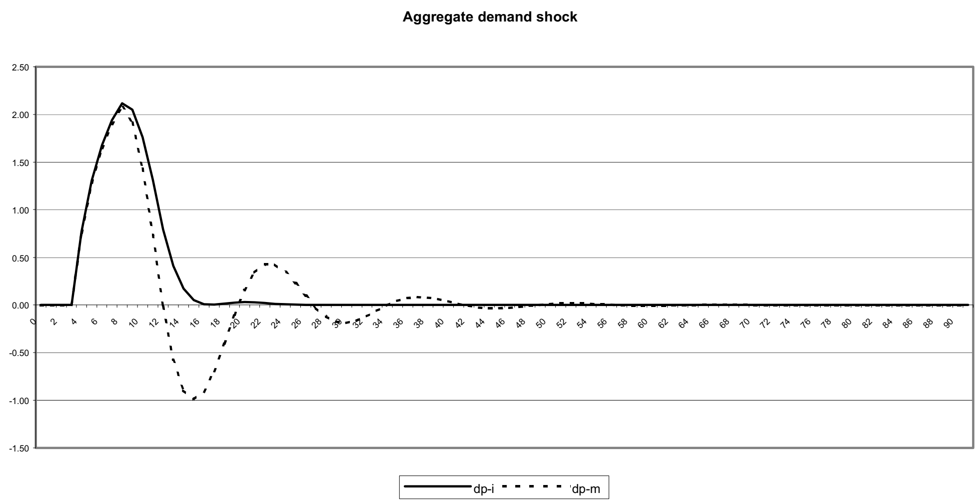


Figure 3

Figure 4, shows that in contrast to what is observed in the case of the output gap, the Friedman rule (*dp-m*) produces a smaller initial response and reduces the overall volatility of the inflation rate when supply shocks occur, relative to the interest rate rule (*dp-i*). The variance of inflation under the Friedman rule is 2.14 compared to 3.36 under the interest rate rule.

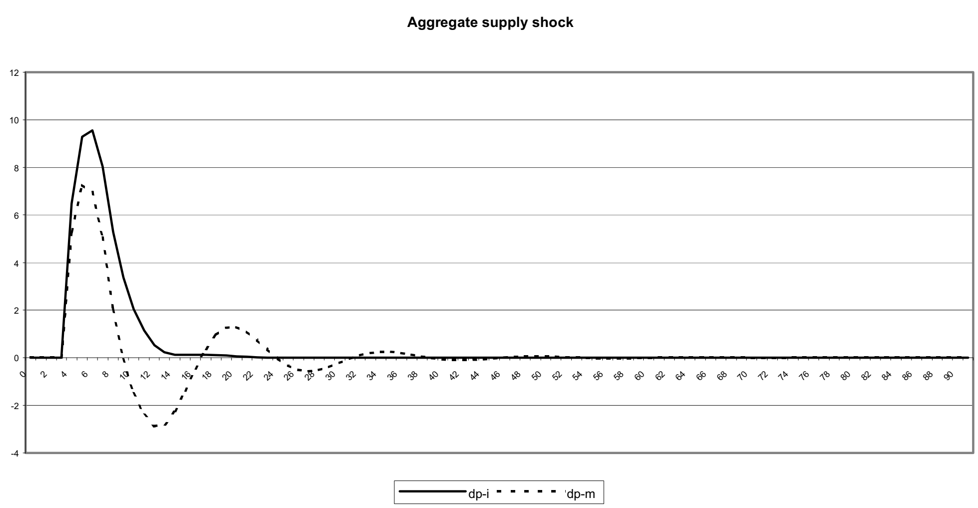
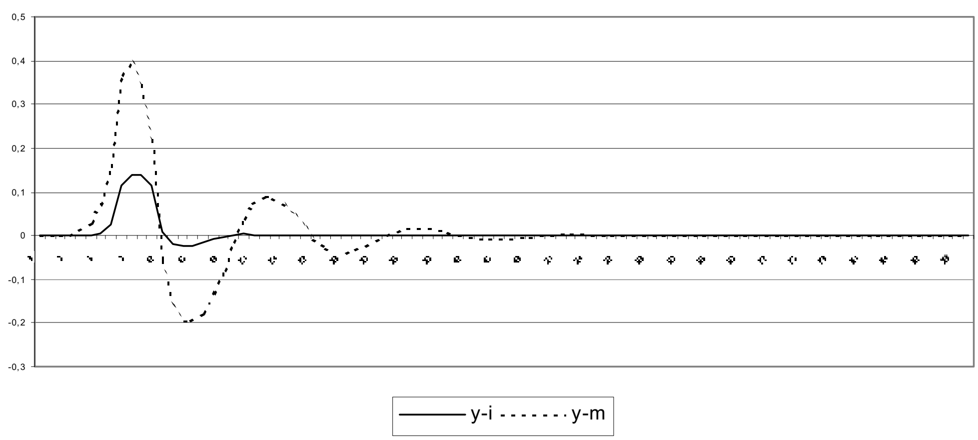


Figure 4

The next two figures (5 and 6) show the effects of random shocks in the money market. For the interest rate model, a one unit reduction in the interest rate (*y-i* and *dp-i*) that lasts for eight quarters is introduced; for the Friedman model a one unit increase in money growth (*y-m* and *dp-m*) for the same period is introduced. Here the interest rate rule gives rise to less volatility in both cases, particularly for the output gap. In this latter case the variance is 0.0007 for the interest rate rule compare to 0.07 for the Friedman rule; for the inflation rate, the variance is 0.003 for the interest rate rule against 0.01 for the Friedman rule.

M onetary instrument shock



Monetary instrument shock

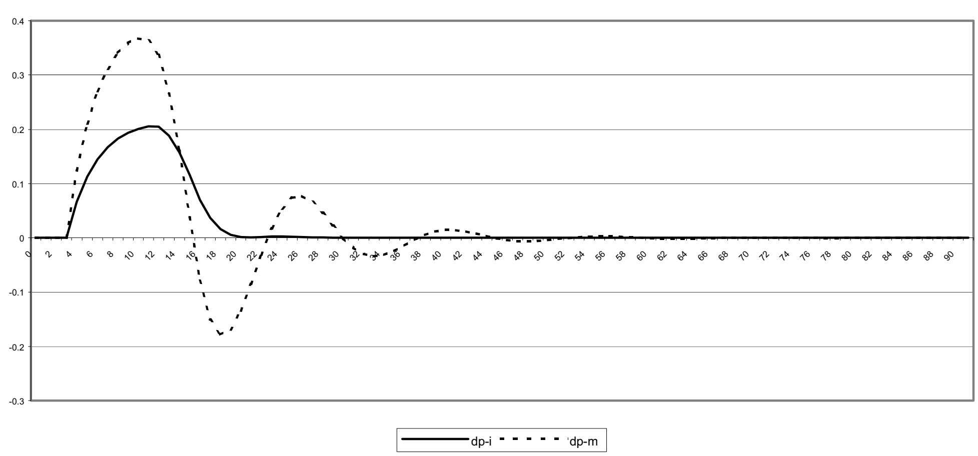


Figure 6

In general, the interest rate rule tends to generate a smaller initial reaction and less overall volatility in the output gap under any kind of shock. It also causes less volatility of the inflation rate when a money market shock occur. The Friedman rule outperforms the interest rate rule only in terms of fluctuations in inflation due to an aggregate supply shock. The reaction of inflation to an aggregate demand shock is similar under the two rules.

3.2 Interest rate rule Vs. Flexible money growth rule

In this section, the introduction of some flexibility in the Friedman rule is evaluated against the interest rate rule. After several trials a money growth rule that adds to the Friedman rule the output gap with a policy parameter of -0.40 and the inflation gap with a policy parameter equal to -1 was chosen.

Figure 7, presents the effect of an aggregate demand shock on the output gap under each type of rule. The output gap exhibits less fluctuations under the interest rate rule (*y-i*) than under the flexible money growth rule (*y-m*). The variance of the output gap under the interest rate rule is 0.11 against 0.35 with the flexible rule. Notice that the flexible rule introduces even more volatility on the output gap than the Friedman rule.

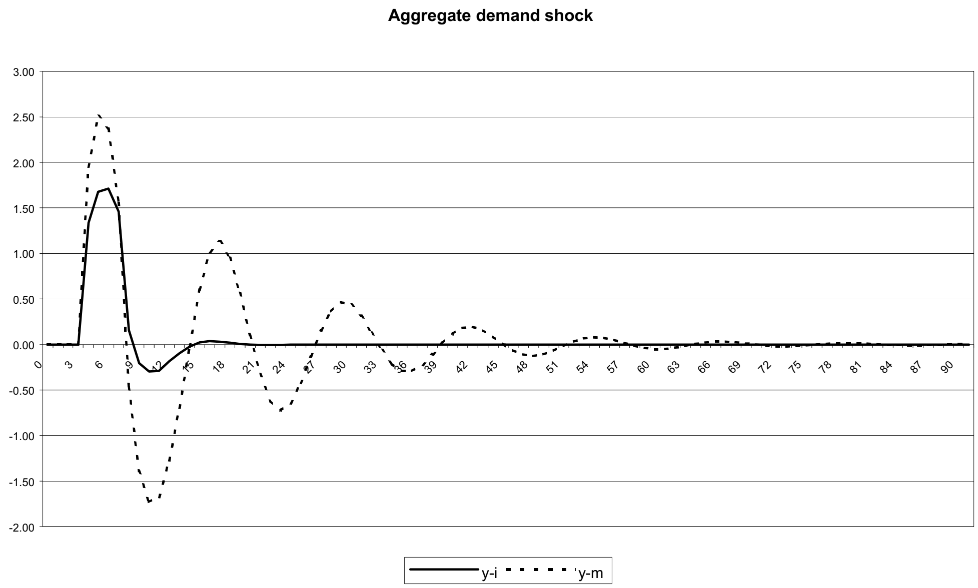


Figure 7

In Figure 8, we observe that under a flexible money growth rule (*dp-m*) an aggregate demand shock produces less volatility of the inflation rate than under the interest rate rule (*dp-i*). The variance of inflation under the flexible rule is 0.16 Vs. 0.23 under the interest rate rule. Also in this case, the flexible money growth rule outperforms the Friedman rule (variance of 0.25).

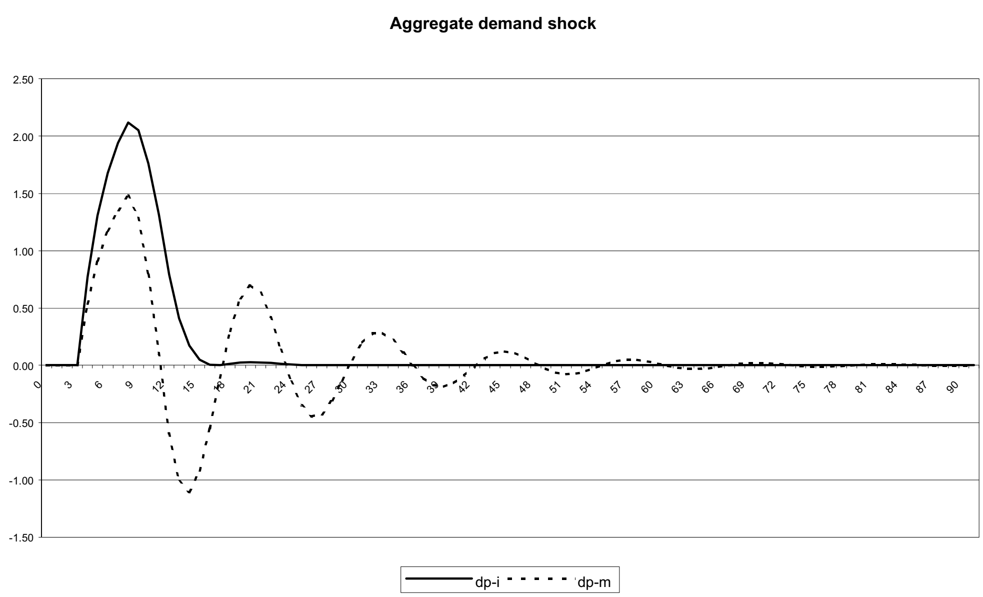


Figure 8

The effect of an aggregate supply shock on the output gap under each rule is displayed in Figure 9. It shows that the interest rate rule (*y*-*i*) generates less fluctuations of the output gap than the flexible money growth rule (*y*-*m*). The variance of the output gap with the interest rate rule is 0.017 compare to 1.77 with the flexible money growth rule. Note that the flexible money growth rule introduces more volatility of the output gap than the Friedman rule (variance 0.53).

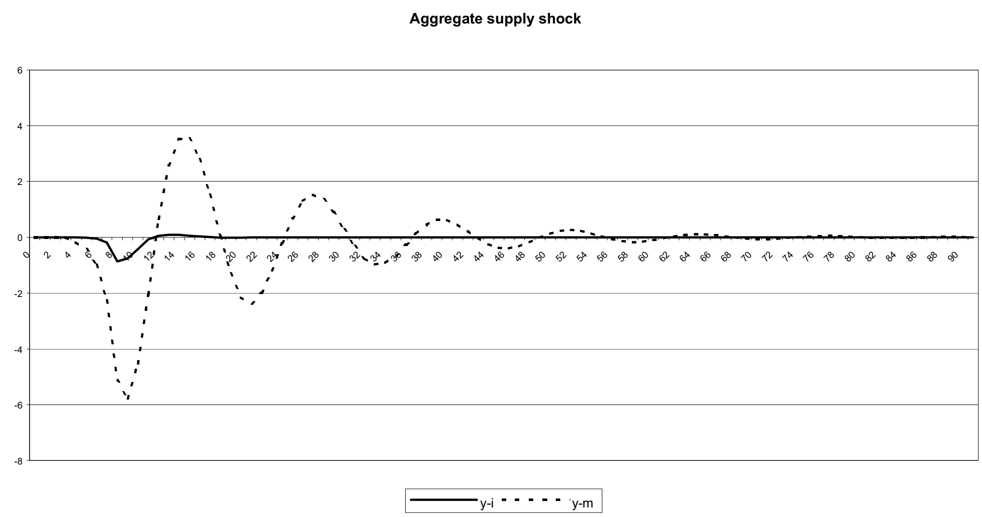


Figure 9

Figure 10, shows that the flexible money growth rule (*dp*-*m*) performs better in terms of inflation volatility than the interest rate rule (*dp*-*i*) in the face of a supply shock. The variance of the inflation rate with the flexible money growth rule is 2.15 Vs. 3.36 with the interest rate rule. The flexible rule performance in this case is quite similar to the Friedman rule (variance 2.14).

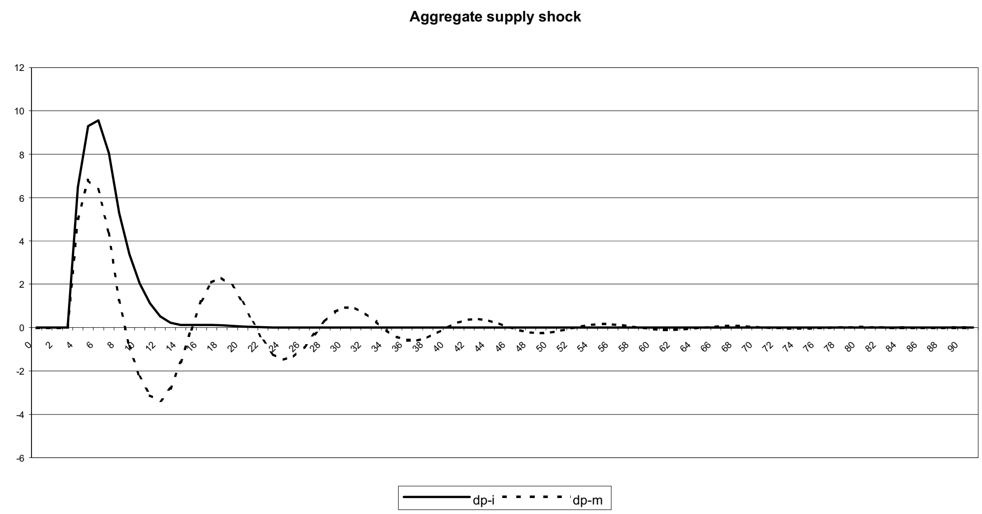


Figure 10

In the case of a shock in the money market, the interest rate rule (*y-i*) performs better than flexible money growth rule (*y-m*) in terms of the output gap (Figure 11) . The variance of the output gap with the interest rate rule is 0.0007 compare to 0.008 with the flexible money growth rule. The effects of a shock in the money market on the inflation rate are very similar (Figure 12). The variance of the inflation rate under the interest rate rule (*dp-i*) is 0.003 Vs. 0.005 under the flexible money growth rule (*dp-m*). In terms of the inflation rate, the flexible money rule outperforms the Friedman rule (variance 0.01 for the inflation rate).

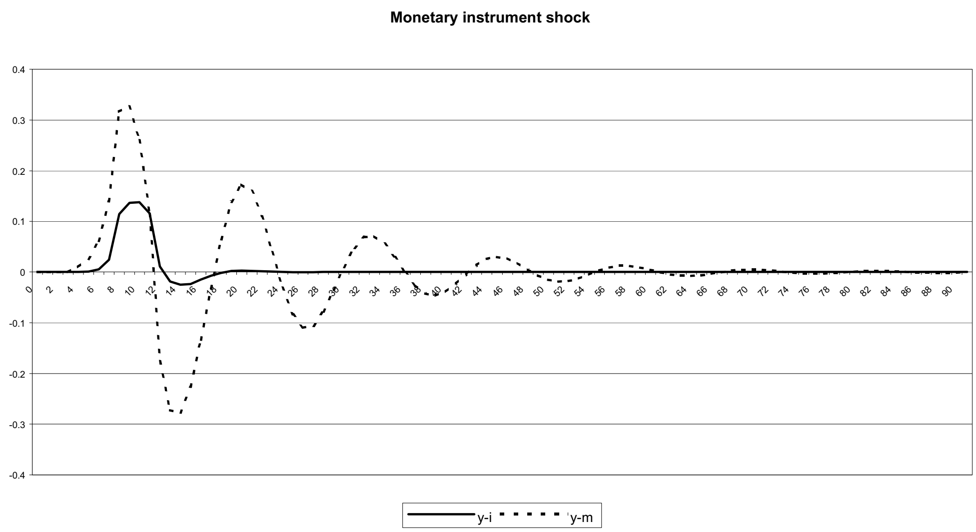


Figure 11

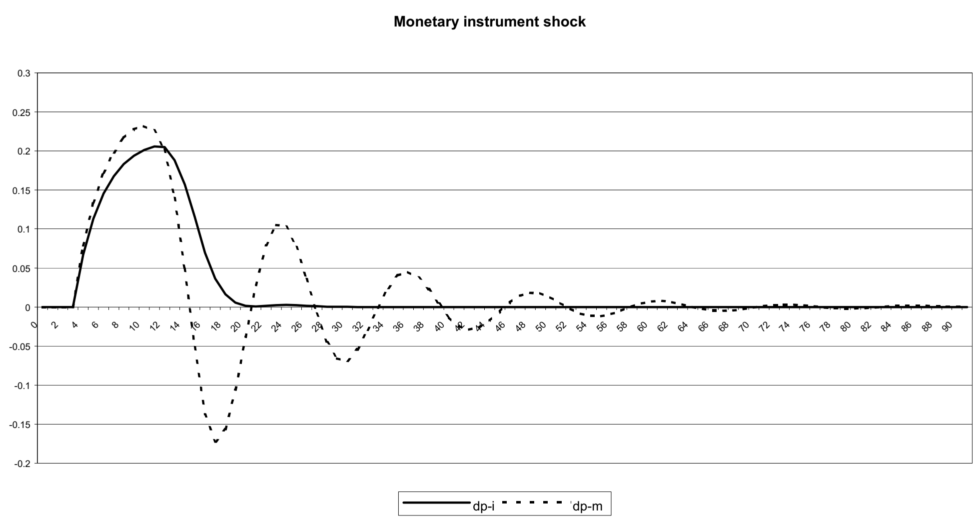


Figure 12

In general, the flexible or feedback money growth rule specified outperforms the interest rate rule and the Friedman constant money growth rule in terms of the reaction of inflation to the different shocks, but introduces more volatility on the output gap. Thus, interestingly, the introduction of some flexibility in the money growth rate in the form of parameters adjusting to the output gap and the inflation gap improves its performance in terms of inflation fluctuations, but not in terms of the output gap behavior. These results held for a variety of combinations of the output gap and inflation gap parameters.

The disadvantage of the money growth rules in terms of output gap volatility is related to the larger effect of the real growth of the monetary base on the output gap relative to the real interest rate effect. In addition, the coefficients of the one-lagged period and the one period ahead output gap are larger in the aggregate demand equation specified with the real monetary base than in the one that includes the real interest rate.

The following table summarizes the results discussed above about the effects of the different kinds of shocks on the output gap and the inflation rate.

Summary Table: Output Gap and Inflation Variance Under Different Kinds of Shocks

	Interest rate rule	**Friedman rule**	**Flexible money rule**
AD shocks			
Output gap	0.11	0.29	0.35
Inflation	0.23	0.25	0.16
AS shocks			
Output gap	0.017	0.53	1.77
Inflation	3.36	2.14	2.15
Money market shocks			
Output gap	0.0007	0.07	0.008
Inflation	0.003	0.01	0.005

4. CONCLUSIONS

This paper attempts to compare the performance of an interest rate rule, similar to the widely popular Taylor rule, with that of the money growth rule proposed by Friedman (1962, *A Program for Monetary Stability*), and a flexible version of this rule that responds to the output gap and the inflation gap (given a target inflation rate set by the monetary authority). Performance in this paper is measured in terms of the volatility (unconditional variance) exhibit by the output gap and the inflation rate when different shocks affect the economy under each type of rule.

The issue is first explored by specifying a theoretical stochastic aggregate demand-aggregate supply model of a forward-looking nature. To this basic model the monetary policy rules under analysis are added. The three resulting models are solved with a rational expectations approach through the method of undetermined coefficients. The variance of the output gap and the inflation rate solutions obtained are compared, assuming that the random errors included in each equation of the model are uncorrelated. The second approach to the problem is based on setting up models with dynamics a little more complex than that of the theoretical ones, and calibrated with information of the Venezuelan economy.

The main conclusion derived from both analyses is that the economy (characterized by the output gap and the rate of inflation) should behave in a fairly similar way when different shocks are introduced under the diverse rules considered. From a theoretical point of view, this conclusion is warranted by the fact that the introduction of different monetary policy rules should not change radically the basic structure of the economy. Hence, the variances for the output gap and the inflation rate under the different rules share a similar specification. In the empirical analysis, this conclusion derives from the fact that the impulse-response functions present similar patterns for each rule under the different random shocks. In general, the interest rate rule is better in terms of stabilization of the output gap, while the money growth rules, particularly the flexible version, is better in terms of inflation stabilization.

These results accord with those in the empirical studies conducted by Neumann and von Hagen (2002) and Ball and Sheridan (2002), which find that different monetary strategies achieved similar disinflationary results during the 90s.

What is then the reason for the substantial improvement in the effectiveness of monetary policy and central banks in the 90s in terms of macroeconomic stabilization? Here we contend that the answer is the widespread change in focus toward price stability in the long-run. Although in the short-run there is still room for output stabilization in terms of reducing its volatility, this objective has been kept in check by the pursuance of the overriding goal of price stability in the long-run. In contrast to previous decades, central banks in the 90s seriously committed to the attainment of price stability. Although, this emphasis of monetary policy on price stability only gained popularity in the 90s, it has been intensively promoted by Milton Friedman since the early 60s.

Both, the academia and the central banks, however, had put up some resistance to the idea that central banks should abandon monetary policy excessively biased towards output stabilization. Since Milton Friedman stated his first seminal ideas about this issue, several researchers (i.e. Robert Lucas, Robert Barro, David Gordon) have been introducing new elements that gradually reinforced the change in focus we see today.

Some countries have accompanied the focus on price stability with profound institutional changes that comprise the granting of legal instrument independence of their central banks to pursue this goal, and the introduction of mechanisms of transparency to make them accountable to society for its achievement. In other countries, notably the United States, the institutional arrangement has not been altered, but the central banks have adapted their practices to the new paradigm[4].

Despite the crucial role assigned to the commitment to price stability in the long-run to the recent success of monetary policy in terms of macroeconomic stabilization, this paper shares Friedman´s concern with the granting of too much discretion to monetary authorities. “The granting of wide and important responsibilities that are neither limited by clearly defined rules for guiding policy nor subject to test by external criteria of performance is a serious defect of our present monetary arrangements. It renders monetary policy a potential source of uncertainty and instability”, (Friedman,1960, p. 86).

A modern restatement of this argument is presented by Woodford (2003), who considers that to lock in this success, it is necessary to accompany it with a policy commitment. “A systematic approach to policy provides an explicit framework for decisionmaking within the bank, but that is also used to explain the bank´s decisions to the public”, (Woodford, 2003, p. 14). This proposal is based on Woodford´s view that when the private sector behavior is forward-looking as implied by optimizing models, central banking is basically about shaping market expectations.

But this study departs from Woodford in his assessment that interest rate rules are the first option to establish a policy commitment. This paper holds that the widespread rejection of monetary policy rules based on the management of a monetary aggregate is not well

4 Mishkin (2000) considers that the FED should “advocate a change in its mandate to put price stability as the overriding, long-run goal of monetary policy”.

supported neither theoretically nor empirically. The evidence provided by Meltzer (2001) and Nelson (2002), makes a strong case in favor of a monetary policy based on monetary aggregates in advanced economies. Meltzer (2001), goes beyond econometrics and present some interesting historic data from periods of deflation “to show than changes in real interest rates cannot explain some major episodes in monetary history”.

The case in favor of a monetary policy based on the control of a monetary aggregate is stronger in less advanced countries with their shallow financial markets and weak fiscal institutions. In this environment, the link between the short-run interest rate managed by the central bank and the long-run rate relevant for aggregate demand decisions may be quite weak and unstable.

A weaker conclusion from this study would be that even if monetary policy is conducted based on an interest rate, monetary aggregates should still play a major role in policy decisions. This view is strongly supported by Poole (1994) and Meltzer (2001), and is embedded in the European Central Bank “two pillars” strategy.

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