ENSAYOS

sobre política económica

Efficient Policy Rule for Inflation Targeting in Colombia

Martha López P.

Revista ESPE, No. 45 Junio 2004
Páginas 80-115

Regla de política eficiente para un régimen de inflación objetivo en Colombia

Martha López P.*

Departamento de Estudios Económicos, Banco Central de Colombia, "Banco de la República". La autora agradece a Lavan Mahadeva, del Banco Central de Inglaterra, por su colaboración y comentarios. También agradezco a Gerardo Lisandro, del Banco Central de Uruguay, y a Hernando Vargas, Carlos Esteban Posada, Andrés Carvajal, Juan Manuel Julio, Eduardo Sarmiento G., Javier Gómez y Carlos Varela por sus amables comentarios a versiones preliminares de este documento. Los errores prevalecientes son míos. Las opiniones expresadas en este documento son de la autora y no representan el punto de vista del Banco de la República.

* Banco de la República. Correo electrónico: mlopezpi@banrep.gov.co

Documento recibido el 21 de julio de 2003; versión final aceptada el 12 de mayo de 2004.

Resumen

Utilizando un modelo macroeconómico de pequeña escala para la economía colombiana, se investiga el problema de seleccionar una regla de política simple; una regla que utilice un conjunto reducido de información, que sea consistente con un régimen de inflación objetivo. A pesar de que las reglas de política simples no son tan eficientes como lo serían las reglas de política óptimas, en la literatura se ha mostrado que algunas reglas simples pueden aproximarlas muy bien. Se explican las características de los parámetros de reacción y de producto en reglas simples de Taylor e IFB, así como el horizonte óptimo de pronóstico para inflación objetivo. Mediante el uso de simulaciones estocásticas del modelo se encuentra que, como se esperaba, las reglas simples que utilizan proyecciones de la inflación en lugar de la inflación contemporánea tienen mejores propiedades de estabilización.

Clasificación JEL: C45, E41, E47, C32.

Palabras claves: *Inflación objetivo, horizonte, reglas de política óptima, reglas simples, metas.*

Efficient Policy Rule for Inflation Targeting in Colombia

Martha López *

In a small macroeconomic model of the Colombian economy I investigate the problem of selecting an efficient simple policy rule – rules that exploit a reduced information set-that is consistent with inflation targeting. Even though simple policy rules are not as efficient as the optimal state-contingent policy rules, in the literature it has been shown that some simple rules can approximate them very well. I spell out the characteristics of the feedback and output parameters in simple Taylor and Inflation-forecast rules, as well as the optimal forecasting horizon for inflation targeting. Using stochastic simulations of the model it is found that, as expected, simple rules that use forecasts of inflation rather than just contemporaneous inflation have better stabilization properties.

Economics Research Department, Central Bank of Colombia, «Banco de la República». The author would like to thank Lavan Mahadeva, from the Central Bank of England, for his useful guidance and comments. I also would like to thank Gerardo Lisandro, from the Central Bank of Uruguay, and Hernando Vargas, Carlos Esteban Posada, Andrés Carvajal, Juan Manuel Julio, Eduardo Sarmiento G; Javier Gómez and Carlos Varela for useful comments on earlier versions of this paper. Any remaining errors are mine. The views expressed in this paper are those of the author and do not necessarily represent the view of the Central Bank of Colombia.

* Banco de la República. E-mail: mlopezpi@banrep.gov.co

Document received July 21st 2003; final version accepted May 12th 2004.

JEL Classification: C45, E41, E47, C32.

Key words: Inflation targeting, horizon, optimal policy rules, simple feedback rules, target

I. INTRODUCTION

Around the world monetary authorities meet periodically to determine whether the monetary policy stance is consistent with their short and mid term targets. Those meetings revolve around the change in the tactics or strategies in order to meet the targets. In the early nineties central bankers of many countries like New Zealand, Canada, the United Kingdom, among others, adopted the inflation targeting strategy as one of the means to control inflation. In recent years, many other countries such as Colombia and Chile have also adopted the inflation targeting strategy. Within this context, monetary authorities need tools and some criteria to gauge the efficiency of macroeconomic policy.

Bernanke and Mishkin (1997) characterized inflation targeting as «constraint discretion» where there is ample scope for discretionary input into any rule. However, in order to evaluate the efficacy of the policy, the inflation targeting strategy should amount to a well-defined monetary policy-rule. Based on previous research on monetary policy rules, that have demonstrated the efficacy of simple rules, in this paper I explore the characteristics that a well-defined simple policy rule should have for inflation targeting in Colombia. I generate the inflation-output variability frontiers as introduced in Taylor (1979), to investigate what kind of reaction function is more efficient in terms of minimization of output gap, inflation and instrument variability.

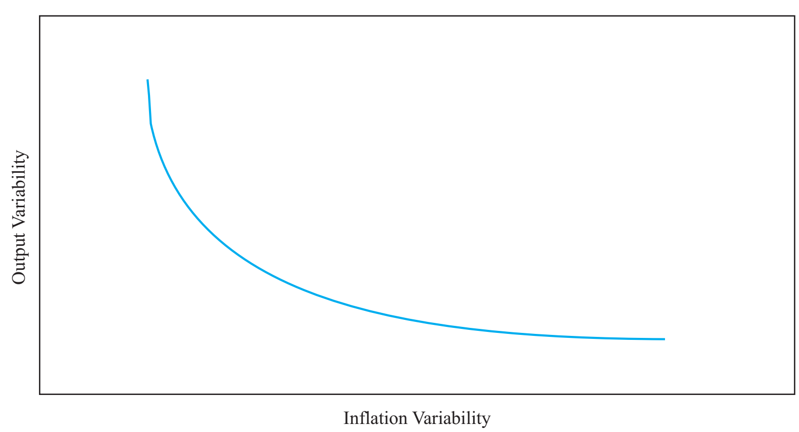
The reminder of the paper is as follows. In section II a brief description of the output-variability trade-off is given. In section III the concepts of optimal-state contingent policy rules and simple policy rules, like the Taylor rule, are discussed briefly. A discussion about the lags in the monetary policy and the ability of Inflation Forecast Based (IFB) rules to embrace the forward looking dimension that the monetary policy should have is presented in section IV. Some other advantages of IFB simple rules are also given. In sections V and VI, I describe two basic ingredients needed to evaluate the performance of any simple policy rule; the objective function of the monetary authorities and the model that describes the economy. In section VII, policy frontiers based on Taylor rules and Inflation Forecast Based rules are computed. The most efficient simple policy rule for the Colombian economy is presented in section VIII. Section IX contains a brief summary and conclusion.

II. THE OUTPUT-INFLATION VARIABILITY TRADE-OFF

In the economics literature it has been argued that there exists a trade-off between the size of the fluctuations in inflation and the size of the fluctuations in real output. In the context of the evaluation of the efficiency of the macroeconomic policies, this means that in the conduction of monetary policy it is useful to construct and estimate a variability trade-off between inflation and unemployment in terms of their fluctuations over time rather than in terms of a single decision made at a single point in time. Focusing on the long-term, which consist of many short-runs, results in a better evaluation of monetary policy.

The idea of the output-inflation variability trade-off is shown in Graph 1. Inefficient macroeconomic policies would lead to outcomes above the curve with both inflation

Graph 1
Output / Inflation variability trade-off



Source: calculations by the author.

fluctuations and unemployment fluctuations higher than what could be achieved with better policies. Hence points moving to the south-west in Figure 1 signal an improvement in policy performance and conversely, points to the north east signal a worsening policy performance. The efficient frontiers, defined in Taylor (1979), are the locus of the lowest achievable combination of inflation and output variability. In addition, on the frontier, one must view reduced output stability as the opportunity cost of improved inflation stability.

The response of monetary policy to macroeconomic shocks helps determine how large effects on real output or inflation will be. For example, suppose that the economy is in a state where real output equals potential output and inflation is steady, and suppose that there is an upward demand shock. It causes real output to rise above potential and there will be inflationary pressures. The monetary authority could respond in two ways. The first response could be to tighten policy sharply in order to control the inflation rate, but it might cause a slow down in the real activity. In this case the response results in more inflation stability and less real output stability. The second response could be to use a more cautious monetary policy that might have less effect in controlling the rise in inflation, but it will have a smaller negative effect on real output. Depending on what the monetary authority decides, its monetary policy helps determine the inflation and output stability.

III. THE EFFICIENT FRONTIERS, OPTIMAL STATE-CONTINGENT AND SIMPLE POLICY RULES

A. OPTIMAL STATE-CONTINGENT RULES

Following Taylor (1994), the optimal State-contingent policy rule is defined as the one that minimizes a weighted sum of output variance and inflation variance (sometimes the variability of the interest rates is also taken into account). The weights are determined by the policy makers tastes.

From optimal control theory it is well known that optimal State-contingent policy rules respond to all variables that offer useful information on the target variables of policy.[1] Optimal state-contingent rules may respond for example not only to the

[1] Rudebush and Svensson (1998).

deviation of inflation from target and the output gap, but also to variables such as the real exchange rate, foreign output gap, and foreign inflation.[2] Because of their complexity, optimal state-contingent policy rules might be very impractical to implement.

Some other simple policy rules, although not as efficient as the state-contingent rules, may approximate them reasonably well and have some additional advantages.

B. EFFICIENT SIMPLE POLICY RULES

Efficient simple policy rules were introduced by Taylor (1979). He proposed an explicit instrument rule for policy that today is known as the Taylor rule. Under such a reaction function, the nominal level of the interest rate is determined by the current level of two variables, the deviation of inflation from a target and, the deviation of actual output from potential, so:

$$(1) \qquad i_t^p = (r_t^* + \pi_t) + \alpha_\pi(\pi_t - \pi_t^*) + \delta\,(y_t - y^*)$$

Where r^* is the equilibrium or long-run real interest rate. Efficient simple policy rules for the conduction of monetary policies are defined as those that deliver the lowest achievable combination of inflation and output variability (or some other variable in the objective function of the central bank) given the structure of the model under consideration.

Taylor (1993) suggested a weight of 0.5 on the output gap and on the inflation deviation from target. However, virtually all attempts to estimate the Taylor rule empirically require the addition of a lagged dependent variable in order to fit well. This means that central banks have tried historically to smooth interest rates changes. Thus the common practice among central banks is to make long series of small steps in the same direction. This behavioral pattern is partly picked up in the econometrics for the Taylor rule, in the guise of the near-unity value of the lagged dependent variable. Taylor (1998) studied the comparative virtues of rules of that include the lagged dependent variable. He concludes that it is allright for the authorities to act slowly in a series of cautious steps, just as long as a forward-looking public can

[2] Dennis (2000).

effectively undo such cautious lags by immediate anticipation. Interest rate rules which respond with a lag assume that people will expect later increases in interest rates if such increases are needed to reduce inflation. Later, I will introduce a smoothing parameter of the interest rate in the setting for the simple policy rule for Colombia.

One important aspect about simple rules is that they have some advantages over optimal state-contingent policy rules. Some of this advantages are that their implementation is much easier; that it is easy for private agents to understand policy, and that they can verify the Central Bank behavior. However, the efficiency of this kind of rules seems to be limited due to the fact that they respond to only a subset of the available information set. According to studies by Rudebusch and Svensson (1998) and others, the most efficient simple rules are rules called Inflation Forecast Based rules (IFB). I devote the next section to this kind of simple policy rules.

IV. LAGS IN THE MONETARY TRANSMISSION MECHANISM AND INFLATION FORECAST BASED RULES

It has long been recognized that monetary policy needs a forward-looking dimension. As Milton Friedman noted, the monetary policy transmission mechanism has «long and variable lags.» The Taylor rule sets an interest rate path on the basis of current or lagged values of output and inflation. By contrast, inflation-targeting central banks focus on inflation forecasts rather than in their actual values. In these central banks, forecasts of future inflation and output play a key role in the monetary policy decision-making process.

Inflation Forecasts Based rules (IFB rules) are rules with response to a rule-consistent inflation forecast. The result is an inflation forecast always returning to the target. Consider the following forecast-based rule

$$(2) \qquad i_t^p = (r_t^* + \pi_t) + \alpha_\pi (E_t \pi_{t+k} - \pi_t^*)$$

where $E_t(\cdot) = E_t(\cdot|\Phi_t)$, where Φ_t is the information set available at time t and E is the mathematical expectations operator. According to the rule, the monetary authorities control deterministically nominal interest rates (i_t) so as to hit a path for the short-term real interest rate. This kind of policy rule is a useful prescriptive tool because deviations of *expected* inflation (the feedback variable) from the inflation target (the policy goal) prescribe remedial policy actions. The rule implies that if new information makes the inflation forecast at horizon k increase, the interest rate should be increased, and vice versa.

Besides allowing the policy-maker the control lag for monetary policy, there are good reasons for believing that forecast-based policy rules, although simple, may not be as restrictive as the Taylor rule. Given that an inflation forecast is formed using all information that is useful for predicting future inflation, (i.e. exchange rate, foreign output, foreign interest rates, import prices, etc.) a simple IFB rule is implicitly responding to a wide array of macroeconomic variables. It is for this reason that IFB rules, although not as efficient as the state-contingent policy rule, may tend to be more efficient than other types of simple, backward-looking rule.

In the next section, I will consider the performance of simple Taylor rules and IFB rules in an inflation targeting framework for Colombia. This is made by embedding the various rules in a small macro model, *Model of Transmission Mechanism* (MMT) and, after performing some stochastic simulations, evaluating the resulting (unconditional) moments of the arguments typically thought to enter the central banks' loss function (output, inflation and the policy instrument).

V. THE MONETARY AUTHORITY'S OBJECTIVE FUNCTION

As in Batini and Nelson (2000), we will interpret «inflation targeting» as having a loss function for monetary policy where deviations of inflation from an explicit inflation target are always given some weight, λ_{π}, but not necessarily all the weight. Strict inflation targeting refers to the situation where only inflation enters the loss function, while «flexible» inflation targeting allows other goal variables.

In the optimization exercises used to derive the optimal policy rule, this is the function that is being minimized. And when comparing the performance of rules like (1) or (2), this loss function is used to compute welfare losses in all experiments. In particular for a discount factor β, $0 < \beta < 1$, we consider the loss function given by:

(3) $$L_t = E_t \sum_{j=0}^{\infty} \beta^j \{\lambda_{\pi}(\pi_{t+j} - \pi^*_{t+j})^2 + \lambda_y (y_{t+j} - y^*_{t+j})^2 + \lambda_{\Delta t}(\Delta i_{t+j})^2\}$$

We use standard weights used in the inflation targeting literature, with $\beta = 0.99$, $\lambda_\pi = 1$, $\lambda_y = 1$ and $\lambda_{\Delta i} = 0.5$. It means that loss is calculated under the assumption that output and inflation variability are equally distasteful and variations in the costs of variability of interest-rate changes receives a penalty half that of the other terms.

VI. A SMALL OPEN ECONOMY MODEL

A. DESCRIPTION OF THE MODEL

In this section it is presented a latest version of a *Small Macro Model of Transmission Mechanism* (SMMT) developed at the Bank by Gómez, Uribe and Vargas (2002)[3] for the description of the Colombian economy. This model is a small, dynamic open economy representation of the Colombian economy. It follows the models developed by Rotemberg and Woodford´s (1997), McCallum and Nelson (1999), Svensson (1998), and Fuhrer and Moore (1995), that are derived from representative agent microfoundations. The model is explicitly foreward-looking in financial markets and, potentially, in the goods market.[4]

The model is based on the following equations:

(4) $$\hat{y}_t = \beta_1\hat{y}_{t-1} + \beta_2\hat{y}_{t+1} - \beta_3\hat{r}_t + \beta_4\hat{y}_t^{usa} + \beta_5\hat{q}_{t-1} + \varepsilon_t^y$$

(5) $$\pi_t^c = (1 - \eta_1 - \eta_2)\pi_{t-1}^c + \eta_1 E_{t-1}\pi_{t+1}^c + \eta_2\pi_{t-1}^m + \eta_3\hat{y}_{t-1} + \varepsilon_t^\pi$$

(6) $$\pi_t^f = \theta_1\pi_{t-1}^c + (1 - \theta_1)\pi_{t-1}^f + \theta_2\varphi_{t-1} + \theta_3\varphi_{t-2} + \theta_4\varphi_{t-5} + \theta_5\varphi_{t-6} + \varepsilon_t^{f\pi}$$

(7) $$\pi_t^T \equiv 0.3\pi_t^f + 0.7\pi_t^c$$

3 The main features and econometric estimations of the model are presented in Gómez, J.; Uribe, J. D., and Vargas, H. (2002). «The Implementation of Inflation Targeting in Colombia,» Borradores de Economía, *Banco de la República*, No. 202. The main difference of the version presented here is that static homogeneity is not imposed in the model, therefore the long-run restrictions on the levels of the variables are not present. However, dynamic homogeneity is tested and still present in the model, allowing the model to be superneutral.

4 It is important to notice, however, that in the calibration of the model not all the equations have been parameterized based on structural parameters and therefore the Lucas critique is not overcame completely.

(8) $\pi_t^m \equiv \pi_t^{\text{int}} + \Delta e_t^{usa}$

(9) $\hat{q}_t = E_{t-1}\hat{q}_{t+1} - (\hat{r}_t - \hat{r}_t^{usa} - \psi_t)$

(10) $\Delta i_t = \omega_1 \Delta i_{t-1} + \omega_2 \Delta i_t^p + (1 - \omega_1 - \omega_2)\Delta i_{t-1}^p + \omega_3 z_{t-4} + \varepsilon_t^i$

Where according to the rational expectations hypothesis of Muth (1961), expectations should satisfy $x_{t+k} = E_{t-1}x_{t+k} + \eta_{t+k}$ and $E(\eta_{t+k}) = 0$.

All variables in the economy are defined as deviations from equilibrium values. Equation (4) is similar to the aggregate demand equation that Svensson (1998), and Rotemberg and Woodford (1997) derive from representative agent microfoundations. Svensson derives a structure in which aggregate demand is a function of foreign demand, current and expected real interest rates, and the real exchange rate. As in Svensson partial adjustment is imposed (i. e. the lag of the left hand side variable is put on the right hand side assuming habit persistence). Finally, ε^y represents an aggregate demand shock.

Equations (5), (6) and (7) define the models' supply side. Equation (5) is an open-economy Phillips curve expressed in terms of core inflation. Core inflation depends on the mixed backward-forward looking term, the lagged change in the imported goods price, π^m, lag of the output gap, and a supply shock. In Svensson (1997), a similar Phillips curve is derived using an open-economy extension of Rotemberg and Woodford´s (1997) representative consumer/producer model. In his derived Phillips curve, prices are determined by the (model-consistent) expectation of future prices, aggregate demand, and the real exchange rate (which impacts through the cost of imported intermediate goods). Based on the over-lapping relative real wage contracting model by Fuhrer and Moore (1995), partial adjustment is imposed to avoid that domestic inflation behave like a jump variable, making it difficult to replicate the persistence found in actual inflation series. The difference between Svensson´s specification and (5) is that the price of imports is used to capture intermediate input effects according to a cost push theory of inflation in the long run.[5]

The Phillips curve is superneutral because the sum of the coefficients on the nominal variables in the curve is one. This property is also known as dynamic homogeneity

5 The growth of total cost is estimated as a weighted average of unit labor cost and the price of imports.

and makes the long-run trade-off between output and inflation disappears, that is in the long run the Phillps curve is vertical. There is a trade-off between economic activity and inflation but this trade-off takes place in the short run. Any attempt to stimulate output is not lasting in the long run; it only results in higher inflation.

Equation (6) describes food inflation. The equation comes from a model developed by Avella (2001). In Colombia supply shocks related to the weather phenomenon, «El Niño», drives food price inflation. At the same time, total inflation in Colombia is mainly determined by output gap and supply shocks in the agricultural sector. Equation (6) tells us that food inflation is determined by core inflation, lags of food inflation and the rainfall deficit, φ.

In equation (7), CPI inflation is expressed as a convex combination of core inflation and food inflation. Equation (8) is the identity that defines price of imports as the sum of foreign inflation and nominal depreciation.

Equation (9) posits a link between the differential of domestic and foreign real interest rate and the real exchange rate. This is simply an uncovered interest parity (UIP) condition, written in real terms to reduce the dimension of the system. This UIP condition simply states that the expected change in the exchange rate fully offsets the foreign-domestic nominal interest rate differential. The shock ψ_t captures other influences on the exchange rate, such as investors' confidence. The real exchange rate is a bilateral rate with the United States, defined in terms of consumer prices.

Finally, equation (10) is the transmission between the market nominal interest rates,[6] i_t, and the central banks' policy nominal interest rate, i_t^p, and z_t is the spread between the market nominal interest rate and the policy interest rate and a long-run constant.

B. DATA, ECONOMETRIC ESTIMATION, AND CALIBRATION

Once the structure discussed above was specified, the model needs to be parameterized. There is a growing literature on the methodology of model calibration. Much of the recent literature on calibration has sought to compare, and perhaps ultimately reconcile,

[6] The market nominal interest rate is the 90 days CD's.

the calibration methodology with more traditional estimation methods. For example King (1995) and Sargent (1998) note that system-based estimation techniques such as the Hansen-Sargent procedure provide an alternative to both calibration and equation by equation model estimation. However, King expresses some skepticism about this approach because the full system estimation generally gives unreasonable results for a portion of model parameters, and recommends generalized methods of moment analysis (GMM), which is similar in spirit to calibration, but provides a variance-covariance matrix for the parameters in the model, which gives the researcher information on the extent of parameter uncertainty.

Using Hansen's (1982) Generalized Method of Moments, GMM, the system of equations (4) (5) and (10), which corresponds to Aggregate demand, Phillips curve and transmission between interest rates, respectively, was estimated. There are eleven parameters to be estimated, named $\sigma = (\beta_1\, \beta_2\, \beta_3\, \beta_4\, \beta_5\, \eta_1\, \eta_2\, \eta_3\, \omega_1\, \omega_2\, \omega_3)$. The vector of instruments used to conform the orthogonality conditions is $\{1, y_{t\text{-}2}, y_{t\text{-}3}, q, q_{t\text{-}1}, q_{t\text{-}2}, r_{t\text{-}2}, tt, tt_{t\text{-}4}, y_{t\text{-}2}^{usa}, \Delta i_{t\text{-}4}, \Delta i^{p}_{t\text{-}1}, z_{t\text{-}5}\}$ where tt represents terms of trade. Equation (6), on the other hand, it was estimated using ordinary least squares given that food inflation depends on core inflation with a lag and core inflation is independent on food inflation, which means that there is not a simultaneity bias. In a subsequent step, some of the parameters were adjusted in order to obtain some reasonable impulse response functions and reasonable forecast out of sample for some of the key variables in the economy, such as inflation and output.

For the empirical analysis, the sample period is 1980:1 through 2002:4 for the system of equations (4), (5) and (10) and 1990.1 thorough 2002.4 for equation (6). Core inflation is calculated as the annual difference in the log of the monthly geometric average of the nonfood component of CPI, $\pi^c_t = \log P^c_t - \log P^c_{t\text{-}4}$. Similarly, inflation of the price of imports calculated with the imported component of the PPI. $\pi^m_t = \log P^m_t - \log P^m_{t\text{-}4}$. Output gap, y_t, is the difference of output from potential, and potential output it was calculated based on the Neoclassical Growth Model.[7] Real interest rate, $(1+r)$, is the ratio between one plus the market passive interest rate and one plus the core inflation rate. Real exchange rate, q, is a bilateral rate with the United States, and its equilibrium value is calculated from a Hoddrick-Presscot filter. Terms of trade, tt, are calculated as the ratio between export goods index and import goods index in the Total PPI price index. The policy interest rate,

[7] Gómez, Uribe and Vargas (2002).

i^p, corresponds to the rate that the Central Bank charges to the financial intermediaries, called the TIB rate. Droughts, φ, are measured as the seasonally adjusted amount of rain that is 20% below the average.

The results from estimating the system of equations (4), (5) and (10) are displayed in Table 1. All the parameter estimates have the expected sign. The first row of Table 1 contains the results of the GMM estimation of η_1, that tell us how much of the core inflation is explained by agents that form their expectations in a rational way, which seems to be quite significant. Import goods inflation did not result significant in the estimation but the value of the coefficient seems to be quite reasonable according to other studies that use kalman filter technique to estimate changing parameters over time. Estimates of η_3 tells us that the effect of the

Table 1

System of Equations for Phillips Curve, Aggregate Demand and Transmission between Interest Rates

Parameter	Coefficient	t-statistic	P-value
η_1	0.352	4.438	0.000
η_2	0.026	1.504	0.134
η_3	0.106	2.999	0.003
β_1	0.891	21.459	0.000
β_3	-0.167	-5.468	0.000
β_4	0.092	0.936	0.351
β_5	0.002	0.038	0.970
ω_1	0.248	3.203	0.002
ω_2	0.440	3.544	0.001
ω_3	-0.036	-0.142	0.887
$J(T)$ =	8.411		

Sample 1980:1-2002:4.
Estimation Technique: Generalized Method of Moments.
*Newey-West HAC Standard Errors & Covariance.
Bandwidth: Fixed (3).
Kernel: Bartlett.
J(T) = 11,524.
Source: calculations by the author.

output gap results significant in the explanation of core inflation in Colombia. This finding is very interesting because as Clarida, Gali, and Gertler (2000) point out, in many countries is not possible to find a direct relationship between output gap and inflation rate but it is necessary introduce a marginal cost equation in order to find the expected relationship.

The parameters $\beta's$, of the aggregate demand equations present the correct signs. However it was not possible to find a set of instruments that allow the inclusion of the forward looking output gap variable in the equation because when it is introduced, the sign of the real interest rate gap it was incorrect or the variable was not significant. Output gap seems to be very persistent as the parameter β_1 indicates. Interest rate changes have also significant effects on output gap. The effect of real exchange rate gap and the output gap of the United States did not appear to be significant but the sign seems to be right. The effect of real exchange rate depreciation could be positive or negative depending of the degree of financial vulnerability in the economy.[8] In a recent study on balance sheet effects in Latin America, Morón and Winkelried (2001)[9] show that in Colombia the potential contractionary effects of a depreciation rate are not very high given that the economy does not present a high level of liability dollarization during the period 1991-2000. Therefore in their econometric estimations, the Colombian economy did not result to be classified as a financially vulnerable economy where the negative wealth effect of a real exchange rate depreciation is higher that the positive substitution effect.

The parameter estimates for the equation that explains the transmission between the policy and the market interest rate are significant except the parameter that corresponds to the long run relation between the series, z_t.

In addition to the parameter estimates and their respective *t*-values, the Hansen (1982) statistic for testing the validity of the over-identifying restrictions implied by the model is reported. This test is the $J(\sigma)$ statistic and it is equal to 8.41. The null hypothesis is that the model is correctly specified. $J(\sigma)$ converges in distribution to a χ^2_{q-p}, where q is the number of population moment conditions and p is the number of parameter to be estimated. In this case, the critical χ^2_{16-10} is 11.52 at a five

8 Woon Gyu Choi, "Liability Dollarization and Balance Sheet Effects Channel," *IMF*, Nov. 2002.

9 E. Morón y D. Winkelried , "Monetary Policy rules for Financially Vulnerable Economies," *IMF*, Nov. 2001.

percent significance level. So we do not reject the null hypothesis and assume that the model is correctly specified.

The estimates for the food inflation equation are shown in Table 2. As Avella (2001) described, the rainfall variable enters with a negative sign at short lags because of the effect of the weather of food supply and with positive sign by the fifth quarter because, as in the cobwed effect, farmers respond to high relative prices with an increase in supply.

In a final step some of the parameter values were adjusted considering some properties of the model such as the impulse response functions and the root of mean squared error of the forecast for some key variables such as the output gap, inflation rate and interest rates.[10] The parameter values that needed to be adjusted were: the parameter on inflation expectations, $\eta_{1,}$ from 0.35 to 0.47, the response of core inflation to output gap, η_3, from 0.106 to 0.047; and the parameter that measures the response of aggregate demand to real exchange rate, β_5, from 0.002

Table 2
Food Inflation Equation

Parameter	Coefficient	t-statistic	P-value
θ_1	0.484	6.706	0.000
θ_2	-0.136	-4.065	0.000
θ_3	-0.104	-2.781	0.008
θ_4	0.144	4.265	0.000
θ_5	0.164	4.563	0.000

Sample 1990:1-2002:4.
Estimation Technique: Ordinary least squares.
Adjusted R-squared 0.938.
Durbin-Watson stat 1.994.
Source: calculations by the author.

10 Banco de la República (2003-2004). "Meta de inflación", Mimeo.

to 0.01. The value of 0.47 for the inflation expectations parameter is more in line with the estimation of the structural parameters in a Phillips curve estimated by Bejarano (2003).[11] The choice of the parameter values it was made with the goal of been able to make a reasonably good dynamic forecast[12] of the core inflation, output gap and import goods inflation for the years 2001 and 2002. The dynamic forecast for core inflation, output growth, and imported goods inflation resulting from the calibration is presented in Graph 2, and the corresponding root of mean squared error of the forecast of the inflation rate for different horizons is presented in Table 3.

Finally, some impulse response functions of the model are presented in Graph 3. These correspond to the response to a shock of one percent increase in the policy rate during four quarters.

VII. PERFORMANCE OF SIMPLE TAYLOR AND IFB RULES

The model is to be closed with a policy rule that should be chosen in such a way that it will minimize the loss function of the monetary authority represented in equation (3). In this section, I compare the performance of some rules and choose the most efficient simple feedback rule. The method used to solve this model with forward expectations was the *Staked Newton* method described by Pierse (1999).[13]

In this section, we start by comparing the performance of Taylor rules and inflation-forecast-based rules by generating the inflation-output variability frontiers to investigate the general properties of each of this kind of rules.

---

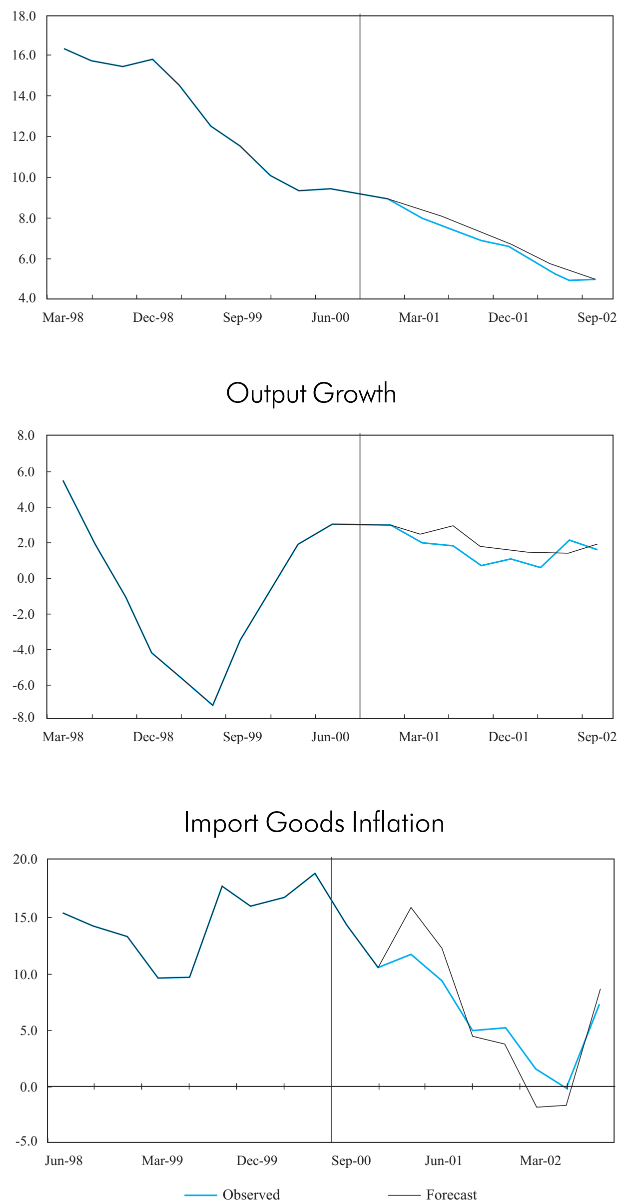
11 Bejarano (2003) found that in Colombia the structural parameter that, according to Calvo (1982), measures the probability of adjustment of prices by firms is about 0.65, which implies a parameter for inflation expectations of 0.57.

12 In a dynamic forecast, the last forecast of the variable is used as an observed value in the forecast for the next quarter and so on.

13 Following Blanchard and Kahn (1980), in the solution of linear difference models under rational expectations it is necessary to meet a stability condition, the saddle-path condition. The model must have a number of eigenvalues inside the unit circle exactly equal to the number of predetermined variables in the model and a number of eigenvalues outside the unit circle exactly equal to the number of unpredetermined variables in the model in order to have a unique stable solution. The model represented by equations 4 – 10 closed by the different policy rules presented in section VII satisfy the saddle-path condition.

Graph 2

Core Inflation



Source: calculations by the author.

Table 3

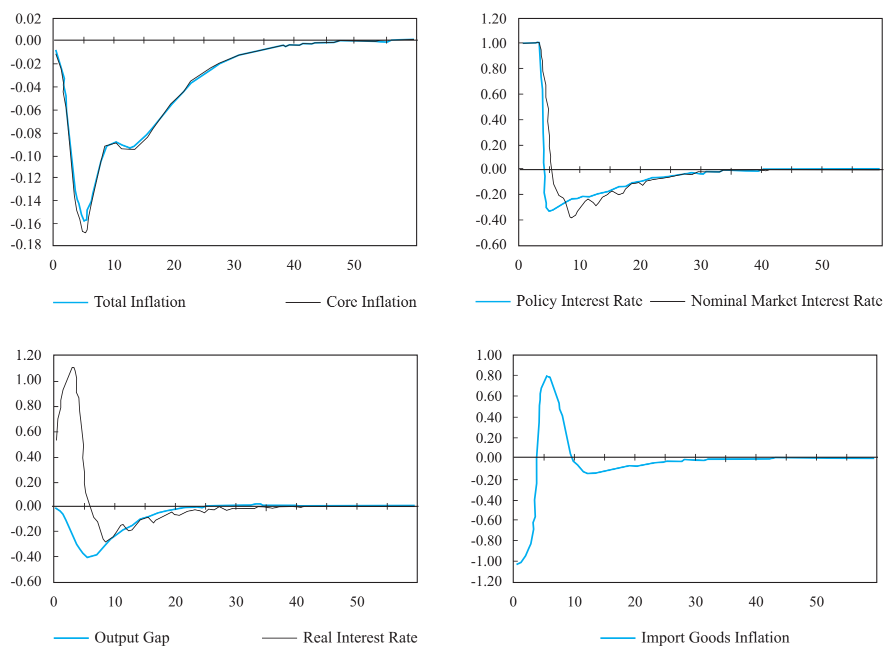
RMSE 2000:3-2002:3

Quarter							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
0.2175	0.3316	0.3668	0.4194	0.3959	0.4652	0.4987	0.4309

Source: calculations by the author.

Graph 3

Response to a one percent monetary policy tightening



Source: calculations by the author.

The frontiers are traced out for what might be termed «reasonable» preferences over inflation and output variability as described in the quadratic loss function in equation (3). Stochastic simulations of the model and a grid search technique over policy rule coefficient are employed to trace out the efficient frontier.[14] For each rule considered, the resulting moments are calculated by averaging the results from 100 draws, each of which is simulated over a 25-year horizon. The measures of variability used are the root mean squared deviation (RMSD) of inflation from its target and output from potential output.

A. PERFORMANCE OF TAYLOR RULES

Here we close the SMMT described in section six with a variety of Taylor rules that are characterized by any policy rule where the central banks' policy nominal interest rate responds to the contemporaneous deviation of output from potential and non-food inflation from target.

$$i^p_t = (r^*_t + \pi_t) + \alpha_\pi(\pi_t - \pi^*_t) + \delta_y(y_t - y^*_t)$$

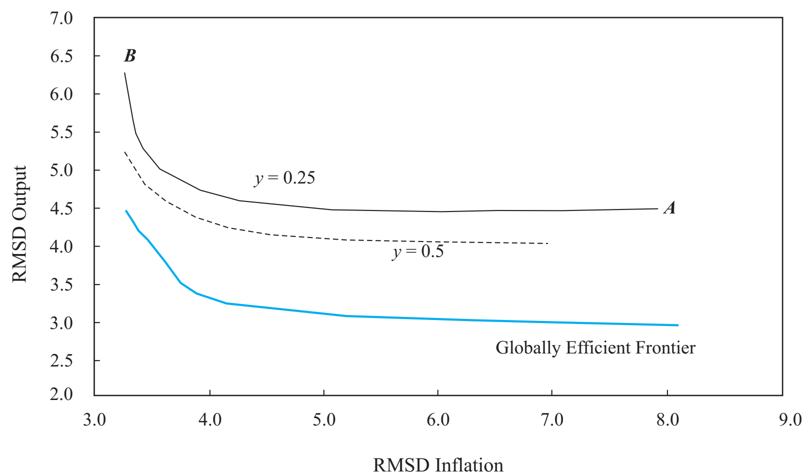
Similarly to Drew and Hunt (1999), I examined 9 combinations on the contemporaneous output gap ranging from 0.25 to 3, with 7 weights on the contemporaneous deviation of inflation from target, ranging from 0.25 to 3, in order to trace out the efficient frontier under Taylor rules.

The output-inflation variability pairs achieved are graphed in Graph 4. The thin line with label $\delta_y = 0.25$ corresponds to the inflation-output variability achieved by holding the weight on the output gap fixed at 0.25 and increasing the weight on the inflation gap from 0.25 (point A) to 3 (point B). Increasing δ_y to 0.5 shifts the trade-off curve towards the origin, as illustrated in Graph 2. Increasing δ_y up to 3 continues to shift the trade-off curve towards the origin. No appreciable shifts occur with δ_y values larger than 6. The thick line trace out the corresponding globally efficient frontier for the Taylor rules.

---

14 The model and the policy rule are subject to a sequence of macroeconomic shocks. Here we consider simultaneous shocks to the aggregate demand, aggregate supply and interest rate transmission.

Graph 4
Taylor Rules



Source: calculations by the author.

B. PERFORMANCE OF IFB RULES

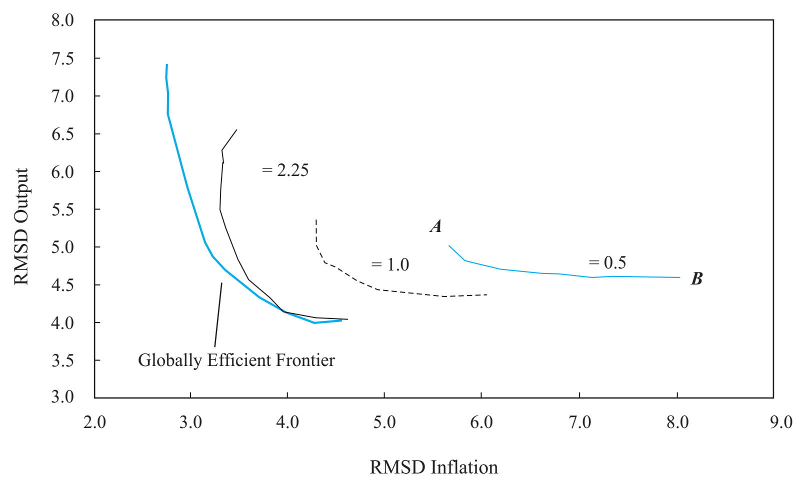
As explained before, these rules adjust to the policy instrument in response to a model-consistent projection of the deviation of inflation from its target rate:

$$i^p_t = (r^*_t + \pi_t) + \alpha_\pi (E_t\pi_{t+k} - \pi^*_t)$$

The parameters { α_π and k} are a calibration choice in this stage of the study. The targeting horizon, k, goes from 2 to 12. The weights, α_π, range in value from 0.25 to 3. In Graph 5, the thin line with α_π= 0.5 is derived using a weight of 0.5 on the projected deviation of inflation from its target and varying the forward-looking targeting horizon. The line AB joins these simulation points. Moving along the locus of points from A to B, the simulations use a policy rule with a progressively more distant inflation forecast horizon.

The thin line where α_π = 1.0 shows the results of the simulations when the weight on the projected inflation gap is increased to 1.0. Increasing the weight reduces

Graph 5
IFB Rules



Source: calculations by the author.

inflation and output variability for targeting horizons that start at $k = 6$ and beyond. Once the weights reach a level of 2.25, reduced inflation variability can only be achieved at the expenses of increased output variability at all targeting horizons examined. At this point, the thick line starts to trace out the globally efficient frontier for IFB rules.

C. COMPARING TAYLOR AND IFB RULES

Here, efficient frontiers under inflation-forecast-based and Taylor rules are compared. Policy rules that respond to forecasts of future inflation seem to perform well in quantitative simulations. Taylor rules are able to achieve lower output variability than IFB rules, but inflation and interest rate variability are larger.

The results for different policy rules specifications are as follows. Table 4 contains the volatility of the goal variables (measured as the unconditional standard

Table 4

Comparing Inflation Forecast Based Rules and Taylor Rules

	Standard Deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest rates	
Inflation forecast based rules				
$k = 6$, $\alpha_\pi = 1.0$	4.42	5.18	5.67	62.36
$k = 6$, $\alpha_\pi = 2.5$	4.51	3.46	7.10	57.50
$k = 6$, $\alpha_\pi = 2.0$	4.38	3.96	6.38	55.22
Taylor-type rules				
$\alpha_\pi = 0.5$, $\delta_y = 0.5$	4.09	5.30	6.19	64.00
$\alpha_\pi = 0.5$, $\delta_y = 1.0$	3.58	4.55	6.97	57.85
$\alpha_\pi = 0.5$, $\delta_y = 2.0$	3.09	4.27	9.66	74.37

Source: calculations by the author.

deviations),[15] and the stochastic welfare loss, $\mathcal{L}$. Looking at the performance of the Taylor rules, it is clear that placing a higher weight on output than on inflation yields welfare improvements only until certain point but with higher weights the welfare loss starts increasing again. Second, simple forecast-based rules perform favorably compared with simple Taylor rules. For example, the best-performing Taylor rule delivers a welfare loss higher than the welfare loss coming from a forecast-based rule with parameters $\{k = 6, \alpha_\pi = 2.0\}$.

This is evidence of the information-encompasing nature of inflation-forecast-based rules. An inflation forecast is formed conditioned on all variables that affect future inflation and output dynamics, not just output and inflation themselves. Even an apparently simple, forecast-based rule is implicitly responding to a wide and complex

15 Here considered the resulting moments are also calculated by averaging the results from 100 draws, each of which is simulated over a 25-year horizon.

set of macroeconomic variables. This is a property of forecast-based rules broadly documented since Svensson and Rudebusch (1998).

D. THE EFFICIENT SIMPLE FEEDBACK RULE FOR A MODEL OF THE COLOMBIAN ECONOMY

In the previous section it was shown that inflation forecast-based-rules are more efficient than Taylor rules in the context of inflation targeting. This is a familiar result found also in other countries targeting inflation directly. Now the exploration has to do with the features of an efficient simple inflation-forecast-based rule for the Colombian economy given the SMMT described in section six. In addition to the parameters α_π and k, I also will investigate if a smoothing parameter, ρ, should be taken into account in the policy rule. The goal is to find the combination of parameters $\{\alpha_\pi, k, \rho\}$ that will provide the lowest welfare loss. Our baseline rule now takes the modified form:

$$i^p_t = (r^*_t + \pi_t) + \alpha_\pi (E_t \pi_{t+k} - \pi^*_t) + \rho\, i^p_{t-1}$$

The volatility of the goal variables (measured as the unconditional standard deviations), and the stochastic welfare loss ($\mathcal{L}$), are reported in Table 5. There, it is provided the results for various combinations of the parameters $\alpha_{\pi,}$ and ρ. In terms of welfare loss, the policy rules with a smoothing parameter, ρ, lower than 0.25 and feedback parameter, $\alpha_{\pi,}$ between 1.75 and 2.25 perform better in general. This is mainly due to a lower output and instrument variability. According to these results, the most efficient combination of parameters $\{\alpha_{\pi,} \rho\}$ is $\alpha_\pi = 2.0$ and $\rho = 0.0$.

The results are very robust to changes in the weights that are assigned to the three goal variables on the monetary authorities' objective function. In Table 6, it was set the same weight on each of the goal variables and the resulting efficient combination of parameters is $\alpha_\pi = 1.5$ and $\rho = 0.0$. This combination is very similar to the one from the baseline case chosen before. In table 7, more weight on inflation stability is put, there, the first best is the combination of parameters $\alpha_\pi = 1.75$ $\rho = 0.25$, and the second best is again the combination $\alpha_\pi = 2.0$ and $\rho = 0.0$. In table 8, it is assigned more weight to output stabilization than to the other two variables. In that case, the smoothing parameter is still zero and the feedback parameter is a little lower than 2.0 (1.5).

Table 5

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 1, \quad \lambda_y = 1, \ \lambda_{\Delta i} = 0.5$)

$\rho = 0.0$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.58	7.16	5.54	87.49
1.00	4.42	5.18	5.67	62.36
1.50	4.37	4.41	6.00	56.44
1.75	4.36	4.15	6.19	55.38
2.00	4.38	3.96	6.38	55.22
2.25	4.43	3.65	6.73	55.62
2.50	4.51	3.46	7.10	57.50

$\rho = 0.125$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.62	6.78	5.47	82.33
1.00	4.47	4.94	5.67	60.44
1.50	4.45	4.22	6.08	56.07
1.75	4.47	4.01	6.33	56.14
2.00	4.51	3.81	6.51	56.09
2.25	4.53	3.67	6.71	56.42
2.50	4.55	3.53	6.82	56.40

$\rho = 0.25$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.68	6.40	5.42	77.64
1.00	4.55	4.68	5.63	58.51
1.50	4.57	4.07	6.23	56.94
1.75	4.61	3.82	6.39	56.21
2.00	4.66	3.67	6.65	57.31
2.25	4.70	3.53	6.85	57.95
2.50	4.79	3.43	7.09	59.92

Table 5 (continuation)

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 1, \quad \lambda_y = 1, \; \lambda_{\Delta i} = 0.5$)

ρ = 0.375				
α_π	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.77	5.97	5.32	72.42
1.00	5.25	3.05	7.41	64.24
1.50	4.76	3.87	6.35	57.84
1.75	5.08	3.26	6.86	59.97
2.00	5.14	3.13	7.10	61.42
2.25	5.25	3.05	7.41	64.24
2.50	5.25	3.05	7.41	64.24
ρ = 0.50				
α_π	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.92	5.56	5.24	68.84
1.00	4.94	4.22	5.86	59.38
1.50	5.11	3.69	6.53	61.04
1.75	5.30	3.55	7.01	65.27
2.00	5.47	3.44	7.46	69.54
2.25	5.71	3.36	7.94	75.38
2.50	5.92	3.29	8.43	81.33

Source: calculations by the author.

Finally I explore the optimal forecast horizon parameter, k. Graph 6 plots the locus of output-inflation variability points delivered by the IFB rule given the efficient parameters $\{\alpha_\pi, \rho\}$. The values of k that are used are 0, 1, …, 12. Moving along the locus of points from A to B, the simulations use a policy rule with a progressively more distant inflation forecast horizon. So, point A shows the pair of inflation/output variability associated with the policy rule when $k = 1$, and point B gives the pair of inflation/output variability

Table 6

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 1, \quad \lambda_y = 1, \quad \lambda_{\Delta i} = 1.0$)

$\rho = 0.0$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.58	7.16	5.54	102.84
1.00	4.42	5.18	5.67	78.41
1.50	4.37	4.41	6.00	74.41
1.75	4.36	4.15	6.19	74.54
2.00	4.38	3.96	6.38	75.60
2.25	4.43	3.65	6.73	78.30
2.50	4.51	3.46	7.10	82.68
$\rho = 0.125$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.62	6.78	5.47	97.32
1.00	4.47	4.94	5.67	76.51
1.50	4.45	4.22	6.08	74.54
1.75	4.47	4.01	6.33	76.17
2.00	4.51	3.81	6.51	77.26
2.25	4.53	3.67	6.71	78.91
2.50	4.55	3.53	6.82	79.65
$\rho = 0.25$				
α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.68	6.40	5.42	92.34
1.00	4.55	4.68	5.63	74.38
1.50	4.57	4.07	6.23	76.37
1.75	4.61	3.82	6.39	76.61
2.00	4.66	3.67	6.65	79.44
2.25	4.70	3.53	6.85	81.39
2.50	4.79	3.43	7.09	85.07

Table 6 (continuation)

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 1, \quad \lambda_y = 1, \quad \lambda_{\Delta i} = 1.0$)

α_π	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
ρ = 0.375				
0.50	4.77	5.97	5.32	86.54
1.00	5.25	3.05	7.41	91.68
1.50	4.76	3.87	6.35	77.98
1.75	5.08	3.26	6.86	83.51
2.00	5.14	3.13	7.10	86.65
2.25	5.25	3.05	7.41	91.68
2.50	5.25	3.05	7.41	91.68
ρ = 0.50				
0.50	4.92	5.56	5.24	82.55
1.00	4.94	4.22	5.86	76.54
1.50	5.11	3.69	6.53	82.39
1.75	5.30	3.55	7.01	89.85
2.00	5.47	3.44	7.46	97.33
2.25	5.71	3.36	7.94	106.88
2.50	5.92	3.29	8.43	116.86

Source: calculations by the author.

associated with a policy rule that responds to expected inflation three years ahead.

The most efficient inflation forecast horizon is also found by minimizing the loss function. In Table 9 it is reported the welfare loss for each forecast horizon. In the model, the most efficient forecast horizon lies somewhere in between, at around six to eight quarters.

Table 7

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 1, \quad \lambda_y = 0.5, \quad \lambda_{\Delta i} = 0.5$)

ρ = 0.0

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.58	7.16	5.54	77.02
1.00	4.42	5.18	5.67	52.60
1.50	4.37	4.41	6.00	46.91
1.75	4.36	4.15	6.19	45.88
2.00	4.38	3.96	6.38	45.65
2.25	4.43	3.65	6.73	45.83
2.50	4.51	3.46	7.10	47.33

ρ = 0.125

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.62	6.78	5.47	71.67
1.00	4.47	4.94	5.67	50.46
1.50	4.45	4.22	6.08	46.18
1.75	4.47	4.01	6.33	46.14
2.00	4.51	3.81	6.51	45.90
2.25	4.53	3.67	6.71	46.18
2.50	4.55	3.53	6.82	46.04

ρ = 0.25

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.68	6.40	5.42	66.67
1.00	4.55	4.68	5.63	48.15
1.50	4.57	4.07	6.23	46.48
1.75	4.61	3.82	6.39	45.61
2.00	4.66	3.67	6.65	46.46
2.25	4.70	3.53	6.85	46.92
2.50	4.79	3.43	7.09	48.43

Table 7 (continuation)

Results on Volatility and Loss with Various IFB Rules

$(\lambda_{\pi} = 1, \quad \lambda_{y} = 0.5, \quad \lambda_{\Delta i} = 0.5)$

ρ = 0.375				
α_{π}	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.77	5.97	5.32	61.06
1.00	5.25	3.05	7.41	50.48
1.50	4.76	3.87	6.35	46.49
1.75	5.08	3.26	6.86	47.08
2.00	5.14	3.13	7.10	48.22
2.25	5.25	3.05	7.41	50.48
2.50	5.25	3.05	7.41	50.48
ρ = 0.50				
α_{π}	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.92	5.56	5.24	56.72
1.00	4.94	4.22	5.86	47.18
1.50	5.11	3.69	6.53	48.01
1.75	5.30	3.55	7.01	51.21
2.00	5.47	3.44	7.46	54.58
2.25	5.71	3.36	7.94	59.07
2.50	5.92	3.29	8.43	63.83

Source: calculations by the author.

VIII. CONCLUSIONS

In this paper it was used the technique of stochastic simulations to select an efficient policy rule in the implementation of inflation targeting in Colombia. This methodology allows the researchers and the monetary authority to take into account the minimization of output, inflation and interest rates variability in the economy. This technique can be used in many other research fields, for example,

Table 8

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 0.5, \quad \lambda_y = 1.0, \quad \lambda_{\Delta i} = 0.5$)

$\rho = 0.0$

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.58	7.16	5.54	61.89
1.00	4.42	5.18	5.67	48.96
1.50	4.37	4.41	6.00	46.74
1.75	4.36	4.15	6.19	46.77
2.00	4.38	3.96	6.38	47.37
2.25	4.43	3.65	6.73	48.94
2.50	4.51	3.46	7.10	51.51

$\rho = 0.125$

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.62	6.78	5.47	59.32
1.00	4.47	4.94	5.67	48.23
1.50	4.45	4.22	6.08	47.16
1.75	4.47	4.01	6.33	48.08
2.00	4.51	3.81	6.51	48.82
2.25	4.53	3.67	6.71	49.69
2.50	4.55	3.53	6.82	50.18

$\rho = 0.25$

α_π	Standard deviation of			Welfare Loss $\mathcal{L}$
	Output	Inflation	Interest Rates	
0.50	4.68	6.40	5.42	57.14
1.00	4.55	4.68	5.63	47.55
1.50	4.57	4.07	6.23	48.65
1.75	4.61	3.82	6.39	48.91
2.00	4.66	3.67	6.65	50.57
2.25	4.70	3.53	6.85	51.73
2.50	4.79	3.43	7.09	54.03

Table 8 (continuation)

Results on Volatility and Loss with Various IFB Rules

($\lambda_\pi = 0.5, \quad \lambda_y = 1.0, \quad \lambda_{\Delta i} = 0.5$)

$\rho = 0.375$				
α_π	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.77	5.97	5.32	54.62
1.00	5.25	3.05	7.41	59.60
1.50	4.76	3.87	6.35	50.34
1.75	5.08	3.26	6.86	54.65
2.00	5.14	3.13	7.10	56.53
2.25	5.25	3.05	7.41	59.60
2.50	5.25	3.05	7.41	59.60

$\rho = 0.50$				
α_π	Standard deviation of			Welfare Loss
	Output	Inflation	Interest Rates	$\mathcal{L}$
0.50	4.92	5.56	5.24	53.39
1.00	4.94	4.22	5.86	50.47
1.50	5.11	3.69	6.53	54.23
1.75	5.30	3.55	7.01	58.97
2.00	5.47	3.44	7.46	63.63
2.25	5.71	3.36	7.94	69.75
2.50	5.92	3.29	8.43	75.93

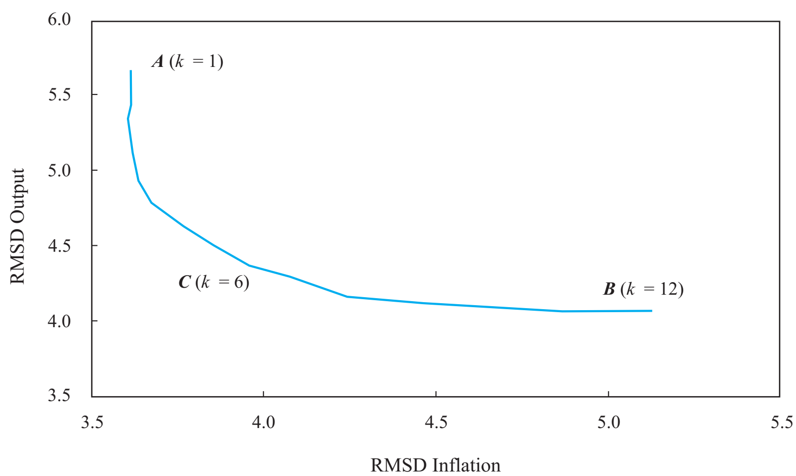
Source: calculations by the author.

measuring the impact of output gap uncertainty in the performance of economic models.

Using stochastic simulations of a small macroeconomic model of the Colombian economy, SMMT, we examined the relative performance of two classes of simple policy rules. For this purpose, I used as evaluation criteria the unconditional standard deviations of the goal variables, and a standard stochastic

Graph 6

Variability Frontier for the IFB Rules in the Colombian Economy



Source: calculations by the author.

Table 9

Efficient Forecast Horizon

k	Welfare Loss $\mathcal{L}$
1	81.83
2	69.05
3	61.30
4	57.86
5	56.29
6	55.22
7	55.64
8	55.65
9	56.28
10	57.37
11	58.78
12	61.20

Source: calculations by the author.

welfare loss function from a monetary authority that undertakes flexible inflation targeting.

The results are it is better to choose an Inflation Forecast Based rule than a Taylor rule for inflation targeting in Colombia. Taylor rules can achieve lower output variability than IFB rules, but the inflation and instrument variability are too high. In terms of welfare loss, IFB rules perform better than Taylor rules. Consequently, a well-defined monetary policy-rule for the Colombian economy should incorporate a forward looking dimension. It is important to keep in mind that even though in the IFB rules the current period output gap does not enter explicitly, its endogenous solution is an important part of the information set that is taken into account in the inflation forecast.

The results from the stochastic simulations are that the most efficient combination of parameters in the IFB rule for this small macroeconomic model is an inflation feedback parameter of between 1.5 and 2.0, a smoothing parameter between 0.0 and 0.25 and an optimal forecast horizon between six and eight quarters. This policy horizon supports the view that inflation targeting in practice should be designed so that the target is achieved over the medium term. Finally, this parameter values are robust to reasonable changes in the weights given to output gap, inflation or interest rates stabilization in the objective function of the monetary authority.

Given that the results presented here depend on how well the small macro model describes the Colombian economy, for future research some other characteristics of the economy should try to be incorporated in the model. Even though this is a model used by the central bank for the prescription of monetary policy because it captures the main characteristics of the Colombian economy, it is still very simple. For example the wealth effects of the monetary policy on the economy are left aside. Another extension could be to use the technique presented here in order to calibrate a simple policy rule in a dynamic stochastic general equilibrium model of the Colombian economy. These models have the advantage that they have strong microfoundations even though they are not as tractable as the small macro model presented here.

REFERENCES

Avella, R. (2001). “Efecto de las lluvias sobre la inflación en Colombia,” en Borradores de Economía, *Banco de la República*, No. 183.

Ball, L. (1998). “Policy Rules for Open Economies,” en *NBER*, Working Paper, No. 6760.

Banco de la República.(2002)“Meta de inflación 2003–2004”, Mimeo.

Batín N.; Nelson, E. (2000). “Optimal Horizons for Inflation Targeting”, *Bank of England*, February.

Bejarano, J. A. (2003). “Estimación estructural y análisis de la curva de Phillips Neo-Keynesiana para Colombia,” tesis de magíster, *Universidad del Rosario*.

Bernanke, B. S.; Mishkin, F. S. (1997). “Inflation Targeting: A New Rule for Monetary Policy?,” in *Journal of Economic Perspectivas*, No. 11, pp. 97-116.

Blanchard, O.; Kahn, C. (1980). “The Solution of Linear Difference Models Under Rational Expectations,” en *Econometrica*, 45, No. 5, July.

Clarida, R.; Gali, J.; Gerltler, M. (1997). “Monetary Policy Rules in Practice: Some International Evidence,” *NBER*, Working Paper, No. 6254.

Dennis, R. (2000). “Optimal Simple Targeting Rules for Small Open Economies”, *Federal Research Bank of San Francisco*, Working Paper, December.

Drew, A.; Hunt, B. (1999). “Efficient Simple Policy Rules and the Implications of Potential Output Uncertainty”, *Reserve Bank of New Zealand*, Discussion Paper, G99/5.

Friedman, M. (1948). “A Monetary and Fiscal Framework for Economic Stability,” in *American Economic Review*, 38(3), pp. 245-264.

Gali; Gertler, . (1999). “Inflation Dynamics: A Structural Econometric Approach,” in *Journal of Monetary Economics*, 44(2), October, pp. 195-222.

Gómez, J.; Uribe, J. D.; Vargas, H. (2002). "The Implementation of Inflation Targeting in Colombia," in Borradores de Economía, *Banco de la República*, No. 202.

Haldane A.; Batini, N. (1998). "Forward-Loking Rules for Monetary Policy," in J. B. Taylor (ed.). *Monetary Policy Rules.* Chicago, University Press for NBER.

King, R. (1995). "Quantitative Theory and Econometrics," in *Federal Research Bank of Richmond Economic Quarterly*, 81/3.

McCallum, B. T.; Nelson, E. (1999). "Nominal Income Targeting in an Open-Economy Optimizing Model," in *Journal of Monetary Economics*, Vol. 43, pp. 553-578.

Pierse, R. G. (1999). "Solution Methods for Nonlinear Models," in *University of Surrey*.

Rotemberg, J.; Woodford, M. (1997). "An Optimization Based Econometric Framework for the Evaluation of Monetary Policy," in Bernanke and Rotemberg (eds.), *NBER Macroeconomics Annual.*

Sargent, T. (1998). "Discussion of Policy Rules for Open Economies by Laurence Ball," paper presented at NBER conference on Monetary Policy Rules, 15-17 January. (Can be obtained via the internet from the University of Chicago Economics Department).

Svensson, L. (1999). "Inflation Targeting as a Monetary Policy Rule," in *Journal of Monetary Economics,* Vol. 43, pp. 607-654.

______ (1998). "Open-Economy Inflation Targeting," in *NBER*, Working Paper, 6545.

______; Rudebush, G. (1998). "Policy Rules for Inflation Targeting," *NBER*, Working Paper, No. 6512.

Taylor, J. (1979). "Estimation and Control of a Macroeconomic Model with Rational Expectations", in *Econometrica* 47:1267-86

______ (1993). "Discretion versus Policy Rules in Practice" in *Carnegie-Rochester Series on Public Policy*, No. 39, 195-214.

______ (1994). “The Inflation-Output Variability Trade-off Revisited,” en J. Fuhrer (ed). *Goals, Guidelines, and Constraints Facing Monetary Policy Makers,* Conference Series No. 38, Boston, Federal Reserve Bank of Boston, pp. 21-38.

______ (1998). “Inflormation Technology and Monetary Policy”, paper prepared for the English International IMES/Bank of Japan Conference, Tokyo.