Efficient policy rule for Inflation Targeting in Colombia

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Abstract[1]

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.

[1] Economics Research Department, Central Bank of Colombia, "*Banco de la Republica*". 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 Hernando Vargas, Carlos Esteban Posada, Andres 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.

1. 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.

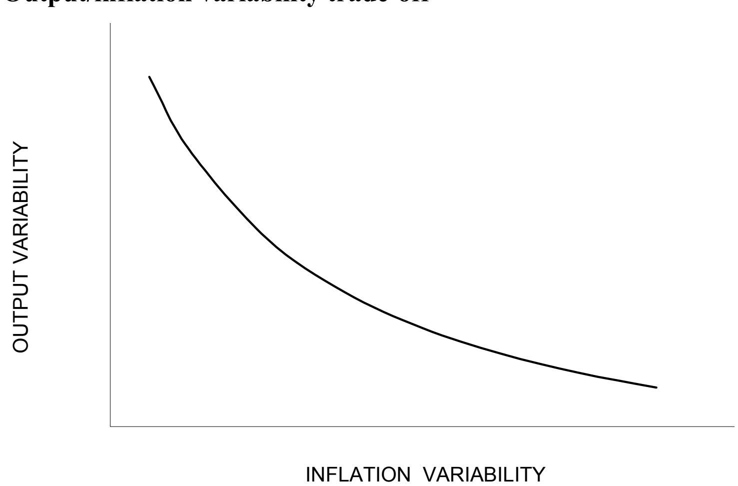
The reminder of the paper is as follows. In section 2 a brief description of the output-variability trade-off is given. In section 3 the concepts of optimal-state contingent policy rules and simple policy rules, like the Taylor rule, are discussed briefly. A discussion about the lags in the monetary 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 4. Some other advantages of IFB simple rules are also given. In sections 5 and 6 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 de economy. In section 7, 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 8. Section 9 contains a brief summary and conclusion.

2. 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 chart 1. Inefficient macroeconomic policies would lead to outcomes above the curve with both inflation fluctuations and unemployment fluctuations higher than 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.

Chart 1
Output/inflation variability trade-off



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.

3. The Efficient Frontiers, Optimal State-Contingent and Simple Policy Rules

3.1 Optimal State-Contingent Rules

Optimal State-contingent policy rules are those that allow the economy to achieve the lowest output-inflation long run variability simultaneously. In Figure 1, it would be the curve closer to the south-west.

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[2]. Optimal state-contingent rules may respond for example not only to the 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[3]. Because of their complexity, optimal state-contingent policy rules might be very impractical to implement.

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

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[2] Rudebush and Svensson (1998).
[3] Dennis (2000)

3.2 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 to the deviation of actual output from potential, so:

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

Where r^* is the equilibrium 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. John Taylor (1998) has studied the comparative virtues of rules of that include the lagged dependent variable. He concludes that it is alright for the authorities to act slowly in a series of cautious steps, just as long as a forward-looking public can 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.

4. 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 forecasts always returning to the target. Consider the following forecast-based rule

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

where $E_t(\bullet) = E_t(\bullet \mid \Phi_t)$, 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).

5. 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<β<1, we consider the loss function given by:

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

We use standard weights used in the inflation targeting literature, with β=0.99, $\lambda_\pi = 1$, λ_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.

6. A Small Open Economy Model

In this section it is presented a *Model of Transmission Mechanism (MMT)* for the description of the Colombian economy[4]. *MMT* is a forward-looking open economy structural model, based mostly on the optimizing model with nominal price stickiness by Rotemberg and Woodford (1997), and Svensson (1998). These models are derived from representative agent microfoundations and robust to the Lucas critique. The *(MMT)* also has similarities with the optimizing IS-LM framework developed by McCallum and Nelson (1999), Svensson (1999) and Ball (1998). 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.

The model is based on the following five equations:

(4) $$y_t = 0.9\, y_{t-1} - 0.1\, r_{t-1} + 0.1\, y_t^{usa} + 0.01 q_{t-1} + \varepsilon_t^y$$

(5) $$\pi_t = (1 - 0.47 - 0.02)\pi_{t-1} + 0.47\, E_{t-1}\pi_{t+1} + 0.02\, \pi_{t-2}^m + 0.048\, y_{t-1} + \varepsilon_t^\pi$$

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

(7) $$q_t = E_{t-1} q_{t+1} - (r_t - r_t^{usa} - \psi_t)$$

(8) $$\Delta i_t = 0.285\, \Delta i_{t-1} + 0.480\, \Delta i_t^p + (1 - 0.285 - 0.480)\Delta i_{t-1}^p - 0.284\, zi_{t-4} + \varepsilon_t^i$$

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.

[4] This is a more recent version of the model presented by Gómez, Uribe and Vargas (2002).

Svensson derives a structure in which aggregate demand is a function of foreign demand, current and expected future 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.

Equation (5) defines the models' supply side. Equation (5) is an open-economy Phillips curve expressed in terms of non-food inflation. The non-food 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 imports. 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.

Equation (6) is the identity that defines price of imports as the sum of foreign inflation and nominal depreciation.

Equation (7) 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.

Equation (8) is the transmission between the market nominal interest rates[5], i_t, and the central banks' policy nominal interest rate, $i_t^{\,p}$. In this equation zi_t is the long-run relationship between the rates.

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, 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 that 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.

The small-macro model presented here was calibrated as follows. Some of the parameters were calibrated based on previous econometric estimates from deep microeconomic parameters. For example the structural parameters used to calibrate the parameters for the lagged and forward-looking inflation rate in the Phillips curve, where estimated using GMM following Gali and Gertler (1999) [6]. The pass-though of import prices to domestic inflation was estimated using the Kalman filter technique (which is very useful in the case of parameters that changes over time)[7]. Aggregate demand equation and equation (8) were estimated straight forward by OLS[8]. In a following step, the parameter values were adjusted considering some properties of the model such

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5 The market nominal interest rate is the 90 days CD's.

6 Bejarano, Jesús (2003) , "Estimación Estructural y análisis de la curva de Phillips Neo-Keynesiana para Colombia", *Magíster Tesis*, Universidad del Rosario.

7 " Estimación del Pass-though variable en el tiempo" Mimeo, Banco de la República, SEE, Dirección de Modelos Macroeconómicos.

8 A better approximation to calibrate the parameters in the Aggregate Demand Equation should provide the underlying parameters in order to overcome completely the Lucas critique.

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[9].

Finally, the model is to be closed with a policy rule that should be chosen in such a way that it minimizes the loss function of the monetary authority represented in equation (3). In the following 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)[10].

7. Performance of simple Taylor and IFB rules

In this section, we start 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.

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[11]. 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.

7.1 Performance of Taylor rules

Here we close the *MMT* 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

[9] "Meta de Inflación" 2003 – 2004 mimeo, SEE - Banco de la República.

[10] The stability conditions for the model, following Blanchard and Kahn, were verified in Matlab and they hold, therefore the stable solution is unique.

[11] 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 equations.

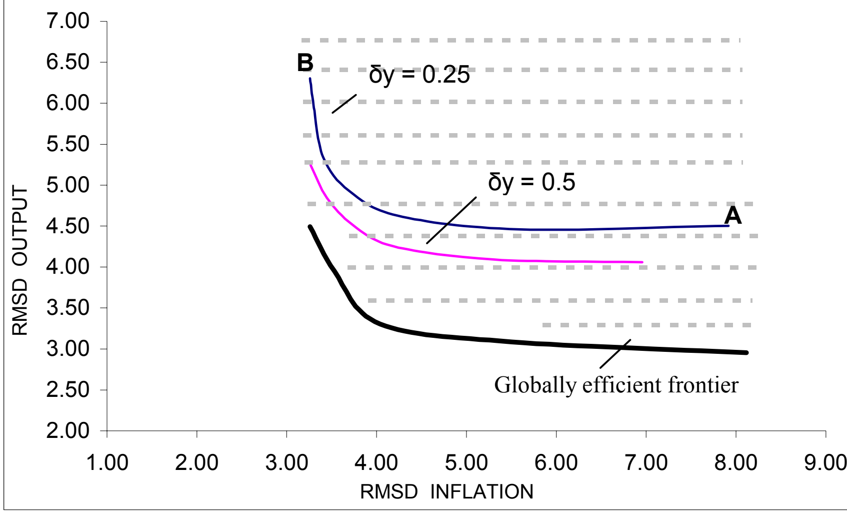
responds to the contemporaneous deviation of output from potential and non-food inflation from target.

$$i_t^p = (r_t^* + \pi_t) + \alpha_\pi(\pi_t - \pi_t^*) + \delta_y(y_t - y_t^*)$$

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 chart 2. The thin line with label δ_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 chart 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.

Chart 2
Taylor Rules

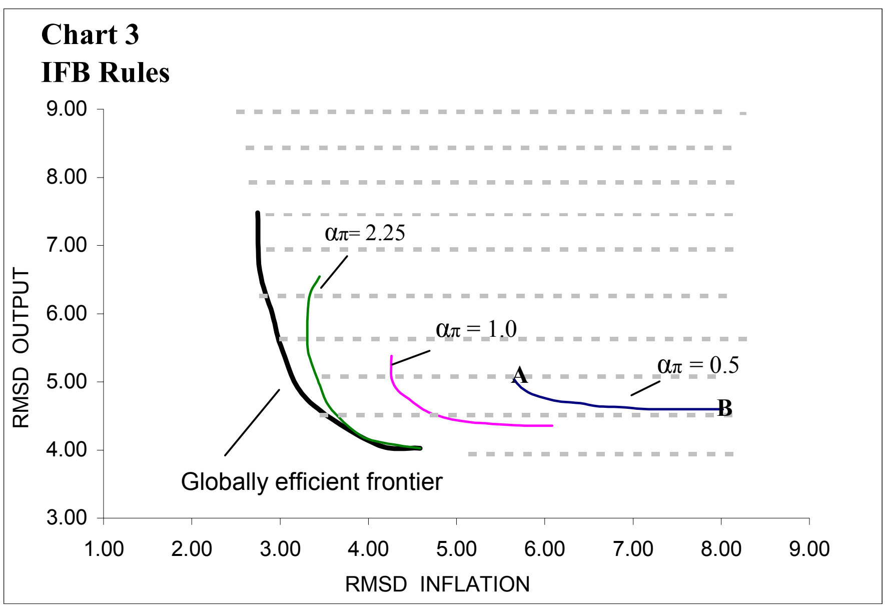


7.2 Performance of IFB rules

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:

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

The parameters $\{\alpha_\pi$ 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 chart 3, the thin line with $\alpha_\pi = 0.5$ 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 with $\alpha_\pi = 1.0$ shows the results of the simulations when the weight on the projected inflation gap is increased to 1.0. Increasing the weight reduces 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.

7.3 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 1 contains the volatility of the goal variables (measured as the unconditional standard deviations)[12], and the stochastic welfare loss, 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-encompassing 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 set of macroeconomic variables. This is a property of forecast-based rules broadly documented since Svensson and Rudebusch (1998).

[12] 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.

Table 1.	**Comparing Inflation Forecast Based rules and Taylor rules**			
	Standard Deviation of			Welfare Loss
	output	inflation	interest rates	*L*
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
$\alpha_\pi = 0.5, \delta_y = 1.5$	3.09	4.27	9.66	74.37

7.4. 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 *MMT* 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:

$$i_t^p = (r_t^* + \pi_t) + \alpha_\pi (E_t \pi_{t+k} - \pi_t^*) + \rho * i_{t-1}^p$$

The volatility of the goal variables (measured as the unconditional standard deviations), and the stochastic welfare loss (L), are reported in table 2. There, it is provided the results for various combinations of the parameters α_π and ρ. In terms of welfare loss, the policy rules with a smoothing parameter, ρ, lower than 0.25 and feedback parameter, α_π, 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 3, 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 4, 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 5, 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).

Finally I explore the optimal forecast horizon parameter, k. Chart 5 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=0, and point B gives the pair of inflation/output variability associated with a policy rule that responds to expected inflation three years ahead.

Chart 5
Variability frontier for the efficient simple rule

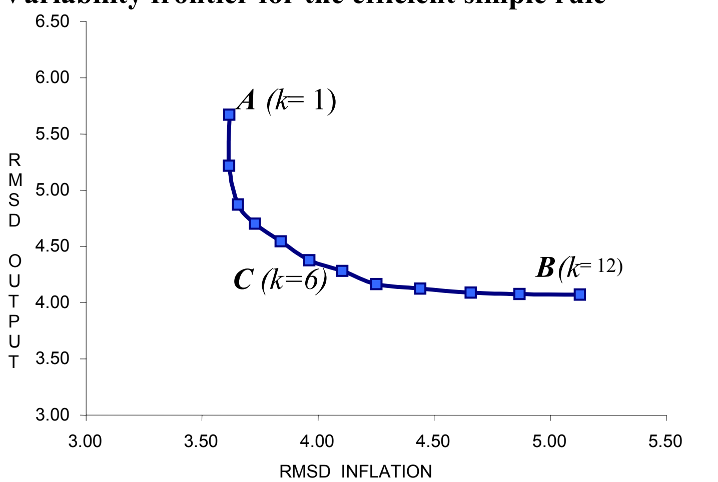


Table 3.
Optimal forecast horizon

k	Welfare Loss 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

The optimal inflation forecast horizon is also found by minimizing the loss function. In table 3 it is reported the welfare loss for each forecast horizon. In the model, the optimal forecast horizon lies somewhere in between, at around six to eight quarters.

Table 2. Results on Volatility and Loss with Various IFB Rules

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

ρ = 0.0				
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	*L*
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

ρ = 0.125				
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	*L*
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

ρ = 0.25				
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	*L*
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

ρ = 0.375				
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	*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	*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

Table 3. Results on Volatility and Loss with Various IFB Rules

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

α_{π}	Standard deviation of			Welfare Loss
	output	inflation	interest rates	*L*
ρ = 0.0				
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
ρ = 0.125				
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
ρ = 0.25				
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
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

Table 4. Results on Volatility and Loss with Various IFB Rules

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

	ρ = 0.0			
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	L
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
	output	inflation	interest rates	L
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
	output	inflation	interest rates	L
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

	ρ = 0.375			
α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	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	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

Table 5. Results on Volatility and Loss with Various IFB Rules

(λ_π = 0.5, λ_y = 1.0, $\lambda_{\Delta i}$ = 0.5)

α_π	Standard deviation of			Welfare Loss
	output	inflation	interest rates	L
ρ = 0.0				
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
ρ = 0.125				
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
ρ = 0.25				
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
ρ = 0.375				
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
ρ = 0.50				
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

8. Conclusions

Using stochastic simulations of a macroeconomic model of the Colombian economy, *MMT*, 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 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 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.

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