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Efficiency of monetary policy under inflation targeting

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Abstract

The policy of inflation targeting is a monetary regime which seeks inflation. His practice was marked by a high stability observed. A debate emerged on the effectiveness and economic performance of this regime. Many searches are interested in this issue without being able to even reach an ultimate consensus. The objective of this paper is to contribute to this debate by clarifying the origin of this monetary regime and by proposing, then, our own quantitative analysis grid. At first, we discuss the theoretical framework of the inflation targeting relating to these conceptual and analytical aspects that seem to complete the reflection on the earlier antinomy. The analysis then focuses on empirical verification. In drawing on the work of Cecchetti and Krause (2002), Flores-Lagoons and Krause (2006) and Mishkin and Schmidt Hebbel (2007), we estimate efficient frontier: inflation variability - output variability, which allows us to deduce the measurement of economic performance and monetary policy efficiency measure.

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1. Introduction

During several decades, high levels of inflation and its strong fluctuation constituted major threats to monetary stability everywhere in the world.

The beginning of the 1990s has marked the beginning of an era of price stability which has promoted the implementation of maintaining this stability-oriented monetary policy.

From a historical perspective, the inflation-targeting regime is the new solution to endless search for the nominal anchor of the economy. This approach was taken in response to the difficulties encountered by several countries in the use of monetary aggregates or the exchange rate as intermediate targets of monetary policy.

As an important component of economic policy, monetary policy decisions affect clearly the price levels and internal and external equilibrium. The monetary policy framework has experienced considerable development from discretionary policy to policies rules.

Since the publication of the work of Kydland and Prescott (1977), it has been shown that discretionary monetary policies engender inflationary bias related to temporal inconsistency problems. Therefore several studies have shown the superiority of political rules, which it evolved from monetary aggregates targeting (Friedman, 1984) to policies targeting of variables reflecting the objectives of monetary policy (Taylor, 1993 ; Svensson and Rudebush, 1998).

The inflation-targeting regime is a strategy for conducting monetary policy with the explicit objective to maintain price stability and sets a target for the development of the rate of inflation. It is identified from a general rational expectations model based on the transmission mechanism of monetary policy. For many countries, the introduction of a policy of inflation targeting has had a real impact on the level and expectations of inflation and other macroeconomic variables such as output and the exchange rate (Mishkin, 1992 ; Schmidt-Hebbel, 2002 ; Truman, 2003 ; Mishkin and Schmidt-Hebbel, 2007).

Faced with these developments, it seemed useful and constructive to focus on the study of a new framework for conducting monetary policy which is the inflation targeting. This work focuses on the assessment of the experience of countries that have adopted the inflation targeting since the 1990s, focusing on both performances on the benefits and the potential costs of the adoption of such a monetary policy framework and try to draw lessons from the twenty years of practice of this regime. This paper is divided into two

main parts. It discusses the theoretical and operational aspects of inflation targeting and the efficiency of monetary policy under this regime. Thus, as a first step, analysis will mainly focus on conceptual and analytical aspects of inflation targeting by drawing the theoretical building on the subject developed in large part by F. Kydland and E. Prescott, R.Barro and D.Gordon, J.Taylor, L.Svensson, L.Ball and N.Sheridan, M.Woodford and B.Bernanke, F.Mishkin and others.

The last axis is to evaluate and analyse the efficiency of monetary policy under inflation targeting regime. In drawing on the work of Cecchetti and Krause (2002), Flores-lagoons and Krause (2006) and Mishkin and Schmidt Hebbel (2006), we estimate efficient frontier: inflation variability - output variability, which allows us to deduce the measurement of economic performance and monetary policy efficiency measure.

The next section discusses the analytical aspects of inflation targeting. Section 3 presents the empirical analysis and shows the results and section 4 concludes.

2 Inflation targeting: Analytical aspects

On the practical level, the Central Bank is oriented towards informational indicators whose role is to provide advanced information on the future evolution of inflation, without considering them as targets. When they are detected, these indicators are intended to allow generated the best inflation forecast. Subject to a proper formulation of the structural model, the inflation forecast could access the rank of intermediate target. It will offer more visibility to the Central Bank and more flexibility in applying the rule of optimal inflation targeting which could provide an anchor for inflation expectations.

2.1. Flexible targeting rule and strict targeting rule

The conduct of monetary policy was the subject of a debate very widespread during the second half of 20th century and long, the debate about the optimal strategy should follow a central bank took the form of a dilemma, between the credibility provided by irrevocable commitments of long period, taking the form of a passive rule and the flexibility afforded by a discretionary policy. The conduct of monetary policy based on the concept of rules fits in line with the work of F. Kydland and E.Prescott (1977)¹ on the temporal inconsistency of optimal policies and those of RBarro and D.Gordon (1983)²

¹ Charles Freedman, central bank independence, in Charles Goodhart « Central Banking Monetary Theory and Practice ». Edited by Paul Mizen, Professor of Monetary Economics, School of Economics, University of Nottingham, UK, 2003; p: 90 -110.

² R. Barro et D. Gordon, « Rules, Discretion and Reputation in a Model of Monetary Policy », Journal of

focused on the credibility of monetary policy. These authors have highlighted that in the presence of asymmetric preferences, the action of the monetary authorities eventually systematically produce inflationary bias and cause “inflation surprises” without gain in terms of average activity.

In this sense, using a Phillips curve incorporating the assumption of rational expectations on the model of R Lucas, R Barro, R and D. Gordon.³ concluded that discretionary use of monetary policy violates the existing rule would be certainly thwarted by the reactions of the economic agents.

The essence of the argument is based on a supply function to the "Lucas" in which it is impossible, ex post, to affect the product systematically⁴.

This debate has been overtaken by the emergence of the concept of contingent or active rule, with the founding work of J.Taylor in 1993. Contingent rule clarifies the systematic reaction of the instrument of monetary policy, according to deviations observed or anticipated objectives⁵. As noted in J.P.Pollin⁶, the determination and the display of a contingent monetary rule allows to solve the problem related to the reconciliation between credibility and flexibility. By displaying a contingent rule, a central bank gains credibility, since it cannot be suspected of inflationary bias. But it retains operational flexibility, allowing it to regulate the cyclical imbalances. However, solving these two problems will be acquired only if the displayed rule is relatively simple, ensuring the understanding of the monetary strategy by all private agents. The rule proposed by J.Taylor seems verified this requirement. By seeking to develop the concept of active rules, as opposed to the passive rules, eminent economists of monetary theory, including L.Svensson, emphasize the role of the optimal rules in the conduct of the recent monetary policy. In this context, they distinguished between the flexible inflation targeting rule

Monetary Economics n° 12, 1983.

³ These economists, replicate that a rule alone is not enough and that should include the assumption that compliance with this rule by the Government would improve its reputation among private actors, which would then strengthen the credibility of its monetary policy.

⁴Jean-Baptiste Desquilbet, Patrick Villieu, l'indépendance de la Banque centrale peut-elle être contreproductive? Une illustration en économie ouverte, *Revue économique*, Vol. 49, No. 6 (Nov. 1998), pp. 1415-1434

⁵ A.Penot & J.P.Pollin : « Construction d'une règle monétaire pour la zone euro ». *Revue Economique*, volume 50, No3, mai 1999, page 536.

⁶ J.P.Pollin, « Pour une règle explicite de politique monétaire dans la zone euro », in « Intégration européenne et institutions économiques» pages 199-200.

which determines the function of social loss of the Central Bank and the rule of strict targeting inflation represents the only target variable. Start from these findings, the first step in the analysis is the specification of the preferences of the Central Bank. We assume that the latter objective inflation and output and seeks to maximize the objective function, made by F. Kydland and E. Prescott and R.Barro and D.Gordon (1983), can take the following form:

$$L = \delta(y - y^*) - \frac{1}{2} \pi^2 \quad (1)$$

With y is the effective production rate and y^* is the potential production rate and π is the inflation rate. According to R.Barro and D.Gordon, a high output is preferable to a low output with constant marginal utility, thus the output between linearly, while inflation is expected to generate an increasing marginal disutility and quadratically.

The parameter δ determines the weight assigned by the Central Bank to the expansion of output relative to the stabilization of inflation. In this case, we assume that the Central Bank is concerned only about the level of the output ignoring its variation. Under inflation targeting, the term inflation π is replaced by $\pi - \pi^*$, where π^* is the inflation target different from zero.

2.1.1. Flexible inflation targeting rule

It is essential to distinguish the social loss function, i.e. the function that has one or more objectives, than at one target. Thus, like K. Rogoff (1985), we can attribute an objective function to the Central Bank, the authority that formulates and updates the implementation of monetary policy⁷. The assigned function is normally chosen so as to minimize the social loss function. The objective function of a Central Bank under inflation targeting regime takes the form:

$$L = \delta(y - y^*) - \frac{1}{2} (\pi - \pi^*)^2 \quad (2)$$

In the model, the output is expressed by a short-term Phillips curve⁸ which is a linear equation:

$$y = y^* + \theta(\pi - \pi^a) + \varepsilon \quad \text{avec } \theta > 0 \quad (3)$$

Where θ determines the effect of inflation surprise on output and ε a supply shock. Since

⁷ ROGOFF, K (1985). «The Optimal Degree of Commitment to an Intermediate Monetary Target », Quarterly Journal of Economics, 100, p : 1169-1190.

⁸Equation (1) is a standard equation for most macroeconomic models that are developed in intermediate textbooks and which assume a certain degree of wage or price adjustment.

we assume that the central bank acts before observing any disturbance of inflation, its objective will be to minimize the expected value of the L-function.

The insertion of the Phillips curve equation (3) in the objective function (2) gives:

$$L = \delta[\theta(\pi - \pi^a) + \varepsilon] - 1/2(\pi - \pi^*)^2 \quad (4)$$

Using a partial derivative of equation (4), we obtain the first-order condition for the optimal value π conditioned by ε and π^a takes as a given:

$$\partial L / \partial \pi = \delta\theta - (\pi - \pi^*) = 0$$

$$\pi - \pi^* = \delta\theta > 0$$

$$\pi = \delta\theta + \pi^* \quad (5)$$

Given this argument, the current inflation will be equal to $\delta\theta + \pi^*$ where $\delta\theta$ if the inflation target equal to zero. In addition, private agents are rational and they exploit the equation (4) to form their expectations about inflation. With private agents forming expectations prior to the observation of any shock to inflation, anticipated inflation is equal to realized inflation:

$$\pi^a = \pi = \delta\theta + \pi^*$$

Thus, real inflation is totally anticipated. Private agents include incentives of the Central Bank (measured by $\delta\theta$) and incorporate them into inflation expectations. As a result, inflation generates no output gain. The size of the inflation bias $\delta\theta$ increases due to the effect of inflation surprise on output θ and the weight given by the Central Bank in its objective of output δ . More θ and δ are large, more the incentive for the central bank to create inflation is high. Thus, private agents expect a higher inflation rate. To derive an optimal solution under the discretion, an alternative specification of the objective function of the Central Bank will be applied. In this context, we assume that the Central Bank should concentrate on the loss associated with fluctuations in output and inflation around their desired levels. Thus, the loss function is quadratic in the output as inflation and can be written as follows:

$$V = 1/2 \delta [(y - (y^* + \chi))]^2 - 1/2(\pi - \pi^*)^2 \quad (6)$$

The Central Bank wants to stabilize the output around $y^* + \chi$, which exceeds potential output y^* by the constant χ . The fact that the Central Bank was concerned about fluctuations in output, this means that a policy of stabilization reduces the output fluctuations caused by a supply shock ε . The attempt of the Monetary Authority to

stabilize the output around $y^* + \chi$ represents a second best solution. the best would involve the elimination of the original distortions in the economy for example, distortions in the labor market, or the presence of competitive monopoly sectors which lead the potential output to be inefficiently low. The alternative interpretation is that χ is the result of political pressure on the Central Bank. Since, as we shall see, the presence of χ leads to a result under optimal described by the inflationary bias and a low utility of anticipation. Substitute the function of aggregate supply (Phillips curve) in equation (6):

$$V = 1/2 \delta [\theta(\pi - \pi^a) + \varepsilon - \chi]^2 - 1/2(\pi - \pi^*)^2 \quad (7)$$

The condition of the first order for the optimal value of π conditioned by ε with π as given in the case of the minimization of the loss function (7) is:

$$\partial V / \partial \pi = \delta \theta^2 (\pi - \pi^a) + \delta \theta (\varepsilon - \chi) + (\pi - \pi^*) = 0$$

$$0 = \delta \theta^2 \pi - \delta \theta^2 \pi^a + \delta \theta (\varepsilon - \chi) + \pi - \pi^*$$

$$\pi = (\delta \theta^2 \pi^a + \delta \theta (\chi - \varepsilon) + (\pi^*)) / (1 + \delta \theta^2) \quad (8)$$

Private agents use equation (7) in the formation of their inflationary expectations. However, given their atomistic characters; they do not take into account what the effect of their anticipated choice of inflation might have on the decision of the Central Bank.

Thus, expectations formed before the observation of the global supply shock ε is equal to:

$$\pi^a = (\delta \theta^2 \pi^a + \delta \theta \chi + (\pi^*)) / (1 + \delta \theta^2)$$

The solution of this equation for π^a has:

$$(1 + \delta \theta^2) \pi^a = \delta \theta^2 \pi^a + \delta \theta \chi + \pi^*$$

$$\pi^a = \delta \theta \chi + \pi^*$$

The insertion of $\pi^a = \delta \theta \chi + \pi^*$ (8) gives an expression for the rate of inflation under discretion:

$$\pi = (\delta \theta^2 (\delta \theta \chi + \pi^*) + \delta \theta \chi - \delta \theta \varepsilon + \pi^*) / (1 + \delta \theta^2)$$

$$\pi = (\delta \theta \chi (\delta \theta^2 + 1) - \delta \theta \varepsilon + \pi^* (\delta \theta^2 + 1)) / (1 + \delta \theta^2)$$

$$\pi^d = \delta \theta \chi [\delta \theta / (1 + \delta \theta^2)] \varepsilon + (\pi^*) \quad (9)$$

Where “d” indicates the discretion. And that the central bank acts with discretion implies that a positive current balance equal to inflation $\delta \theta \chi + \pi^*$, or $\delta \theta \chi$ if the inflation target is

zero. It has no effect on the output, since the private sector provides completely this inflation rate $\pi = \delta\theta\chi + \pi^*$. The size of the inflationary bias increases by distortion χ , the effect of inflation surprise θ , and the weight given by the Central Bank to its output target δ , taking π^* as given. An increase of χ leads to a higher rate of inflation in balance. An increase in θ elevates the output effects of inflation surprise and increases the marginal tendency of the Central Bank to generate more inflation. However, by increasing the impact of inflation surprise on output, an increase in θ reduces the inflation surprise intended to move the output to $y^* + \chi$. A positive supply shock or a negative coefficient ϵ leads to low inflation. If the central bank wants to reduce the impact of positive supply shock on output, inflation will increase because more than the objective of output δ is large, more the impact of the supply shock on output is small and the effect on inflation is high.

To recap, a discretionary policy leads to a high inflation equilibrium compared to the target rules. In fact, inflation is more variable under discretion than under commitment to a rule. The problems that can occur under the discretion arise because central banks respond optimally to the incentives they face, but incentives are wrong. Once the incentives are correct, complete flexibility in the current conduct of politics is possible.

An alternative approach tends to reduce the problems resulting from the discretion by a policy of restrictive flexibility. The gain to reduce the flexibility takes the form of a low average inflation rate. A variety of rules designed to limit the flexibility of the Central Bank have been suggested and analyzed. Inflation targeting is currently the form of the rules most commonly discussed. Assume now that the Central Bank focuses on output and inflation and, in addition, is penalized for deviations from current inflation to its target level. In other words, the objective of the Central Bank is to minimize:

$$V = \frac{1}{2} \delta [E(y_t - \chi) | \psi_t]^2 - \frac{1}{2} (1 + \beta) [E(\pi_t - \pi^*) | \psi_t]^2 \quad (10)$$

The term $E(y_t - \chi) | \psi_t$, represents the predicted deviations of output from its level target $y^* + \chi$, the prediction is based on a set of information ψ_t that the Central Bank has at time t . The term $E(\pi_t - \pi^*) | \psi_t$ denotes deviations from predicted inflation π_t , the inflation rate target π^* . The β parameter expresses the sensitivity of the interest to the deviation of the inflation rate. It measures the weight of deviations of inflation from its target rate. We assume that the Central Bank fixed the rate of inflation target exactly to its socially

optimal level or an indifferent inflation rate p^9 .

Thus the expression $1/2[E(\pi_t - p) | \psi_t]^2 - 1/2 \beta [E(\pi_t - \pi^*) | \psi_t]^2$ may be replaced by

$$1/2(1+\beta)[E(\pi_t - \pi^*) | \psi_t]^2$$

First, we will refer to targets rules of the form "flexible inflation targeting" (flexible inflation targeting¹⁰), This type of targeting rule allows the central bank to make a trade-off between the achievement of inflation target or the achievement of other objectives.

insert the function of aggregate supply (Phillips curve) $(y = y^* + \theta (\pi - \pi^a) + \varepsilon$ in equation (10):

$$V = 1/2 \delta E[\theta (\pi - \pi^a) + \varepsilon - \chi]^2 - 1/2(1+\beta) E(\pi - \pi^*)^2 \quad (11)$$

The first-order condition for the optimal value of π under condition of ε and take expectations as data in the case of the minimization of the loss function (11) is:

$$\partial V / \partial \pi = \delta \theta^2 (\pi - \pi^a) + \delta \theta (\varepsilon - \chi) + (\pi - \pi^*) + \beta (\pi - \pi^*) = 0$$

$$0 = \delta \theta^2 \pi - \delta \theta^2 \pi^a + \delta \theta (\varepsilon - \chi) + \pi - \pi^* + \beta \pi - \beta \pi^*$$

$$\pi = \frac{\delta \theta^2 \pi^a - \delta \theta (\chi - \varepsilon) + \pi^* + \beta \pi^*}{(1 + \beta + \delta \theta^2)} \quad (12)$$

Assume that the expectations are rational. Inflation expectations of the public formed before observing a global supply shock are expressed by:

$$\pi^a = \frac{\delta \theta^2 \pi^a + \delta \theta \chi + \pi^* + \beta \pi^*}{(1 + \beta + \delta \theta^2)}$$

The solution of this equation for π^a :

$$(1 + \beta + \delta \theta^2) \pi^a = \delta \theta^2 \pi^a + \delta \theta \chi + \pi^* + \beta \pi^*$$

$$(1 + \beta) \pi^a = \delta \theta \chi + \pi^* + \beta \pi^*$$

$$\pi^a = \frac{\pi^*}{1 + \beta}$$

⁹ The socially optimal or indifferent inflation rate can be associated with a rate of inflation at which the costs of inflation should not exceed its benefits. Moderate inflation allows adjustment of real price and helps the monetary authority to stimulate the economy when the market interest rates are close to zero.

¹⁰ « Let me first specify what I mean by this. Strict inflation targeting is when the central bank is only concerned about keeping inflation as close to a *given* inflation target as possible, and nothing else. Flexible inflation targeting is when the central bank is to some extent also concerned about other things, for instance, the stability of interest rates exchange rates, output and employment ». Lars E.O. Svensson, "Inflation targeting in an open economy: Strict or flexible inflation targeting?" Institute for International Economic Studies, Stockholm University, November 1997.

The substitution of the new value in (12), gives an expression of the dynamic consistency of the inflation rate:

$$\pi^c = \frac{\delta\theta^2 \left(\pi^* + \frac{\delta\theta\chi}{1+\beta} \right) \pi^a + \delta\theta(\chi - \varepsilon) + (1 + \beta)\pi^*}{(1 + \beta + \delta\theta^2)}$$

$$(1 + \beta + \delta\theta^2)\pi^c = \delta\theta^2\pi^* + \delta\theta^2 \frac{\delta\theta\chi}{1+\beta} + \delta\theta(\chi - \varepsilon) + (1 + \beta)\pi^*$$

$$\pi^c = \pi^* + \frac{\delta^2\theta^3\chi}{(1 + \beta)(1 + \beta + \delta\theta^2)} + \frac{\delta\theta\chi(1 + \beta)}{(1 + \beta)(1 + \beta + \delta\theta^2)} - \frac{\delta\theta\varepsilon}{(1 + \beta + \delta\theta^2)}$$

$$\pi^c = \pi^* + \frac{\delta\theta\chi}{(1 + \beta)} - \frac{\delta\theta\varepsilon}{(1 + \beta + \delta\theta^2)} \quad (13)$$

However, the inflation target now is above the rate which is socially preferred, since the Central Bank wishes to stabilize the output around $y^* + \chi$, which exceeds y the economic equilibrium output y^* .

In other words, with $\chi = 0$, the inflation target will be equal to the socially optimal rate of inflation. For $\beta = 0$, the discretionary solution to the temporal coherence without inflation targeting rule gives:

$$\pi^{NC} = \pi^* + \delta\theta\chi - \frac{\delta\theta\varepsilon}{(1 + \delta\theta^2)} \quad (14)$$

Comparison of equations (13) and (14) shows that the inflation targeting reduces the inflationary bias of $\delta\theta\chi$ to $\frac{\delta\theta\chi}{(1 + \beta)}$.

The penalty of the reduction of the inflationary bias is a response from the Central Bank to the supply shock, but the coefficient (ε) decreases by $\frac{\delta\theta}{(1 + \delta\theta^2)}$ to

$$\frac{\delta\theta}{(1 + \beta + \delta\theta^2)}$$

Thus the output is more variable than under the discretion. A better balance between credibility and flexibility ensures the implementation of "escape clauses" clearly defined in the inflation targeting regime. If a previously defined event occurs, the Central Bank uses an escape clause, thus abandoning the rule and pursuing a discretionary policy, which proves optimal posteriori, leading to inflationary expectations. However, inflation

will be lower, than in the purely discretionary regime, due to a low inflationary bias.

2.1.2. Rule of strict inflation targeting

The preceding analysis was made in the context of a flexible targeting rule. However, the targeting rules may take the form of strict targeting, when the central bank is expected to achieve the target with precision, regardless of the implications for other objectives.

Given that the central criterion adopted by the monetary authorities is clearly an inflation target, the Central Bank strives to minimize a function in which inflation is the variable target (loss function of the central bank):

$$V = \frac{1}{2} \delta [E(y_t - y^{b*}) | \psi_t]^2 + \frac{1}{2} (1 + \beta) [E(\pi - \pi^{b*}) | \psi_t]^2 \quad (15)$$

The higher index b denoting the parameter values that may differ from those of the social loss function (6). According to L. Svensson (1997), if $\pi^{b*} < \pi^*$, the central bank is more concerned about inflation than the output gap, While, if $\delta^b < \delta$, it is less concerned with the output gap than inflation. L.Svensson (1999)¹¹ combines the equation (15) to a policy of inflation targeting.

We are talking about "strict inflation targeting rule" when the Central Bank is concerned that of inflation, that is, $\delta^b = 0$. The loss function of the Central Bank under a strict targeting is given by:

$$V = \frac{1}{2} (1 + \beta) [E(\pi - \pi^{b*}) | \psi_t]^2 \quad (16)$$

The first-order condition for the value of π , taking expectations as given, is expressed by the equation: $\pi - \pi^{b*} = 0$. If one assumes that the variable target π , can be freely chosen, the Central Bank is still able to reach the target, $\pi_t = \pi^{b*}$ and thus achieve in practice the implicit target path.

It thus appears that the rule of strict inflation targeting ensures equal to π^{b*} average rate of inflation and that economic agents form their inflation expectations exactly at the level of rate desired by the rule of the inflation targeting $\pi^a = \pi^{b*}$. The inflationary bias is completely removed. The rule of strict policy provides an "optimal anchor for inflation expectations.

The strict rule policy is not a condition or observable supply shock ϵ , or the target output

¹¹ L. E. Svensson, "Inflation targeting as a monetary policy rule", Journal of Monetary Economics, 43 pp: 607-654, 1999.

y *. It is important to note that in this loss function inflation is both an objective and a target level of stability. The effort of the central bank to stabilize output only adds expensive noise to the inflation. The strict inflation targeting provides a stabilizing role for monetary policy. Thus, arbitration credibility flexibility has disappeared. The cost of stabilization will thus depend on the variance of supply shocks¹².

A simple rule policy is better than the discretion if the gain of credibility of a low inflation rate is larger than the restriction of stabilization policies. Secondly a better balance between credibility and flexibility ensures the implementation of "escape clauses". Finally, the optimal rule provides an anchor for inflation expectations.

3. The monetary policy efficiency under inflation targeting

The question of the economic performance of inflation targeting policy is at the heart of the economic debate in recent years. Our objective is attempting to measure economic performance of monetary policy in the economic literature that a stable monetary environment reflects a good macroeconomic performance.

The Inflation targeting policy is economically efficient, when it generates an increased degree of stability in the macroeconomic environment. And establish a relationship between stability and performance.

Stable monetary environment \implies low degree of uncertainty \implies degree of interaction between the variables high \implies convergent responses to shocks.¹³

The purpose of this study is to establish the methodology we adopt to assess the economic performance of the inflation targeting policy. We will try in what follows to judge the performance of the inflation targeting policy based on the effect of macroeconomic stability and in particular the environment of monetary policy.

We can measure the macroeconomic performance of a country, focusing on the stability of inflation and real growth. The majority of previous work showed that inflation and growth evolve in better way in the country pursuing the IT (Inflation Targeting) in countries that practice other monetary regimes.

¹² Given the relatively high vulnerability of emerging markets to supply shocks, the strict inflation targeting cannot be applied, however, without costs.

¹³ Aguir, A. (2014), "Inflation Targeting: An Alternative to Monetary Policy" International Journal of Economics and Finance Vol 6, No 7

In what follows, we calculate other performance measures to identify the contribution of the effectiveness of monetary policy in the differences of macroeconomic performance between countries with the IT and those without the IT.

3.1 Method of estimation:

In drawing on the work of Cecchetti and Krause (2002), Flores-lagoons and Krause (2006) and Mishkin and Schmidt Hebbel (2006), we estimate the border of efficiency: inflation variability - variability of output, which allows us to deduce the measures of economic performance and efficiency measures of monetary policy. The performance of monetary policy can be estimated by using the principle of arbitrage between the variability of inflation and the variability of output practiced by those responsible for monetary policy. This arbitration allows us to construct an efficiency frontier. The border of the Inflation-Output variability is explained by considering an economy that affected by two types of disturbances: of aggregate demand shocks and aggregate supply shocks. The aggregate supply shocks lead to movements of the output and inflation in a sense opposite, forcing the monetary authority to arbitrate between the variability of output. The position of the efficiency frontier depends on the intensity of aggregate supply shocks.

The efficiency frontier is also an indicator of the degree of optimality of monetary policy. When monetary policy is sub-optimal, the economy will be exposed to greater volatility of output and inflation, it will be located at a significant distance from the border. Movement towards the efficiency frontier indicates an improvement of monetary policy.

This feature of the efficient frontier allows us to construct measures of economic performance and the performance of the monetary policy in order to distinguish the contribution of the efficiency of monetary policy than the variability of shocks in the differences observed in macroeconomic performance between countries without the CI and those with the CI. We follow the methodology of Cecchetti, Flores-lagoons and Kraus (2006), by applying their method to the two groups of emerging countries pursuing the inflation targeting to those of a group of emerging neighbouring countries having economic and social indicators comparable.

Our study focuses on 16 emerging countries practicing inflation targeting, 11 emerging countries practicing other monetary policy (appendix 1&2). Our primary source for data is the IMF's International Finance Statistics.

We begin by obtaining a measure of the performance of an economy in terms of output-inflation variability. Specifically, we derive a standard conventional goal of a

Central Bank which is the minimization of the following loss function, determined by quadratic deviation of the inflation of the output:

$$L = \lambda (\pi_t - \pi_t^*)^2 + (1 - \lambda) (\gamma_t - \gamma_t^*)^2$$

With:

π_t is the rate of inflation;

π_t^* is the target of inflation;

γ_t is the logarithm of the output level;

γ_t^* is the target or the trend level of output.

λ is the weight attached to the inflation.

Thus our measure of macroeconomic performance, L , is a weighted average of the observed variability of inflation and output relative to their target levels. The difference between the observed measures of the performance of countries without IT (LNIT) and those of countries with IT (LIT) reflects differences in the macroeconomic results.

If $\Delta L = L_{NIT} - L_{IT}$ is negative, then the countries without the IT have better macroeconomic performance than the countries with the IT. Similarly, we compare the macroeconomic performance of the countries with the IT, pre and post adoption of inflation targeting.

If $\Delta L = L_{\text{post IT}} - L_{\text{pre IT}}$, is negative, then the country with the IT recorded a gain of performance after the adoption of the IT. This change in performance can also be caused by a change in the position of the efficiency frontier (better performance is explained only by smaller supply shocks) or a change in the efficiency of the policy monetary or both. The change in performance due to the change in the size of the shock is derived from the following combination of optimal variances of output and inflation:

$$S = \lambda (\pi_t - \pi_t^*)_{\text{opt}}^2 + (1 - \lambda) (\gamma_t - \gamma_t^*)_{\text{opt}}^2$$

With $(\pi_t - \pi_t^*)_{\text{opt}}^2$ and $(\gamma_t - \gamma_t^*)_{\text{opt}}^2$ are the deviations of inflation and output relative to their targets under an optimal policy. S is a measure of the variability of supply shocks. For example, a negative difference of this measure between countries without the IT and the country with the IT, $\Delta S = S_{NIT} - S_{IT}$, indicates that the shocks hitting the country without the CI are smaller than the shock of the country with the IT. Also, a negative value of $\Delta S = S_{\text{post IT}} - S_{\text{pre IT}}$ implies that IT countries are confronted to smaller shocks after the adoption of the inflation targeting.

Finally, we are evolving the efficiency of monetary policy by measuring how the current performance is achieved compared to the optimal policy (i.e, the distance to the border of efficiency). We call this measure E and the set thus:

$$E = \lambda [(\pi_t - \pi_t^*)^2 - (\pi_t - \pi_t^*)_{opt}^2] + (1 - \lambda) [(\gamma_t - \gamma_t^*)^2 - (\gamma_t - \gamma_t^*)_{opt}^2]$$

Thus the smallest value of E indicates that the monetary performance is closer to the optimal policy. The differences in the efficiency of policy between countries without the IT and those with the IT are obtained by calculating $\Delta E = E_{NIT} - E_{IT}$; a negative value of ΔE implies that countries without the IT policy is more efficient.

Similarly, the change in the efficiency of the policy of the countries with the IT through time is calculated: $\Delta E = E_{post\ IT} - E_{pre\ IT}$, ΔE is negative if the country with the IT had improved their efficiency policy after the adoption of inflation targeting. The calculation of these performance measures requires the frontier estimation of variability Output-Inflation. Previously, one needs to derive a function of reaction by the minimization of loss function, subject to the constraints imposed by the structure of the economy. Given this estimate and the weight value assigned λ has inflation in the loss of the authorities function, it is possible to plot a point on the efficient frontier. The variation in the weight assigned to the variability of inflation allows us to delineate the border of full efficiency. We will proceed in two main stages: We consider a simple model of demand and aggregate supply, then we use these estimates to construct the efficiency frontier and calculate L, S and E.

In what follows we admit the following symbols:

$\pi_t = \pi_t - \pi_t^*$: deviation of inflation from its target value.

$\pi_t = \gamma_t - \gamma_t^*$: deviation of output from its potential level.

We consider the supply and demand dynamic model used by Cecchetti, Flores-lagoons and Kraus (2006)¹⁴. This model involves the following equations:

$$\tilde{y}_t = \alpha_1 \tilde{y}_{t-1} + \alpha_2 \tilde{y}_{t-2} + \alpha_3 \gamma_{t-1} + \alpha_4 \gamma_{t-2} + \alpha_5 \pi_{t-1} + \alpha_6 \pi_{t-2} + \varepsilon_{1,t}$$

$$\pi_t = \beta_1 \tilde{y}_{t-1} + \beta_2 \tilde{y}_{t-2} + \beta_3 \pi_{t-1} + \beta_4 \pi_{t-2} + \varepsilon_{2,t}$$

Either, the following matrix: $X_t = AX_{t-1} + B \tilde{y}_{t-1} + v_t$

¹⁴ These authors applied the same model equations to 24 industrialized countries and emerging economies

$$\text{With } X_t = \begin{bmatrix} i_{t-1} \\ \tilde{y}_t \\ \tilde{y}_{t-1} \\ \pi_t \\ \pi_{t-1} \end{bmatrix}, A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ \alpha_2 & \alpha_3 & \alpha_4 & \alpha_5 & \alpha_6 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & \beta_1 & \beta_2 & \beta_3 & \beta_4 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}, B = \begin{bmatrix} 1 \\ \alpha_1 \\ 0 \\ 0 \\ 0 \end{bmatrix}, v_t = \begin{bmatrix} 0 \\ \varepsilon_{1,t} \\ 0 \\ \varepsilon_{2,t} \\ 0 \end{bmatrix}$$

The first equation returns a function of aggregate demand where the non-trend output is explained by its two own delayed values, two lags of the nominal interest rate and two lags of inflation values. The second equation represents a Phillips curve in which deviations of inflation from its target or objective is a function of its two lagged values and two values delayed non-trend output.

We believe these two equations for an alternative country group by using the method of the panel dynamic ordinary least square (Pooled OLS). Having estimated the dynamic structure of the economy, we continue by obtaining an optimal function of the monetary policy. The Central Bank selects a path for the interest rate from the minimization of the loss function subject to the dynamics of the economy. Consider the loss function of a period of the following quadratic form:

$$L = \lambda_1 (\pi_t - \pi_t^*)^2 + \lambda_2 (\tilde{y}_t - \tilde{y}_t^*)^2 + \lambda_3 (i_t - i_{t-1})^2$$

$$= \lambda_1 (\pi_t)^2 + \lambda_2 (\tilde{y}_t)^2 + \lambda_3 (i_t - i_{t-1})^2$$

This loss function defines a flexible targeting regime insofar as, it accords:

- weights λ_1 to the deviation of the inflation of its value target.
- weight λ_2 to the deviation of output from its potential level.
- weight λ_3 interest rate of smoothing interest rates.

In the particular case where $\lambda_2 = \lambda_3 = 0$, this loss function refers to a policy of strict inflation targeting.

For a discount factor $0 < \delta < 1$, the intertemporal loss function J related in time t , is the following form:

$$J = \hat{E}_t = \sum_{\tau=0}^{\infty} \delta^\tau L_{t+\tau}$$

\hat{E}_t denotes the operator of conditional anticipation of the information available in t .

Rudebusch and Svensson (1998) have shown that the intertemporal loss function can be

interpreted as the unconditional expectation in the case $\delta = 1$. This loss function is the weighted sum of the unconditional variances of the target variable, for the period of study relating to the loss function.

Thus, the loss function to minimize becomes form:

$$E[L] = \lambda_1 \text{V a r} [\pi_t - \pi_t^*] + \lambda_2 \text{V a r} [\gamma_t - \gamma_t^*] + \lambda_3 \text{V a r} [i_t - i_{t-1}]$$

$$= \lambda_1 \text{V a r} [\pi_t] + \lambda_2 \text{V a r} [\tilde{y}_t] + \lambda_3 \text{V a r} [i_t - i_{t-1}]$$

The vector of target variables $Y_t = Y_t = \begin{bmatrix} \pi_t \\ \tilde{y}_t \\ i_t - i_{t-1} \end{bmatrix}$, Y_t , can be expressed in terms of

X_t, i_t

As follows:

$$Y_t = C_X X_t + C_i \cdot i_t$$

With: $C_X = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix}$ and $C_i = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

Thus the loss function of a period can be deduced from the following matrix notation:

$$L_t = Y_t' \cdot K \cdot Y_t$$

With: $K = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix}$

By replacing the previous expression Y_t in L_t , we get:

$$L_t = (C_X X_t + C_i i_t)' \cdot K \cdot (C_X X_t + C_i i_t)$$

$$= X_t' \cdot Q \cdot X_t + 2 X_t' \cdot U \cdot i_t + i_t' \cdot R \cdot i_t$$

With

$$Q = C_X' \cdot K \cdot C_X$$

$$U = C_X' \cdot K \cdot C_i$$

$$R = C_i' \cdot K \cdot C_i$$

If the monetary authorities decide to follow a simple rule of the evolution of the instrument where the interest rate will be determined based on the evolution of the variables X_t , that rule will have the following form: $i_t = f(X_t)$

Thus, the Central Bank will attempt to solve the following optimization problem:

$$\text{Min } E_t \sum_{\tau=0}^{\infty} \delta^\tau (X'_{t+\tau} \cdot Q \cdot X_{t+\tau} + 2X'_{t+\tau} \cdot U \cdot i_{t+\tau} + i'_{t+\tau} \cdot R \cdot i_{t+\tau})$$

$$\text{Under constraints } \begin{cases} X_t = A X_{t-1} + B i_{t-1} + v_t \\ \text{and} \\ i_t = f(X_t) \end{cases}$$

This optimization problem discloses a sequential decision process. In fact, we have an objective to optimize using a series of decisions to make these decisions are related to each other and the information gets progressively as the system evolves. The identification of the optimal strategy for this process requires the use of the dynamic programming technique.

The solution of this optimization problem led to the following results:

$$f = - (R + \delta B' \cdot V \cdot B)^{-1} \cdot (U' + \delta B' \cdot V \cdot A)$$

$$\text{With } V = Q + U \cdot f + f' \cdot U' + f' \cdot U' + f' \cdot R \cdot f + \delta (A + B \cdot f)' \cdot V \cdot (A + B \cdot f)$$

The intertemporal loss function will be equal to:

$$X' \cdot V \cdot X_t + \frac{\delta}{1-\delta} \text{trace} (V \Sigma_{vv})$$

Where: $\Sigma_{vv} = E [v_t v_t']$ covariance matrix of the error vector.

To determine the numerical solution of the function f , we have used an iterative method similar to that used by Oudiz and Sachs (1985) using a computer program designed for this purpose, executable on Eviews.

Once determined the function $i_t = f(X_t)$, and under the assumption that the Central Bank wants the stability of inflation and output only ($\lambda_3 = 0$) and ($\lambda_1 + \lambda_2 = 1$), we can calculate the optimum values $(\pi_t - \pi^*)_{\text{opt}}$ and $(\gamma_t - \gamma^*)_{\text{opt}}$.

These two coordinates correspond to a point on the efficient frontier (variability Inflation-Output). Varying λ_1 and λ_2 we obtain a set of point's representatives the efficiency

frontier. Then with the estimation of the efficiency frontier, we determine the optimal variances of inflation and output necessary to calculate performance measures.

Like Cecchetti, Flores - Lagoons and Krause (2006), we assume that $\lambda_1 = 0.8$ and $\lambda_2 = 0.2$, to determine the various performance measures L, S and E.

The measures of the variability of inflation are based on the deviation of the CPI target for countries practising the IT, and the deviation of the CPI trend Hoodrick - Prescott (HP) for countries without the IT. For both groups of countries, the variability of the output is based on the output gap or the deviation from the HP trend. Thus we will be able to calculate the performance measures presented above to identify the contribution of changes in the effectiveness of monetary policy and supply shocks to the observed differences in macroeconomic performance between different groups of countries. To identify the impact of IT, our approach is to compare the performance between seven groups for the 19 emerging countries practicing the inflation targeting and 11 emerging countries practicing other monetary policies:

- countries with IT before IT # countries with IT after IT,
- countries with IT before IT # countries with IT after IT (convergence period),
- countries with IT before IT # countries with IT after IT (period of stationarity)
- country without IT before 1999: 4 # country without IT after 1999: 4,
- countries with IT after the IT # country without IT after 1999: 4,
- countries with IT after IT (convergence period), # countries without IT after 1999: 4;
- countries with IT after IT (period of stationarity), # country without IT after 1999: 4

3.2. Estimation results:

Using the method for estimating the panel dynamic ordinary least square (Pooled OLS), the estimated model of the economy (the two equations of supply and demand), for the 27 countries in the sample, is as follows:

$$\gamma_t = 0.0067 i_{t-1} + 0.063 i_{t-2} + 0.522 \gamma_{t-1} + 0.404 \gamma_{t-2} - 0.053 \pi_{t-1} + 0.071 \pi_{t-2}$$

$$\pi_t = -0.002 \gamma_{t-1} + 0.006 \gamma_{t-2} + 1.270 \pi_{t-1} - 0.340 \pi_{t-2} + \varepsilon_{2,t}$$

Table 1 report the estimated measures of economic performance (L), the efficiency of monetary policy ϵ and variability of supply shocks (S) for each pair of groups of countries.

The first line of table 1 indicates the action estimated for countries engaged in targeting inflation before and after the adoption of this plan. In these countries, economic performance (L) improved after the adoption of the inflation targeting. This performance

gain is reflected by the negative value $\Delta L = - 6.40$. The defalcation of the gain shows that it comes at a rate of 84% of positive supply shocks and 16% of the efficiency of monetary policy under inflation targeting regime.

This proportion has improved during the period of convergence for the efficiency of monetary policy, as saying that that during the period of the stationary positive supply shocks has improved and gain the efficiency of monetary policy remained stable.

Countries not practicing inflation targeting have experienced economic inefficiency during the period [2000 - 2013] compared to the initial period [1990-1999]. This inefficiency valued at $\Delta L = 68.99$ is due to adverse supply shocks and a loss of efficiency of the monetary policy pursued by these countries (table 1, 4th line). The comparison of the two groups of countries during the period of post targeting shows that countries pursuing inflation targeting have experienced a better economic performance. This difference in performance is partly explained by a good monetary policy, especially during the period of convergence targets.

Table 1: calculation Loss L, S and E

	L1	E1	S1		L2	E2	S2	Variations		
								L2-L1	E2-E1	S2-
Countries with CI, before CI (in % of L)	24.41	2.57	21.84	Countries with CI, before CI (in % of L)	18.01	1.58	16.43	-6.40	-1	-5.40
		11	89			9	91		16	84
Countries with CI, before CI (in % of L)	24.41	2.57	21.84	Countries with CI, convergence period (in % of L)	28.09	1.32	26.77	3.68	-1.25	4.93
		11	89			5	95		-34	134
Countries with CI, before CI (in % of L)	24.41	2.57	21.84	Countries with CI, stationarity period (in % of L)	4.60	1.38	3.22	-19.81	-1.19	-18.62
		11	89			30	70		6	94
Country without CI, before 2000:1 (in % of L)	8.65	2.77	5.88	Country without the CI, before 2000:1 (in % of L)	74.99	4.90	72.74	68.99	2.13	66.86
		32	68			6	94		3	97
Countries with CI, after CI (in % of L)	18.01	1.58	16.43	Country without the CI, before 2000:1 (in % of L)	74.99	4.90	72.74	59.63	3.32	56.31
		9	91			6	94		6	94
Countries with CI, convergence period (in % of L)	28.09	1.32	26.77	Country without the CI , before 2000:1 (in % of L)	74.99	4.90	72.74	49.55	3.58	45.97
		5	95			6	94		7	93
Countries with CI, stationarity period (in % of L)	4.60	1.38	3.22	Country without the CI, before 2000:1 (in % of L)	74.99	4.90	72.74	73.04	3.52	69.52
		30	70			6	94		5	95

The signs (-) means a gain in performance

The signs (-) means a loss of performance

Conclusion

In this paper our study focused on the analysis of conceptual and analytical aspects of inflation targeting as one of the most commonly used optimal rules in recent years. We have shown how this notion of optimal rule should guide the behavior of the Central Bank in the monetary policy decisions towards the achievement of the inflation target in relying in this sense on a theoretical scheme under construction.

In this sense, we are based on the work of F. Kydland and E. Prescott (1977) and those of R.Barro and D.Gordon (1983), which revolves around the problem known as the time inconsistency and the credibility of monetary policy still relevant in monetary theory.

The theoretical contribution which is based on the concept of credibility is based on two elements. The first is an aggregate supply function linking positively the output gap to non-anticipated inflation (supply curve" to the Lucas'). The second is a social loss function, meeting precise specifications that make the Central Bank is tempted to make inflation surprise to stimulate the production and employment.

To explain these two concepts, we resorted to the rule of J.Taylor (1993), we have used the rule of J. Taylor (1993) which is the best-known formal expression. This rule owed its popularity in the subsequent theoretical clarifications by L.Svenson.

In a second step, we study the question of the effectiveness of the policy of inflation targeting. The use of the econometric technique of vector autoregression, of a sample of countries practicing the IT compared to a sample of countries pursuing other monetary regimes and having economic and social indicators comparable. Allowed us to show that the adoption of the IT regime resulted in significant differences in macroeconomic performance. To ensure that these performance differences are attributable to the choice of the inflation-targeting regime, it was estimated the efficiency frontier: variability of inflation - variability of output, which allows the deduction of the economic performance and measures efficiency of monetary policy.

Drawing on the work of Cecchetti and Krause (2002), Flores Lagoons and Krause (2006) and Mishkin and Schmidt-Hebbel (2006), our study on the same group of countries demonstrate that this monetary regime is conducive to sustainable economic growth and the inflation targeting countries recognize more macroeconomic performance as its neighbor of not targeting and that these differences are generally attributable to the choice of this new regime.

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Table 1 : Period pre and Post inflation targeting

IT countries	Period Pre targets		period Post Ciblage			
			Period of convergence targets		Period of stationarity	
Czech Republic	1990 :Q1	1997 :Q4	1998 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Korea	1990 :Q1	1997 :Q4	1998 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Poland	1990 :Q1	1997 :Q4	1998:Q1	2004 :Q4	2005 :Q1	2012 :Q4
Brazil	1990 :Q1	1998 :Q4	1999 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Chile	1990 :Q1	1999 :Q2	1999 :Q3	2004 :Q4	2005 :Q1	2012 :Q4
Colombia	1990 :Q1	1998 :Q4	1999 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Guatemala	1990 :Q1	2001 :Q4	2002 :Q1	2006 :Q4	2007 :Q1	2012 :Q4
South Africa	1990 :Q1	1999 :Q4	2000:Q1	2000 :Q4	2001 :Q1	2012 :Q4
Thailand	1990 :Q1	1999 :Q4	*	*	2000 :Q1	2012 :Q4
Mexico	1990 :Q1	1998 :Q4	1999:Q1	2002 :Q4	2003 :Q1	2012 :Q4
Israël	1990 :Q1	1991 :Q4	1992 :Q1	2000 :Q4	2001 :Q1	2012 :Q4
Indonesia	1990 :Q1	2004 :Q4	2005 :Q1	2009 :Q4	2010 :Q1	2012 :Q4
Hungary	1990 :Q1	2000 :Q4	2001 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Peru	1990 :Q1	1993 :Q4	1994 :Q1	2004 :Q4	2005 :Q1	2012 :Q4
Philippines	1990 :Q1	2000 :Q4	2001 :Q1	2003 :Q1	2003 :Q2	2012 :Q4
Turkey	1990 :Q1	2005 :Q4	*	*	2006 :Q1	2012 :Q4

Table 2: Emerging Markets Sample

IT countries	Start of Inflation Targeting Regime	Non-IT countries
Brazil	1999Q1	Argentina
Chile	1999Q3	Indonesia
Colombia	1999Q1	Jordan
Czech Republic	1998Q1	Malaysia
Guatemala	2002Q1	Morocco
Hungary	2001Q1	Uruguay
Indonesia	2005Q1	Paraguay

Israel	1992Q1	Georgia
Korea	1998Q1	Croatia
Mexico	1999Q1	Bulgaria
Peru	1994Q1	Bolivia
Philippines	2001Q1	
Poland	1998Q1	
Thailand	2000Q1	
South Africa	2000Q1	
Turkey	2006Q1	