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Taylor Rules and Inflation Targeting Do Not Work with Systematic Foreign Exchange Market Intervention^{*}

Víctor Olivo^ψ

Abstract

This paper examines how the systematic attempt to influence directly the path of the nominal exchange rate due to “fear of floating” affects the conduct of monetary policy under a Taylor rule and inflation targeting. The paper demonstrates that implementing a Taylor rule or an inflation-targeting scheme simultaneously with policies that try to moderate the rate of depreciation of the nominal exchange rate may result in an inconsistent monetary policy. In addition, the paper shows in a relatively simple framework the close theoretical connection between a Taylor rule and inflation targeting.

^{*} S. M. Miller made important contributions to previous versions of the paper. Any remaining errors are the sole responsibility of the author.

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Reglas de Taylor y Esquemas de Inflación Objetivo no Funcionan con Intervención Sistemática en el Mercado Cambiario

Víctor Olivo^Ψ

Este trabajo examina como el intento sistemático de influenciar directamente la trayectoria del tipo de cambio nominal debido al “miedo a flotar”, afecta la conducción de la política monetaria bajo una regla de Taylor y un esquema de inflación objetivo. El trabajo demuestra que la implementación de una regla de Taylor o un esquema de inflación objetivo, simultáneamente con estrategias que tratan de moderar la depreciación del tipo de cambio nominal, puede dar como resultado una política monetaria inconsistente. Adicionalmente, el trabajo muestra dentro de un marco analítico relativamente simple la estrecha relación teórica entre una regla de Taylor y una estrategia de inflación objetivo.

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1.- Introduction

Inflation targeting became widely popular among central banks during the 1990s. The first wave of central banks adopted inflation targeting in the first half of this decade in industrialized countries. In the late 1990s, however, several Latin American central banks embarked on inflation targeting. Currently, the central banks of Chile, Mexico, Brazil and Colombia practice inflation targeting.

Jointly with the spreading of inflation targeting, an explosion occurred in the literature that covers different practical and theoretical aspects of this monetary policy regime. Bofinger (2001), however, points out that in contrast to monetary targeting that was applied by central banks after intensive academic discussion, inflation targeting was first put in practice by central banks and then researchers began to provide the theoretical support. The literature available on inflation targeting has covered an ample spectrum of topics, such as: i) country experiences with the scheme (Leiderman and Svensson, 1995, Bernanke et al 1999); ii) implementation of inflation targeting as inflation forecast targeting (Svensson, 1996); iii) analysis of the responses to different shocks, consequences of model uncertainty, effects of interest rate smoothing and stabilization, comparison with nominal GDP targeting, and implications of forward-looking behavior (Svensson, 1997); iv) studying inflation targeting in the context of monetary policy rules (Svensson, 1998); v) examining the efficiency of inflation targeting in relation to Taylor rules in closed economies (Ball, 1997) and open economies (Ball, 1998).

Although inflation targeting currently reflects the monetary policy strategy choice of those countries that want to provide the economy with a nominal anchor while avoiding the excessive rigidity of “hard” or “soft” pegs, Calvo and Reinhart (2000) argue that many

countries that say they allow their exchange rate to float actually do not. Those authors content that an epidemic case exists of “fear of floating.”

This paper studies how the systematic attempt to influence directly the path of the nominal exchange rate due to “fear of floating” affects the conduct of monetary policy under a Taylor rule and inflation targeting. The paper demonstrates that implementing a Taylor rule or an inflation-targeting scheme simultaneously with policies that try to moderate the rate of depreciation of the nominal exchange rate may result in an inconsistent monetary policy. In addition, the paper shows in a relatively simple framework the close theoretical connection between a Taylor rule and inflation targeting.

This issue is important, because as mentioned previously, inflation targeting has spread rapidly in countries that may experience simultaneously “fear of floating”.

The paper is organized as follows. Section 2 examines the relationship between a Taylor rule and inflation targeting in a closed economy. Section 3 extends the analysis to an open economy. In particular, it focuses on the effect in a Taylor rule and inflation targeting of adopting simultaneously an exchange rate system based on a crawling peg. This analysis implicitly assumes imperfect capital mobility, so the monetary authority can exert some degree of control over the domestic interest rate. Section 4 examines the effect in a Taylor rule and inflation targeting regime of systematic intervention in the foreign exchange market to curb the rate of depreciation of the nominal exchange rate without pursuing any precise target for that variable. Section 5 concludes.

2.- Taylor Rules and Inflation Targeting: Closed Economy

The closed economy model developed here closely follows Ball (1997). It consists of a dynamic IS function, and a Phillips curve. In contrast to Ball, I substitute the real interest rate (r) using the Fisher ex post relationship, and solve the model for the nominal

interest rate (i). I measure all variables as deviations with respect to their respective means in logarithms.

In this model, it takes two periods for monetary policy to affect inflation (π) through changes in the interest rate -- one period for policy to affect output (y), and one period for output to affect inflation. The model includes the following equations:

IS curve:

$$y_t = -br_{t-1} + ly_{t-1} + e_t.$$

(1)

Phillips curve:

$$p_t = p_{t-1} + ay_{t-1} + h_t.$$

(2)

Fisher ex post relation:

$$i_{t-1} = r_{t-1} + p_{t-1}.$$

(3)

Substituting this relation into equation (1) produces:

$$y_t = -bi_{t-1} + bp_{t-1} + ly_{t-1} + e_t, \quad \text{and}$$

(1a)

$$p_t = p_{t-1} + ay_{t-1} + h_t.$$

(2a)

For period $t+1$, the model is written as follows:

$$y_{t+1} = -bi_t + bp_t + ly_t + e_{t+1}, \quad \text{and}$$

(1b)

$$\mathbf{p}_{t+1} = \mathbf{p}_t + \mathbf{a}y_t + \mathbf{h}_{t+1}.$$

(2b)

Taylor Rule

The transmission mechanism of monetary policy assumed in the model implies that the policymaker minimizes the following expected quadratic loss function in terms of output and inflation variance:

$$E_t(L) = cE_t(y_{t+1})^2 + E_t(\mathbf{p}_{t+2})^2.$$

(4)

Substituting the assumed structure of the economy in the loss function yields:

$$E_t(L) = c(-\mathbf{b}i_t + \mathbf{b}\mathbf{p}_t + \mathbf{l}y_t)^2 + [E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1})]^2, \quad \text{and}$$

(4a)

$$E_t(L) = c(-\mathbf{b}i_t + \mathbf{b}\mathbf{p}_t + \mathbf{l}y_t)^2 + [\mathbf{p}_t + \mathbf{a}y_t + \mathbf{a}(-\mathbf{b}i_t + \mathbf{b}\mathbf{p}_t + \mathbf{l}y_t)]^2.$$

(4b)

Minimizing E(L) with respect to i_t and solving for i_t produces:

$$i_t = \left[\frac{\mathbf{l}}{\mathbf{b}} + \frac{\mathbf{a}^2}{\mathbf{b}(\mathbf{c} + \mathbf{a}^2)} \right] y_t + \left[1 + \frac{\mathbf{a}^2}{\mathbf{a}\mathbf{b}(\mathbf{c} + \mathbf{a}^2)} \right] \mathbf{p}_t.$$

(5)

Hence, this model generates an optimal policy rule, Taylor rule, where its parameters depend on the structure of the economy and the weight that the policymaker assigns to output variability in the loss function (c).

When the policymaker assigns no weight to output fluctuations (c=0), the interest rate rule reduces to:

$$i_t = \frac{(1+I)}{\mathbf{b}} y_t + (1 + \frac{1}{\mathbf{ab}}) \mathbf{p}_t .$$

(6)

Strict Inflation Targeting

This section demonstrates that inflation targeting implicitly implies an interest rate rule.

Ball (1997) defines strict inflation targeting as a policy that minimizes the variance of inflation around its average level. With monetary policy affecting inflation with a two-period lag, we define strict inflation targeting as follows:

$$E_t(\mathbf{p}_{t+2}) = 0 .$$

(7)

Using equation (2) updated two periods causes equation (8) to equal:

$$E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1}) = 0 .$$

(8)

Substituting equations (1b) and (2b) into this expression results in:

$$\mathbf{p}_t + \mathbf{a}y_t + \mathbf{a}(-\mathbf{b}i_t + \mathbf{b}\mathbf{p}_t + Iy_t) = 0 .$$

(9)

Solving this expression for i_t , produces:

$$i_t = \frac{(1+I)}{\mathbf{b}} y_t + (1 + \frac{1}{\mathbf{ab}}) \mathbf{p}_t .$$

(10)

The previous equation equals the Taylor rule with $c=0$ (i.e., Equation 5). Hence, strict inflation targeting matches a Taylor rule where the policymaker gives zero weight to

output variance. Because the Taylor rule is the optimal rule in this model, strict inflation targeting is also an optimal rule for the particular case that $c=0$.

Although the policymaker assigns a zero weight to output fluctuations, the implicit policy rule still responds to this variable due to the structure of the model.

Flexible Inflation Targeting

Inflation targeting more generally equals a partial adjustment rule where expected inflation in period $t+2$ equals a fraction of expected inflation in period $t+1$. That is:

$$E_t(\mathbf{p}_{t+2}) = \mathbf{q}E_t(\mathbf{p}_{t+1}), \quad \mathbf{q} < 1.$$

(11)

Once again, using equation (2) updated two periods, equation (11) equals:

$$E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1}) = \mathbf{q}E_t(\mathbf{p}_{t+1}).$$

(12)

Substituting equations (1b) and (2b) into this expression and re-arranging terms leads to:

$$(1-\mathbf{q})(\mathbf{p}_t + \mathbf{a}y_t) + \mathbf{a}(-\mathbf{b}i_t + \mathbf{b}\mathbf{p}_t + \mathbf{l}y_t) = 0.$$

(13)

Solving for i_t produces:

$$i_t = \left[\frac{(1-\mathbf{q}) + \mathbf{l}}{\mathbf{b}} \right] y_t + \left[1 + \frac{(1-\mathbf{q})}{\mathbf{a}\mathbf{b}} \right] \mathbf{p}_t.$$

(14)

If we define:

$$(1-\mathbf{q}) = \frac{\mathbf{a}^2}{\mathbf{c} + \mathbf{a}^2} \quad \text{or} \quad \mathbf{q} = \frac{\mathbf{c}}{\mathbf{c} + \mathbf{a}^2},$$

(15)

and substitute it into equation (14), then equation (5) emerges. This implies that flexible inflation targeting is, in general, the optimal policy rule in this model. The value of θ implicitly depends on the weight that the policymaker assigns to output volatility in the loss function (c). A larger value of θ , that is a more gradual path toward the inflation target, associates with a larger c , given the value of α .

3.- Taylor Rules and Inflation Targeting: Crawling Peg

This section develops a model similar to that of Ball (1998), but assumes that the exchange rate follows a crawling peg. Combining a Taylor rule or inflation targeting with a crawling peg may seem strange at first, but that policy strategy currently reflects the Hungarian and Israeli situations (IMF-IFS, May 2002).

In the open economy model, I introduce the logarithm of the real exchange rate (q) into the IS function and the change of the nominal exchange rate ($e_t - e_{t-1}$) into the Phillips function. The rate of the crawl (Ω) is specified as a fraction of the differential between domestic and foreign inflation, where the latter is normalized to zero ($0 \leq \Omega \leq 1$). Thus, the model setup is as follows:

IS curve:

$$y_t = -br_{t-1} + ly_{t-1} + dq_{t-1} + e_t.$$

(16)

Phillips curve:

$$p_t = p_{t-1} + ay_{t-1} + y(e_{t-1} - e_{t-2}) + h_t.$$

(17)

Fisher ex post relation:

$$i_{t-1} = r_{t-1} + \mathbf{p}_{t-1}.$$

(18)

Crawling peg rule:

$$e_{t-1} - e_{t-2} = \Omega \mathbf{p}_{t-1}; \mathbf{p}_{t-1}^* = 0.$$

(19)

Definition of the real exchange rate:

$$q_{t-1} - q_{t-2} = (e_{t-1} - e_{t-2}) - \mathbf{p}_{t-1};$$

(20)

$$q_{t-1} = q_{t-2} + (\Omega - 1)\mathbf{p}_{t-1}.$$

(21)

Substituting the previous definitions into equations (16) and (17) yields:

$$y_t = -\mathbf{b}i_{t-1} + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_{t-1} + \mathbf{l}y_{t-1} + \mathbf{d}q_{t-2} + \mathbf{e}_t, \quad \text{and}$$

(22)

$$\mathbf{p}_t = (1 + \mathbf{y}\Omega)\mathbf{p}_{t-1} + \mathbf{a}y_{t-1} + \mathbf{h}_t.$$

(23)

Moving one period ahead leads to:

$$y_{t+1} = -\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1} + \mathbf{e}_{t+1}, \quad \text{and}$$

(22a)

$$\mathbf{p}_{t+1} = (1 + \mathbf{y}\Omega)\mathbf{p}_t + \mathbf{a}y_t + \mathbf{h}_{t+1}.$$

(23a)

In this model, the introduction of the crawling peg rule maintains the two-period lag with which monetary policy affects inflation. The crawling rule breaks the explicit

connection between the exchange rate and the interest rate. The interest rate, however, still affects the behavior of the exchange rate indirectly through its effect on the amount of intervention necessary to maintain the crawling rule.

Taylor Rule

As before, the loss function equals:

$$E_t(L) = cE_t(y_{t+1})^2 + E_t(\mathbf{p}_{t+2})^2 .$$

(24)

Substituting the equations of the model into the loss function produces:

$$E_t(L) = c[-\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1}]^2 + [(1 + \mathbf{y}\Omega)E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1})]^2 , \quad \text{and} \quad \text{then}$$

(25)

$$E_t(L) = c\{-\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1}\}^2 + \{(1 + \mathbf{y}\Omega)[(1 + \mathbf{y}\Omega)\mathbf{p}_t + \mathbf{a}y_t] + \mathbf{a}[-\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1}]\}^2 .$$

(26)

Minimizing E(L) with respect to i_t and solving for i_t leads to:

$$i_t = \left[\frac{\mathbf{l}}{\mathbf{b}} + \frac{\mathbf{a}^2(1 + \mathbf{y}\Omega)}{\mathbf{b}(c + \mathbf{a}^2)} \right] y_t + \left[1 + \frac{\mathbf{d}(\Omega - 1)}{\mathbf{b}} + \frac{\mathbf{a}(1 + \mathbf{y}\Omega)^2}{\mathbf{b}(c + \mathbf{a}^2)} \right] \mathbf{p}_t + \frac{\mathbf{d}}{\mathbf{b}} q_{t-1} .$$

(27)

Again, the optimal policy in this model equals a Taylor rule. Now, the parameters of the policy rule depend positively on the rate of the crawl (Ω).

The case where $c=0$ yields the following interest rate rule:

$$i_t = \left[\frac{\mathbf{l}}{\mathbf{b}} + \frac{(1 + \mathbf{y}\Omega)}{\mathbf{b}} \right] y_t + \left[1 + \frac{\mathbf{d}(\Omega - 1)}{\mathbf{b}} + \frac{(1 + \mathbf{y}\Omega)^2}{\mathbf{a}\mathbf{b}} \right] \mathbf{p}_t + \frac{\mathbf{d}}{\mathbf{b}} q_{t-1} .$$

(28)

Strict Inflation Targeting

As in the closed economy model, strict inflation targeting implies that:

$$E_t(\mathbf{p}_{t+2}) = 0.$$

(29)

This leads to:

$$(1 + \mathbf{y}\Omega)E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1}) = 0,$$

or

(30)

$$(1 + \mathbf{y}\Omega)[(1 + \mathbf{y}\Omega)\mathbf{p}_t + \mathbf{a}y_t] + \mathbf{a}[-\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1}] = 0.$$

(30a)

Solving for i_t results in:

$$i_t = \left[\frac{\mathbf{l}}{\mathbf{b}} + \frac{(1 + \mathbf{y}\Omega)}{\mathbf{b}} \right] y_t + \left[1 + \frac{\mathbf{d}(\Omega - 1)}{\mathbf{b}} + \frac{(1 + \mathbf{y}\Omega)^2}{\mathbf{a}\mathbf{b}} \right] \mathbf{p}_t + \frac{\mathbf{d}}{\mathbf{b}} q_{t-1}.$$

(31)

Strict inflation targeting equals the optimal Taylor rule with $c=0$.

Flexible Inflation Targeting

As in the closed economy case, a gradual inflation targeting is defined as follows:

$$E_t(\mathbf{p}_{t+2}) = \mathbf{q}E_t(\mathbf{p}_{t+1}).$$

(32)

Equation (32) can be re-written as follows:

$$(1 + \mathbf{y}\Omega)E_t(\mathbf{p}_{t+1}) + \mathbf{a}E_t(y_{t+1}) = \mathbf{q}E_t(\mathbf{p}_{t+1}),$$

or

(33)

$$[(1 + \mathbf{y}\Omega) - \mathbf{q}][(1 + \mathbf{y}\Omega)\mathbf{p}_t + \mathbf{a}y_t] + \mathbf{a}[-\mathbf{b}i_t + (\mathbf{b} + \mathbf{d}(\Omega - 1))\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}q_{t-1}] = 0.$$

(33a)

Solving for i_t yields:

$$i_t = \left[\frac{1}{b} + \frac{(1-q)+y\Omega}{b} \right] y_t + \left\{ 1 + \frac{d(\Omega-1)}{b} + \frac{(1+y\Omega)[(1-q)+y\Omega]}{ab} \right\} p_t + \frac{d}{b} q_{t-1}$$

(34)

If we define:

$$(1-q)+y\Omega = \frac{a^2}{c+a^2}(1+y\Omega) \text{ or } q = \frac{c(1+y\Omega)}{c+a^2},$$

and substitute this expression into equation (34), we obtain equation (27). Therefore, flexible inflation targeting is, in general, an optimal policy. Note that when $c=0$, then equations (28), (31) and (34) are all identical.

Taylor Rules and Inflation Targeting under a Crawling Peg Regime

The previous results show that the parameters of the nominal interest rate rule depend positively on the rate of the crawl (Ω). Setting a relatively low value of Ω to reduce inflation towards some target value, diminishes the response of the interest rate for a given deviation of output and inflation with respect to their respective means. In addition, as long as the crawling peg regime produces an appreciation of the real exchange rate, the last term of the policy rule also indicates a lower interest rate for given deviations of output and inflation. The reduced response of the interest rate, in turn, generates pressures on inflation by rising aggregate demand, and on international reserves as it increases the amount of intervention in the foreign exchange market necessary to support the crawling rule. ¹Hence, in a crawling peg regime, the interest rate rule or its inflation targeting counterpart may

generate an interest rate too low to maintain the peg. This is a result that one can intuitively expect. If a policymaker that observes a positive gap between actual and target inflation chooses to reduce the rate of depreciation of the nominal exchange rate through direct intervention in the foreign exchange market, then she wants to avoid a direct tightening of monetary policy to close this gap.

4.- Taylor Rules and Inflation Targeting: Systematic Foreign Exchange Market Intervention

This section develops an analysis of the effect on Taylor rules and inflation targeting of systematic intervention of the monetary authority in the foreign exchange market to moderate the rate of depreciation of the nominal exchange rate. In contrast to the crawling peg model, this section focuses on the case where policymakers do not have an explicit target for the nominal exchange rate, but by trying to control what they perceive as high rates of depreciation not related to fundamentals, direct intervention in the foreign exchange market become systematic. In this model the amount of intervention is an exogenous variable.

We specify a model similar to that of Ball (1998), but assume that the rate of depreciation of the nominal exchange rate depends negatively on the interest rate and the systematic intervention of the monetary authority in the foreign exchange market. The model includes the following equations:

IS curve:

$$y_t = -br_{t-1} + ly_{t-1} + dq_{t-1} + e_t.$$

(35)

Phillips curve:

$$p_t = p_{t-1} + ay_{t-1} + y(e_{t-1} - e_{t-2}) + h_t.$$

¹ Thus in this model, the amount of intervention in the foreign exchange market is an endogenous variable that depends on the interest rate.

(36)

Fisher ex post relation:

$$\dot{i}_{t-1} = r_{t-1} + \mathbf{p}_{t-1}.$$

(37)

Nominal exchange rate adjustment:

$$e_{t-1} - e_{t-2} = -\mathbf{t}i_{t-1} - \mathbf{g}f^x_{t-1} + \mathbf{u}_{t-1}.$$

(38)

Definition of the real exchange rate:

$$q_{t-1} = e_{t-1} - \mathbf{p}_{t-1}; \mathbf{p}_{t-1}^* = 0.$$

(39)

Substituting the previous definitions in the equations of the basic model and moving one period ahead, yields the following:

$$y_{t+1} = -(\mathbf{b} + \mathbf{d}\mathbf{t})i_t + (\mathbf{b} - \mathbf{d})\mathbf{p}_t + \mathbf{l}y_t + \mathbf{d}(e_{t-1} - \mathbf{g}f^x_t) + \mathbf{e}_{t+1} + \mathbf{d}\mathbf{n}_{t+1}, \quad \text{and}$$

(40)

$$\mathbf{p}_{t+1} = \mathbf{p}_t + \mathbf{a}y_t - \mathbf{y}\mathbf{t}i_t - \mathbf{y}\mathbf{g}f^x_t + \mathbf{h}_{t+1} + \mathbf{y}\mathbf{n}_{t+1}.$$

(41)

Taylor Rule

In contrast to the previous model, the present monetary policy affects both output and inflation with one period lag. Hence, in this case, the loss function to minimize is the following:

$$E_t(L) = cE_t(y_{t+1})^2 + E_t(\mathbf{p}_{t+1})^2.$$

(42)

Minimizing $E(L)$ with respect to i_t and solving for i_t subject to the assumed structure of the economy produces:

$$\begin{aligned}
i_t = & \frac{cI(\mathbf{b} + dt) + \mathbf{a}yt}{c(\mathbf{b} + dt)^2 + (yt)^2} y_t + \frac{c(\mathbf{b} - d)(\mathbf{b} + dt) + yt}{c(\mathbf{b} + dt)^2 + (yt)^2} \mathbf{p}_t \\
& + \frac{cd(\mathbf{b} + dt)}{c(\mathbf{b} + dt)^2 + (yt)^2} e_{t-1} - \frac{cdg(\mathbf{b} + dt) + y^2gt}{c(\mathbf{b} + dt)^2 + (yt)^2} fx_t
\end{aligned}$$

(43)

Notice that in (43) the interest rate responds to the lagged value of the nominal exchange rate and to the level of intervention in the foreign exchange market.

Ball (1998) holds that “In open economies, inflation targets and Taylor rules are suboptimal unless they are modified in important ways. Different rules are required because monetary policy affects the economy through exchange-rate as well as interest-rate channels” (p. 1). The interest-rate rule in equation (43) -- assuming zero intervention in the foreign exchange market -- differs from a standard Taylor rule, because it includes the exchange rate lagged one period. This term captures the effect of the exchange rate on inflation that Ball (1998) considers the source of suboptimality of the standard Taylor rule in open economies.²

The case where $c=0$ generates the following Taylor rule:

$$i_t = \frac{\mathbf{a}}{yt} y_t + \frac{1}{yt} \mathbf{p}_t - \frac{\mathbf{g}}{t} fx_t$$

(44)

Strict Inflation Targeting

In this case, we define strict inflation targeting as follows:

$$E_t(\mathbf{p}_{t+1}) = 0.$$

(45)

Substituting equation (36) into the inflation targeting definition results in the following expression:

$$\mathbf{p}_t + \mathbf{a}y_t - yt_i - ygfx_t = 0.$$

(46)

² How equation (43) compares to Ball’s rule based on a monetary condition index in terms of optimality is beyond the scope of this paper.

Solving for i_t yields an expression equivalent to equation (44):

$$i_t = \frac{\mathbf{a}}{\mathbf{y}t} y_t + \frac{1}{\mathbf{y}t} \mathbf{p}_t - \frac{\mathbf{g}}{t} f x_t .$$

(47)

In equations (44) and (47), the lagged exchange rate term does not appear, so as Ball (1998) argues, strict inflation targeting may not be optimal in an open economy. Whether the reaction of the interest rate rule to foreign exchange intervention is consistent with inflation targeting is analyzed below.

Flexible Inflation Targeting

As discussed by Ball (1998), monetary policy in this model can control inflation period by period. In this context, the definition of flexible inflation targeting (i.e., $E_t \pi_{t+2} = \theta E_t \pi_{t+1}$) does not determine a unique policy rule. Hence, it is not possible to identify the Taylor rule equivalent to flexible inflation targeting in this model. Ball (1998) proposes, however, that targeting long-run inflation defined as $\mathbf{p}_t^L = \mathbf{p}_t - \mathbf{y}e_{t-1}$ makes possible to obtain an operative definition of flexible inflation targeting. Substituting this definition of inflation in equations (40) and (41) yields:

$$y_{t+1} = -(\mathbf{b} + \mathbf{d}t)i_t + (\mathbf{b} - \mathbf{d})\mathbf{p}_t^L + \mathbf{l}y_t + [\mathbf{d} + (\mathbf{b} - \mathbf{d})\mathbf{y}]e_{t-1} , \quad \text{and}$$

$$-\mathbf{d}\mathbf{g}x_t + \mathbf{e}_{t+1} + \mathbf{d}\mathbf{n}_{t+1}$$

(48)

$$\mathbf{p}_{t+1}^L = \mathbf{p}_t^L + \mathbf{a}y_t + \mathbf{h}_{t+1} .$$

(49)

The definition of flexible inflation targeting is now cast in terms of long-run inflation:

$$E_t (\mathbf{p}_{t+2}^L) = \mathbf{q}E_t (\mathbf{p}_{t+1}^L) .$$

(50)

Making the appropriate substitutions into equation (50) and solving for i_t produces:

$$\begin{aligned}
i_t = & \left[\frac{(1-q)}{(b+dt)} + \frac{l}{(b+dt)} \right] y_t + \left[\frac{(1-q)}{a(b+dt)} + \frac{(b-d)}{(b+dt)} \right] p_t^L \\
& + \left[\frac{d+(b-d)y}{(b+dt)} \right] e_{t-1} - \left[\frac{dg}{(b+dt)} f_{x_t} \right]
\end{aligned}
\tag{51}$$

If we define:

$$(1-q) = \frac{a^2}{c+a^2} \text{ or } q = \frac{c}{c+a^2},$$

and substitute this expression into equation (51), we obtain an equation equal to the one derived by minimizing the expected loss function $E_t(L) = cE_t(y_{t+1})^2 + E_t(p_{t+2}^L)^2$ with respect to i_t subject to the assumed structure of the economy. The value of θ is equal to that derived in the closed economy model.

What is important to highlight, however, is that this result does not change the fact that intervention in the foreign exchange market appears as a variable in the interest rate rule.

Taylor Rules and Inflation Targeting with Systematic Intervention in the Foreign Exchange Market

Equations (43), (44), and (47) show that systematic intervention in the foreign exchange market to decrease the rate of depreciation of the nominal exchange rate reduces the response of the interest rate to deviations in output and inflation from their mean values. In contrast to the crawling peg case, intervention in the foreign exchange market appears as an explicit variable in the Taylor rule instead of affecting its parameters.

Again, the reduced response of the interest rate is a result that one can intuitively expect. If a policymaker that observes a positive gap between actual and target inflation chooses to moderate the rate of depreciation of the nominal exchange rate through direct intervention in the foreign exchange market, then she wants to avoid a direct tightening of monetary policy to close this gap. This diminished response of the interest rate, however, generates pressures on the inflation rate by increasing aggregate demand and on the

nominal exchange rate to depreciate, thus reducing the credibility of the anti-inflation stance of monetary policy. Therefore, policymakers concerned with the effects of the behavior of the exchange rate on the inflation target should adopt a monetary policy strategy that adjusts the interest rate to changes in the nominal exchange rate, and avoids direct intervention in the foreign exchange market.

Intervention in the foreign exchange market under inflation targeting has received some attention lately. In an inflation targeting seminar organized by the Bank of Mexico (March 4-5, 2002), a panel discussion was held on this topic. The participant from the Central Bank of Chile argued that central banks that choose to intervene in the foreign exchange market in the context of inflation targeting should not compromise the credibility of the policy regime. In general, the panel agreed that non-systematic and pre-defined (in time and amount) intervention to attenuate fluctuations of the exchange rate due to factors not directly related to fundamentals can occur along with inflation targeting. Very occasional interventions in a context where fundamentals are robust, may signal to economic agents the policymakers' perception that strong movements of the nominal exchange rate are not justified. For example, policymakers in country A may decide to intervene in the foreign exchange market for a very short time and in a limited amount, if they perceive that a financial crisis in country B is causing a strong depreciation of its currency that they do not think accords with the fundamentals of country A's economy. Also, rules to control volatility of the nominal exchange rate should be designed and monitor carefully to avoid systematic intervention and its consequences on the consistency of monetary policy. The problem for inflation targeting emerges when what should be occasional interventions turn systematic, because it is not possible to distinguish when fundamentals and non-fundamentals factors are driving the foreign exchange market.

5.- Conclusions

This paper uses a model similar to that developed by Ball (1998) to analyze how the attempt to influence directly the behavior of the nominal exchange rate affects the conduct monetary policy under a Taylor rule and inflation targeting.

In section 3, I extend Ball's (1998) model to an open economy with a crawling exchange rate regime. In this case, the policymakers have explicit targets for the nominal exchange rate that require a certain – endogenous – level of intervention. In this model, the parameters of the optimal nominal interest rate rule depend positively on the rate of the crawling peg (Ω). This implies that setting a relatively low value of Ω to reduce inflation towards some target value, decreases the level of the interest rate for a given deviation of output and inflation with respect to their means. This, in turn, generates pressures on aggregate demand and international reserves.

In section 4, I extend Ball's (1998) model to include systematic intervention of the monetary authority in the foreign exchange market to moderate the rate of depreciation of the nominal exchange rate. In this case, policymakers do not have nominal exchange rate targets, but in trying to control what they consider high rates of depreciation, their intervention actions become systematic. We show that intervention reduces the response of the interest rate to deviations in output and inflation from their mean values. This decreased response of the interest rate generates pressures on aggregate demand and the nominal exchange rate to depreciate, thus reducing the credibility of the anti-inflation stance of monetary policy.

The main conclusion of the paper is that a conflict exists between the implementation of a Taylor rule or inflation targeting, and systematic intervention in the foreign exchange market. Policymakers should know that such potential conflicts may arise in attempts to implement an independent monetary policy while simultaneously trying to control the behavior of the nominal exchange rate. Thus, our results formalize the notion

that a monetary policy based on a Taylor rule or inflation targeting requires a fairly “clean” flexible exchange rate regime. This issue is relevant because as Calvo and Reinhart (2000) point out “fear of floating” is a generalized problem. They argue, however, that in many countries, interest rate policy replaces foreign exchange intervention as the preferred means of smoothing exchange rates.³ Nevertheless, the temptation to intervene directly to reduce volatility may still be present. Calvo and Reinhart (2000) hold: “In the context of less-than-freely-floating exchange rates, purchases and sales of international reserves are routinely a means for smoothing exchange rate fluctuations (often, alongside interest rate policy, as discussed)” (p. 10).

Recently, some economists argue, however, that non-systematic intervention in the foreign exchange market may be compatible with inflation targeting. On this issue, central banks that have adopted inflation targeting should evaluate carefully, given the specific characteristics of their respective economies, intervention strategies that do not erode the credibility of the monetary policy regime. In particular, central banks adopting inflation targeting without a strong reputation may stifle the effectiveness of the scheme, if they embark very early in exchange rate smoothing through direct intervention in the foreign exchange market.

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³ In an inflation targeting regime excessive response to exchange rate fluctuations may also generate some problems. This subject, however, lies beyond the scope of this paper.

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