



**“WITHOUT NEGLECTING THE  
ECONOMIC GROWTH:  
MONETARY POLICY,  
CREDIBILITY, AND  
INFLATION TARGETING IN AN  
IS-MP MODEL”**

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# **Without Neglecting the Economic Growth: Monetary Policy, Credibility, and Inflation Targeting in an IS-MP Model**

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## **Abstract**

This article shows the effect caused by credibility on interest rate settings in an economy with inflation targeting. With this intention, it is presented a theoretical model which aims at showing the implications of credibility for an optimal monetary policy strategy (through interest rate settings) implemented by an inflation targeting central bank. It is argued that when credibility increases it requires smaller interest rate variations in order to control inflation and keep it converging to the target. In addition, this study analyzes the impacts of credibility and monetary policy through interest rate settings, on investment and, consequently, on output equilibrium. The findings indicate that when credibility is high (low) the public is inclined to behave forward-looking (backward-looking). Concerning inflation targeting strategy, a forward-looking behavior suggests that inflation expectations are more anchored to the inflation target meaning that the strategy is serving its ends. Last but not least, a high credibility implies a low crowding out effect, which in turn contributes to a more efficient fiscal policy (less loss in the output due to an increase in the interest rate).

**Key words:** inflation targeting, monetary policy, interest rate, credibility, output.

JEL classification: E42, E52.

## 1. Introduction

Macroeconomic theory is moving toward a new consensus regarding the role of monetary policy and how central banks should act considering a world surrounded by uncertainties.<sup>1</sup> Since the contributions of Friedman (1968), Kydland and Prescott (1977) and Barro and Gordon (1983a and 1983b), central banks attempt to act through rule-based policies in order to avoid the problems of time inconsistency and loss of credibility as well as to reduce uncertainties.

The concept of credibility is controversial and has different interpretations in economic literature. According to Blackburn and Christensen (1989), credibility can be understood as beliefs about the current and future courses of the economic policies, which are consistent with the program originally announced by policymakers. Drazen (2000) presents two distinct concepts about credibility: the credibility of the policymaker and the credibility of the policy. The first means that the policymaker will attempt to do exactly what he says, while the second could be thought of as the expectation that policy will be carried out.

In a general way, monetary policy is considered credible if the central bank follows a rule (or a strategy) which is not subject to the dynamic inconsistency problem. Taking into consideration an inflation targeting system, the public's expectations have a crucial role. In practice, the most used anti-inflationary political rule has been the announcement of intervals for inflation fluctuation.

In order to improve credibility and thus the ability to guide public's expectations, the central bank attempts to develop and strength its reputation. The basic idea is that with a high reputation, the accuracy of the public's inflation forecast is improved and, as a consequence, central bank's accountability is increased. In other words, reputation and credibility can considerably ameliorate the effectiveness of monetary policy since they increase the confidence of the public on expectations regarding future central bank's actions. As pointed out by Drazen (2000, p. 168):

“A better way of thinking about reputation is in terms of an inference problem in forming expectations of a policymaker's future actions. (...) Since we make inferences about future behavior based on what has been observed in the past, the focus is on how past observed actions lead one to expect future behavior of a given sort, that is, serve to build a reputation for future actions.”

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<sup>1</sup> For an analysis of this literature, see Goodfriend and King (1997), Svensson, (1999a, 1999b, 2003), Woodford (2007), and Goodfriend (2007).

Due to the fact that the central bank can influence the forward-looking behavior of the public in order to affect the economic performance through its policies, reputation performs a relevant role in this framework. Under this perspective, policy signals from credible monetary authorities (with high reputations) will be better understood by the public implying a more effective monetary transmission mechanism (through expectations) and a lower cost of disinflation.

This article shows the effect caused by credibility on interest rate settings in an economy with explicit inflation targeting. As Goodfriend (2007, p. 63) stressed: “credibility must anchor inflation expectations so that a central bank can manipulate real interest rates reliably with a nominal interest rate policy instrument to manage aggregate demand”. In this sense, it is presented a theoretical model which aims at showing the implications of credibility for an optimal monetary policy strategy – through interest rate settings – implemented by an inflation targeting central bank. It is argued that when credibility increases it requires smaller interest rate variations in order to control inflation and keep it converging to the target. Moreover, this study also analyzes the impacts of credibility and monetary policy through interest rate settings, on investment and, consequently, on output equilibrium.

The remainder of this article is organized in the following way. The second section presents the importance of credibility for monetary policy. The third section approaches the role of inflation targeting central banks, presents a model regarding the role of monetary policy through an optimal interest rate strategy under an explicit flexible inflation targeting regime, and analyzes the influence of credibility for this optimal policy. The fourth section presents the implications of credibility and the optimal monetary policy for the output equilibrium, highlighting the behavior of aggregate demand. Finally, the fifth section presents the concluding remarks.

## **2. Inflation targeting features**

In contrast to simple policy rules, the inflation targeting allows the central bank to use the instruments together with all relevant information to achieve the target. Furthermore, this monetary regime enables the use of discretionary policies without implying a loss of credibility. In other words, inflation targeting represents a case where there is constrained discretion, as pointed out by Bernanke (2003, p. 2):

“Under constrained discretion, the central bank is free to do its best to

stabilize output and employment in the face of short-run disturbances, with the appropriate caution born of our imperfect knowledge of the economy and of the effects of policy (this is the "discretion" part of constrained discretion). However, a crucial proviso is that, in conducting stabilization policy, the central bank must also maintain a strong commitment to keeping inflation – and, hence, public expectations of inflation – firmly under control (the ‘constrained’ part of constrained discretion).”

The new macroeconomic consensus implies that the effect caused by monetary policy management on real activity may not be neglected. Goodfriend and King (1997) highlight both positive and normative implications. In relation to the positive view, economic fluctuations are associated with monetary policy. Based on normative perspective, aggregate demand must be managed by monetary policy in order to reach efficient macroeconomic outcomes.

In short, nowadays a set of characteristics is considered essential for a good performance of central banks in the conduction of the monetary policy, which in turn strengthens the choice of an inflation targeting regime as a nominal anchor. Mishkin (2000) highlights seven points: (i) price stability should be the overriding, long-run goal of monetary policy; (ii) an explicit nominal anchor should be adopted; (iii) a central bank should be goal dependent; (iv) a central bank should be instrument independent; (v) a central bank should be accountable; (vi) a central bank should stress transparency and communication, and; (vii) a central bank should also have the goal of financial stability.

Inflation targeting regime has as its main feature the official announcement of ranges for inflation fluctuations and the explicit recognition that the main objective of the monetary policy is to assure a low and stable inflation rate. Moreover, this monetary regime contributes to reduce uncertainties about the goals and instruments of monetary policy without precluding policy activism, and provides a strategy that allows for the pursuit of objectives other than price stability in a more disciplined and consistent manner. Inflation targeting helps to reduce uncertainty about the future course of inflation and guides expectations because it provides monetary policy with a nominal anchor and improves the central bank transparency.<sup>2</sup>

Since inflation targeting represents a strategy concerned with bringing both inflation and inflation expectations to the announced target as well as reducing the

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<sup>2</sup> For an analysis regarding inflation targeting, central bank transparency and their effects on interest rate, see de Mendonça and Simão Filho (2007), Montes (2008), and Oreiro and Neves (2008).

uncertainties and both sacrifice ratios and output volatility, this framework pushes central banks to develop credibility in order to improve the public's expectations. Hence, it is expected that credible inflation targets strengthen forward-looking behavior on the estimation of inflation and thus weaken the weight of past inflation. In other words, inflation expectations play a fundamental role in this environment.

Therefore, based on an inflation targeting system, credibility is crucial for its success, because it helps increasing the speed of convergence of inflation expectations to the inflation target. Notwithstanding, it is important to note that credibility is built over time. As a consequence, inflation targeting will not reduce inflation expectations quickly, but rather it will do so gradually over time.

### 3. Optimal interest rate rule under inflation targeting

Aiming at analyzing the consequence of the credibility on public's expectations and thus on monetary policy, a theoretical model is developed in order to present the interest rate setting by the central bank in the management of the monetary policy taking into account an explicit flexible inflation targeting regime.<sup>3</sup>

A first step in the model is to show how the output ( $y$ ) is influenced by the real interest rate ( $r$ ) and by the expectations of the public regarding output variation ( $E(\Delta y)$ ). Therefore, it is assumed that

$$(1) \quad y_t = A + E_{t-1}(\Delta y_t) - \delta r_{t-1}, \quad \delta > 0$$

where  $A$  is the sum of exogenous multiplied-up demands.

It is important to highlight that a divergence between the expected interest rate and the equilibrium interest rate implies non-negligible effects on output expectations. When the expected interest rate is lower than the equilibrium interest rate, the effect on the expected output variation is positive (the contrary is also true). Hence,

$$(2) \quad E_{t-1}(\Delta y_t) = X_{t-1} - b[E_{t-1}(r_t) - r^*],$$

where,  $X$  is a vector of explanatory variables.

The model considers the possibility of difference between the current output and the potential output ( $y^*$ ). In equilibrium, the effects caused by expectations are

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<sup>3</sup> Recent empirical analysis for the Brazilian case shows that higher credibility implies lower variations in the interest rate for controlling inflation (see de Mendonça, 2007; and de Mendonça and de Guimarães e Souza, G.J., 2009).

negligible and the output is defined by the interest rate that equalizes  $y$  to  $y^*$ , that is,

$$(3) \quad y^* = A - \delta r^*.$$

Taking into account equations (1) and (3), the output gap is given by

$$(4) \quad y_t - y^* = E_{t-1}(\Delta y_t) - \delta(r_{t-1} - r^*).$$

The interpretation of the equation above is that the output gap depends on both divergences between the expected real interest rate and the equilibrium interest rate (see equation 2) and between observed interest rate of the previous period and the equilibrium interest rate.

In this model the private economy is represented by an augmented Phillips curve (backward-looking) with inflation inertia effects. Moreover, the Phillips curve equation represents a constraint to the model and reveals the trade-off between inflation and output gap.

$$(5) \quad \pi_t = \theta \pi_{t-1} + (1-\theta)E_{t-2}(\pi_t) + \alpha(y_{t-1} - y^*) + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma^2), 0 < \theta < 1 \text{ and } \alpha > 0.$$

According to equation (5), inflation at  $t$  ( $\pi_t$ ) depends on: past inflation (inertia); inflation expectation built at  $t-2$  for inflation at period  $t$ ; and the output gap at period  $t-1$  which means that if the central bank intends to reduce inflation, the cost of disinflation is not negligible.<sup>4</sup>

The model assumes that the social welfare function is given by the central bank loss function, suggesting that the central bank is concerned with inflation and output. Hence,

$$(6) \quad L = \frac{1}{2}(\pi_{t+1} - \pi^T)^2 + \frac{\lambda}{2}(y_t - y^*)^2 \quad \text{where, } \lambda > 0$$

$\lambda$  represents the weight central bank gives to output gap.

The justification for the use of the “double lag” timing assumptions and hence  $\pi_{t+1}$  match the view of the Bank of England (1999). According to Carlin and Soskyce (2006, p. 153): “The double lag structure (...) emphasizes that a decision taken today by the central bank to react to a shock will only affect the inflation rate two periods latter (...). When the economy is disturbed in the current period (period zero), the central bank looks ahead to the implications for inflation and sets the interest rate so as to determine  $y_t$ , which in turn determines the desired value of  $\pi_2$ .” Since the central

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<sup>4</sup> The option for a linear Phillips curve rather than a non-linear or an asymmetric one is sufficient for the purpose of this article. Hence, it is important to clarify that its simplicity does not affect the results of this model.

bank can only choose  $y_t$  and  $\pi_2$  by its interest rate decision, its loss function takes the form presented through equation (6).

With the objective to find the optimal monetary policy, the substitution of equation (5) into equation (6) is made and the result is minimized with respect to  $y_t$ , that is,  $\frac{\partial L}{\partial y_t} = \alpha(\pi_{t+1} - \pi^T) + \lambda(y_t - y^*) = 0$ . Thus, the optimal monetary rule corresponds to

$$(7) \quad (\pi_{t+1} - \pi^T) = -\frac{\lambda}{\alpha}(y_t - y^*).$$

Making use of equation (5) the above equation becomes

$$(8) \quad (y_t - y^*) \left( -\alpha - \frac{\lambda}{\alpha} \right) = [\theta\pi_t + (1-\theta)E_{t-1}(\pi_{t+1}) - \pi^T].$$

Taking into consideration equations (4) and (5) the result above may be rewritten as:

$$(9) \quad \left( -\alpha - \frac{\lambda}{\alpha} \right) [E_{t-1}(\Delta y_t) - \delta(r_{t-1} - r^*)] = \\ \left[ \theta[\theta\pi_{t-1} + (1-\theta)E_{t-2}(\pi_t) + \alpha(y_{t-1} - y^*)] + (1-\theta)E_{t-1}(\pi_{t+1}) - \pi^T \right].$$

Rearranging the equation above to find optimal interest rate strategy, then

$$(10) \quad r_{t-1} - r^* = \\ \frac{E_{t-1}(\Delta y_t)}{\delta} + \left( \frac{\alpha}{\delta(\alpha^2 + \lambda)} \right) \left\{ [(1-\theta)[E_{t-1}(\pi_{t+1}) + \theta E_{t-2}(\pi_t)] + \theta^2 \pi_{t-1} - \pi^T] + \theta \alpha (y_{t-1} - y^*) \right\}.$$

Since the current interest rate affects the economy with lags, and that this effect on output occurs before the effect on inflation due to the transmission mechanism of monetary policy, the loss function may be rewritten as

$$L = \frac{\lambda}{2}(y_{t+1} - y_e)^2 + \frac{1}{2}(\pi_{t+2} - \pi^T)^2, \text{ which in turn, implies that the previous equation}$$

corresponds to

$$(11) \quad (r_t - r^*) = \\ \frac{E_t(\Delta y_{t+1})}{\delta} + \left( \frac{\alpha}{\delta(\alpha^2 + \lambda)} \right) \left\{ [(1-\theta)[E_t(\pi_{t+2}) + \theta E_{t-1}(\pi_{t+1})] + \theta^2 \pi_t - \pi^T] + \theta \alpha (y_t - y^*) \right\}, \text{ or}$$

$$(r_t - r^*) = \\ \gamma E_t(\Delta y_{t+1}) + \tau \left\{ [(1-\theta)[E_t(\pi_{t+2}) + \theta E_{t-1}(\pi_{t+1})] + \theta^2 \pi_t - \pi^T] + \theta \alpha (y_t - y^*) \right\}$$

$$\text{where, } \left( \frac{\alpha}{\delta(\alpha^2 + \lambda)} \right) = \tau \text{ and } \frac{1}{\delta} = \gamma.$$

The equation above represents an optimal interest rate response for an inflation targeting central bank (MP curve in the model).<sup>5</sup> It captures the idea stated by Zimmermann (2003) that the central bank uses all available information regarding current and future courses of both inflation and the real side of the economy in an attempt to stabilize inflation and the output gap at the same time. Furthermore, it is important to note that due to the lagged effects of monetary policy, the central bank, for instance, needs to react to inflation forecasts. If the inflation forecast indicates that inflation will rise, the central bank should raise interest rate before actual inflation start to rise and vice-versa.

The interest rate strategy represented by equation (11) specifies the magnitude in which the interest rate must be changed in reaction to changes in inflation rate, inflation expectations, expectations of future output change, and output gap. Moreover, when a decrease in inflation followed by temporary output losses is a result of central bank's responses, the interest rate rule is optimal in the sense that marginal utility and marginal cost of monetary policy actions are equalized.

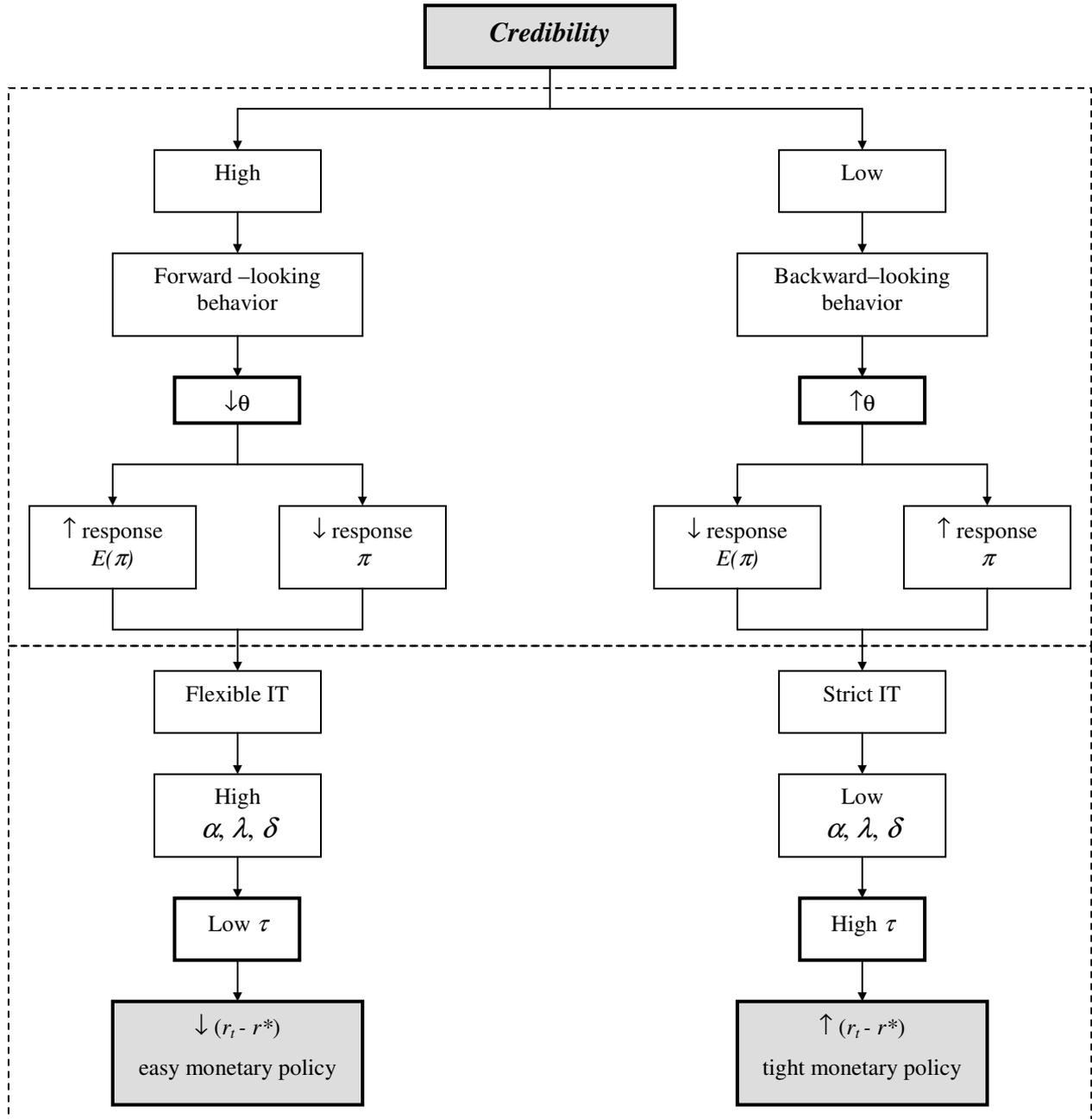
Equation (11) allows observing important implications for the analysis regarding the effects from credibility to the optimal monetary policy. In this sense, the parameters  $\theta$  and  $\tau$  play a crucial role in this analysis (scheme 1 shows the cases of low and high credibility and its implications for the monetary policy management). When there exists a high (low) credibility the public will behave based on a forward-looking (backward-looking) manner. Thus, taking into consideration  $\theta$ , it is observed that a smaller (larger) value implies that inflation expectations become more relevant than current inflation for the interest rate response.

It is important to stress that a high credibility allows the central bank takes into account in its reaction function both departures of inflation from inflation target and output gap. In other words, the central bank's behavior is closer to flexible inflation targeting strategy than strict inflation targeting strategy (see scheme 1). Due to a strategy close to flexible inflation targeting (strict inflation targeting) implies high (low) values of  $\alpha$ ,  $\lambda$ , and  $\delta$ , the consequence is a low (high)  $\tau$ . In brief, a low (high) value of  $\tau$  implies a weak (strong) reaction of interest rate.

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<sup>5</sup> MP curve is the central bank reaction as suggested by Romer (2000).

**Scheme 1**  
*Effects from credibility*



#### 4. Aggregate demand, equilibrium, and monetary policy

In order to understand how the monetary policy affects aggregate demand, the determination of consumption and investment are fundamental (Romer, 2001). Therefore, investment and consumption functions are presented and the output equilibrium is analyzed taking into consideration two distinct cases: (i) credibility being

built - as a consequence, it takes more time and effort to stabilize the economy (low credibility), and; (ii) developed credibility – therefore the task of monetary policy becomes easier and with less costs for the society (high credibility).

#### 4.1. Investment, consumption, and equilibrium

The model of aggregate demand is based on Fazzari, Ferri and Greenberg (2008). In this sense, the basic investment function is given by

$$(12) \quad I_t = \eta_0 y_{t-1} + \eta_1 [E_{t-1}(y_t) - y_{t-1}] + \eta_2 \left( \frac{1}{E_t(p_{t+1})} \right) [E_t(CF_{t+1})] - \eta_3 r_t,$$

where:

$I_t$  represents the real level of investment that is realized at the end of period  $t$ . The term  $\eta_0 y_{t-1}$  can be interpreted as replacement investment, assuming geometric depreciation and a constant capital-output ratio (with a depreciation rate of  $v$  and a capital-output ratio of  $\varphi$ , and  $\eta_0 = v\varphi$ ). The term  $\eta_1 [E_{t-1}(y_t) - y_{t-1}]$  follows from the accelerator model, where the accelerator relates the real level of investment to the expected change in real output between period  $t$  and  $t-1$  concerning information at  $t-1$ . The term  $\eta_2 \left( \frac{1}{E_t(p_{t+1})} \right) [E_t(CF_{t+1})]$  represents the influence of expected nominal cash flow, that is, the expected availability of internal resource, for the investments; the expected nominal cash flow  $E_t(CF_{t+1})$  is deflated by the expected price level  $E_t(p_{t+1})$  to correspond to real investment.<sup>6</sup> The term  $(-\eta_3 r)$  follows from the traditional relation between real interest rate and investment.<sup>7</sup>

Considering  $g_t^e = \frac{E_{t-1}(y_t) - y_{t-1}}{y_{t-1}}$  as the expected economic growth rate between

period  $t-1$  and  $t$ , thus equation (12) can be rewritten as,

$$(13) \quad I_t = \eta_0 y_{t-1} + \eta_1 g_t^e y_{t-1} + \eta_2 \left( \frac{1}{E_t(p_{t+1})} \right) [E_t(CF_{t+1})] - \eta_3 r_t.$$

It is important to note that the expected nominal cash flow results from the

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<sup>6</sup> As Fazzari, Ferri and Greenberg (2008, p. 559) pointed out: “Greater cash flow raises the amount of investments that firms can undertake without incurring the risks and costs associated with debt or new share issues”.

<sup>7</sup> It is important to stress that different from the case which the interest rate affects the output with a lag, the actual interest rate is relevant for current investment decisions.

difference between the expected nominal revenue [ $E_t(p_{t+1})E_t(y_{t+1})$ ] and the expected wage bill [ $E_t(W_{t+1})$ ] added to the expected nominal interest costs [ $E_t(R_{t+1})D_{t+1}$ ], then,<sup>8</sup>

$$(14) \quad E_t(CF_{t+1}) = E_t(p_{t+1})E_t(y_{t+1}) - E_t(W_{t+1}) - E_t(R_{t+1})D_{t+1}.$$

Assuming a constant wage share in expected nominal aggregate income denoted by  $w$ , this implies that  $E_t(W_{t+1}) = w[E_t(p_{t+1})E_t(y_{t+1})]$ , and thus the equation above corresponds to,<sup>9</sup>

$$(15) \quad E_t(CF_{t+1}) = (1-w)[E_t(p_{t+1})E_t(y_{t+1})] - E_t(R_{t+1})D_{t+1}.$$

Making the substitution of (15) into (13), the investment function becomes,

$$(16) \quad I_t = \eta_0 y_{t-1} + \eta_1 g_t^e y_{t-1} + \eta_2 (1-w) E_t(y_{t+1}) - \eta_2 E_t(R_{t+1}) \frac{D_{t+1}}{E_t(p_{t+1})} - \eta_3 r_t.$$

Rewriting the investment function in an intensive form, then

$$(17) \quad i_t = \frac{I_t}{Y_{t-1}} = \eta_0 + \eta_1 g_t^e + \eta_2 (1-w) \frac{E_t(y_{t+1})}{y_{t-1}} \left( \frac{y_t}{y_t} \right) - \eta_2 E_t(R_{t+1}) \frac{D_{t+1}}{E_t(p_{t+1}) y_{t-1}} - \eta_3 r_t.$$

Due to the fact that,  $\frac{E_t(y_{t+1})}{y_t} = (1 + g_{t+1}^e)$  and  $\frac{y_t}{y_{t-1}} = (1 + g_t)$ , equation (17) becomes

$$(18) \quad i_t = \eta_0 + \eta_1 g_t^e + \eta_2 (1-w)(1 + g_{t+1}^e)(1 + g_t) - \eta_2 E_t(R_{t+1}) \frac{D_{t+1}}{E_t(p_{t+1}) y_{t-1}} - \eta_3 r_t.$$

Assuming the ratio of beginning of period nominal debt to lagged nominal income, then  $d_t = \frac{D_t}{p_{t-1} y_{t-1}}$  and, consequently,  $d_{t+1} = \frac{D_{t+1}}{p_t y_t}$ . As a consequence, the investment equation in its intensive form may be written as

$$(19) \quad i_t = \eta_0 + \eta_1 g_t^e + \eta_2 (1-w)(1 + g_{t+1}^e)(1 + g_t) - \eta_2 E_t(R_{t+1}) d_{t+1} \frac{p_t y_t}{E_t(p_{t+1}) y_{t-1}} - \eta_3 r_t$$

$$i_t = \eta_0 + \eta_1 g_t^e + \frac{y_t}{y_{t-1}} \left[ \eta_2 \mu (1 + g_{t+1}^e) - \eta_2 E_t(R_{t+1}) d_{t+1} \frac{p_t}{E_t(p_{t+1})} \right] - \eta_3 r_t,$$

where it is assumed that  $\mu = 1 - w$  and  $\frac{y_t}{y_{t-1}} = (1 + g_t)$ .

Based on equation (19), while an increase in expected growth rate contributes to an increase in investment, an increase in real interest rate reduces it. The terms between

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<sup>8</sup> Where ( $D_{t+1}$ ) is the predetermined nominal stock of debt outstanding at the beginning of period  $t+1$ , that is,  $D_{t+1} = D_t(1+r_t) + p_t I_t - CF_t$ .

<sup>9</sup> This assumption, according to Fazzari, Ferri and Greenberg (2008), is consistent with a fixed mark-up model of pricing that arises from monopolistic competition.

brackets deserve the following observations:

(i) Since  $d_{t+1} = \frac{D_{t+1}}{p_t y_t}$  and,  $D_{t+1} = D_t(1+R_t) + p_t I_t - CF_t$ , then,  $d_{t+1}$  is known in period  $t$  and

affects investments inversely in this period;

(ii) When  $g_{t+1}^e$  raises, investments increase, and when  $y_t$  increases,  $d_{t+1}$  decreases;

(iii) With respect to the ratio  $\frac{p_t}{E_t(p_{t+1})}$ , it is assumed that when  $E_t(p_{t+1})$  increases,  $p_t$

raises by a larger proportion, and then investments reduce. It happens because, based on higher expectations about future prices, the private sector starts a defensive process in regards to present income by raising its prices, which leads to a generalized increase of current prices, and then of  $p_t$  in a higher proportion than  $E_t(p_{t+1})$ . This situation creates uncertainties in the economy which cause investment reductions. In addition, when  $p_t$  starts to increase (leading to an acceleration of the inflation rate) the public creates expectations for a higher real interest rate because it knows that the monetary authority will react (raising the nominal interest rate) against the inflationary process, as well as against the deterioration of inflation expectations, if both threaten the inflation target; hence,  $E_t(R_{t+1})$  will also increase.

In order to express the multiplier effect, a simple consumption function, where aggregate disposable income ( $y_t - \psi y_t$ ) explains aggregate consumption expenditures, is presented. In this function  $C_0$  represents the autonomous consumption and  $C_1$  the average marginal propensity to consume, hence:

$$(20) \quad C_t = C_0 + C_1(y_t - \psi y_t), \text{ where, } C_0 > 0, 0 < C_1 < 1, \text{ and } 0 < \psi < 1.$$

It is considered that output is determined by demand and the equilibrium is given by,<sup>10</sup>

$$(21) \quad y_t = C_t + I_t + A_t.$$

Substituting (20) into (21) and dividing the result by lagged output, then

$$(22) \quad 1 + g_t = \frac{y_t}{y_{t-1}} = \frac{C_0 + C_1(y_t - \psi y_t)}{y_{t-1}} + i_t + a_t.$$

Making the substitution of equation (19) into (22), the result is given by

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<sup>10</sup>  $A_t$  represents the sum of government expenditures (G) with net foreign expenditures (X-M) and thus  $A_t = G_t + X_t - M_t$ . For its turn,  $a_t = A_t/y_{t-1}$ ,  $c_0 = C_0/y_{t-1}$ , and it is assumed that net foreign income is zero.

$$(23) \quad \frac{y_t}{y_{t-1}} = \left[ \frac{1}{1 - \left( \eta_2 \mu (1 + g_{t+1}^e) - \eta_2 E_t(R_{t+1}) d_{t+1} \frac{p_t}{E_t(p_{t+1})} + C_1 - C_1 \psi \right)} \right] (\eta_0 + \eta_h g_t^e + a_t + c_0 - \eta_b r_t)$$

$$\frac{y_t}{y_{t-1}} = \left[ \frac{1}{1 - \left( \eta_2 \mu (1 + g_{t+1}^e) - \eta_2 E_t(R_{t+1}) d_{t+1} \frac{p_t}{E_t(p_{t+1})} + (1 - \psi) C_1 \right)} \right] (\eta_0 + \eta_h g_t^e + \beta_t - \eta_b r_t)$$

where  $\beta_t = a_t + c_0$ .

Equation (23) represents the IS curve in the model. The main causes of changes in the multiplier (the ratio between brackets) are: (i) the first term is  $[\eta_2 \mu (1 + g_{t+1}^e)]$  where an increase (decrease) in the expectation of future economic growth ( $g_{t+1}^e$ ) implies an increase (decrease) in the multiplier; (ii) the second term  $\left[ \eta_2 E_t(R_{t+1}) d_{t+1} \frac{p_t}{E_t(p_{t+1})} \right]$  indicates that when the price expectation is lower than the expectation concerning the nominal interest rate, the result is an increase in the expectation of the real interest rate which in turn implies an increase in the debt service of firms,<sup>11</sup> and then, a decrease in the multiplier; (iii) the third term  $[(1 - \psi) C_1]$  means that an increase (decrease) in the marginal propensity to consume or a decrease (increase) in taxation ( $\psi$ ) amplifies (reduces) the multiplier. It must be highlighted that these causes determine the slope of the IS curve.

Due to the relevance of credibility in the management of the monetary policy, expectations perform a crucial role in the model. Further, expectations are fundamental in the decision-making process of investment. Under this environment government announcements regarding public investments are capable of affecting expectations (for example, expected economic growth rate). Therefore, among the variables of equation (23),  $g_t^e$  becomes fundamental for explaining shifts of the IS curve.

Assuming that the government announces that will make new infrastructure investments, positive public's expectation regarding a sustainable economic growth is a consequence (meaning that  $g_t^e, g_{t+1}^e > 0$ ). Based on equation (23) whenever  $g_t^e$  increases there exists an increase in private investment ( $I_t$ ). This increase in aggregate investment

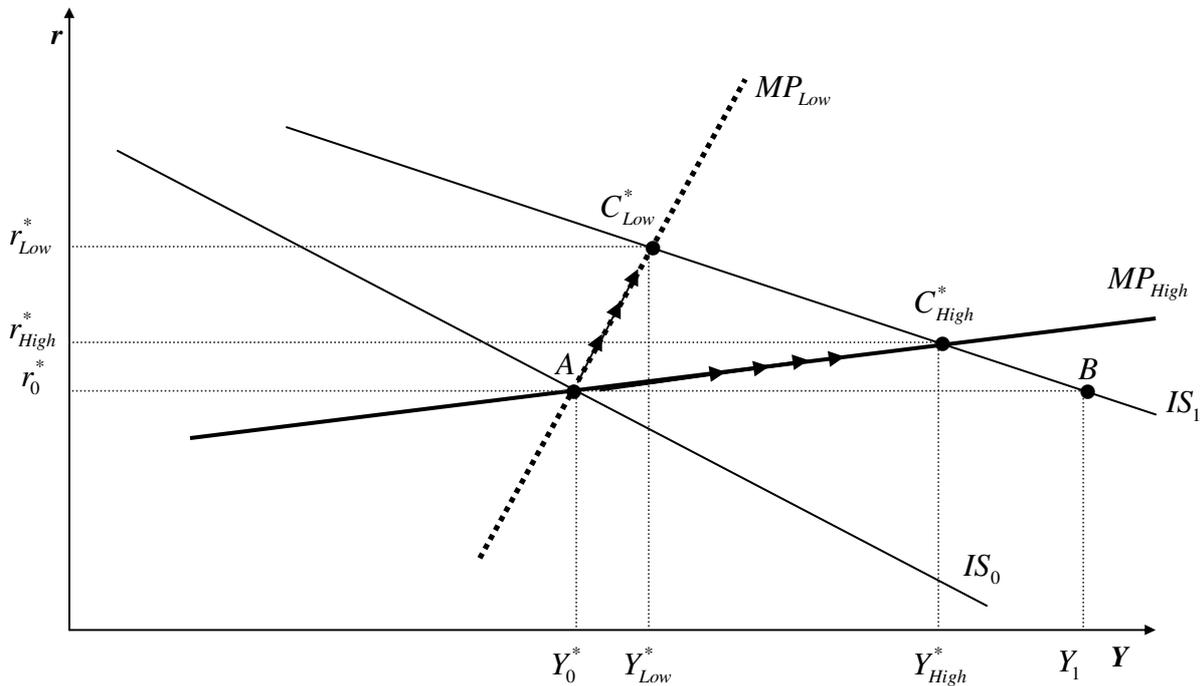
<sup>11</sup> It is assumed that the effect caused by the expected interest rate on the real interest rate is direct.

implies demand and productive capacity effects, affecting both output and inflation.

#### 4.2. Demand shocks, credibility, and growth

Assuming a positive shock on both  $g_t^e$  and  $g_{t+1}^e$  caused by government announcements of new infrastructure investment, the IS curve shifts for the right and becomes flatter promoting an increase in the aggregate demand. Therefore the economy moves from point A to point B (see figure 1). As a consequence of the demand effect an inflationary pressure is created (output –  $Y_1$  – is greater than the original potential output –  $Y_0^*$ ), which will imply a central bank reaction increasing the interest rate in order to mitigate this pressure. It must be noted that the magnitude of the central bank response depends on the level of its credibility (see scheme 1).

**Figure 1**  
*Effects of credibility on IS-MP model*



It is important to highlight that in contrast with the pattern models concerning the subject, this model considers that the crowding out effect is partial. The justification is that the capacity effect promotes an increase in the potential output (given by  $Y_{High}^*$  regarding  $MP_{High}$ , and  $Y_{Low}^*$  regarding  $MP_{Low}$ ) which determines the new interest rate of

equilibrium ( $r_{High}^*$  or  $r_{Low}^*$ , respectively). Hence, though the new equilibrium presents a higher interest rate, an economic growth is observed.

It must be stressed that the equilibrium can be changed due to different levels of credibility (high and low – determining points  $C_{High}^*$  and  $C_{Low}^*$ ). According to scheme 1, central bank's responses through interest rate are less aggressive when credibility is high (which means a flatter MP curve –  $MP_{High}$  – because the parameter  $\tau$  is lower). Therefore, through equation (23), if responses through interest rate are weaker, the impacts on output will be lower. It also suggests that both monetary policy and output are becoming less volatile. As a consequence, based on the analysis regarding the influence of credibility for the optimal monetary policy, as well as on equation (23) which models the output behavior, it is possible to argue in favor of the importance exerted by credibility for the output growth.

## 5. Conclusion

This study presented a theoretical analysis regarding the effects of credibility on the optimal monetary policy. The findings indicate that when credibility is high (low) the public is inclined to behave forward-looking (backward-looking). Concerning inflation targeting strategy, a forward-looking behavior suggests that inflation expectations are more anchored to the inflation target meaning that the strategy is serving its ends. In the case of high credibility, inflation expectations are more relevant than current and past inflation for the central bank's reaction. As a consequence, without abandoning the focus on price stability, the monetary policy is less tight than in the case of low credibility and thus the impact on the output is attenuated. Hence, when credibility is higher, both interest rate and output are less volatile.

This analysis also approaches the magnitude of the impacts of fiscal policies (announcements) on the economy taking into account the credibility of the monetary policy. Under this view, a high credibility implies a low crowding out effect, which in turn contributes to a more efficient fiscal policy (less loss in the output due to an increase in the interest rate).

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