Modified Taylor Rule for the Brazilian Economy: convention and conservatism in 11 years of inflation targeting (2000-2010)

André de Melo Modenesi
Institute of Economics at Federal University of Rio de Janeiro (IE/UFRJ)

Norberto Montani Martins
Institute of Economics at Federal University of Rio de Janeiro (IE/UFRJ)

Rui Lyrio Modenesi
Member of Brazilian Keynesian Association (AKB)

Modified Taylor Rule for the Brazilian Economy: convention and conservatism in 11 years of inflation targeting (2000-2010) [*]

September, 2012

André de Melo Modenesi

Associate professor in the Institute of Economics at Federal University of Rio de Janeiro (IE/UFRJ), researcher of the National Council for Scientific and Technological Development (CNPq) and Director of Brazilian Keynesian Association (AKB)

Norberto Montani Martins

Research assistant at IE/UFRJ, scholar of the International Celso Furtado Center for Development Policies, Master candidate in Economics at IE/UFRJ and Member of AKB.

Rui Lyrio Modenesi

Former associate professor in the Department of Economics at Fluminense Federal University (UFF), retired economist of Brazilian Development Bank (BNDES) and Member of AKB

Abstract

With the purpose of evaluating Brazilian Central Bank's (BCB) policy after the adoption of inflation targeting, we estimate a *modified* version of Taylor rule in the period 2000-2010. The term *modified* refers to an important innovation with regard to the reviewed literature: the inclusion of a proxy for international interest rate in the original equation. This study reinforces and expands results achieved by Modenesi (2011) and also provides as a novelty the evidence that BCB reacts to foreign interest rates when setting its basic rate (Selic). BCB has reduced autonomy: Selic is endogenous not only to domestic conditions (inflation and output gaps), but also to foreign interest rate (measured by Libor). The evidence provided might support the argument that BCB policy is ruled by a pro-conservative convention substantiated in the adoption of a Taylor rule containing three distinctive features: 1) high degree of interest rate smoothness; 2) high *pure domestic* equilibrium interest rate; and 3) high interest rate differential. Items 2) and 3) largely explain the overvaluation of real, a key element of price stabilization.

1   Introduction

Almost two decades after the launching of the Real Plan (RP), in mid-1994, and the achievement of price stability, a satisfactory reduction in Brazilian basic interest rate (hereafter referred to as Selic[1]) is yet to be seen. In fact, the country is known to lead the ranking of the world's highest interest rates.

Initially, the Central Bank of Brazil (BCB) used the need to offset current account deficit (4.3% of GDP in 1998) and, eventually, to preserve international reserves as a justification for maintaining Selic rate at a high level. The loose fiscal policy of President Cardoso's first term has also been cited as a cause of the rigidity in monetary policy.

The abandonment of the exchange rate anchor in 1999, the improvement in external accounts, and the adoption of a contractionary fiscal policy – with a primary surplus of around 3.5% of GDP – were expected to bring the basic interest rate down, but they proved to be not sufficient to cause a *substantial* decline in Selic nonetheless. The real Selic non-negligibly indeed fell over the period 2000-2010 to an average of 10% p.y.[2] However, it still remained at a very high level – almost four times the real basic interest rate of 2.7% p.y. on average practiced by developing countries over the same period. Therefore, one may affirm that BCB has been extremely conservative in setting Selic. The phenomena of Brazil's high interest rate have been offered many explanations. Among them we highlight the existence of a *convention*, in Keynesian terms, shared by the economic agents (BCB among them) justifying the long-lasting high levels of Brazilian interest rate and the overvaluation of real.

This paper aims at assessing the conduct of monetary policy after the introduction of a floating exchange rate regime and the adoption of inflation targeting (IT). More specifically, the main purpose is to estimate BCB's reaction function in the period 2000-

---

[1] In Brazil, the basic interest rate goes by the acronym (Selic) for Sistema Especial de Liquidação e de Custódia (Special System for Settlement and Custody), the settlement system for most domestic securities of Brazilian central government.

[2] It is also important to observe what happened to the volatility of the interest rate, which has gone down, because now the exchange rate absorbs some of the shocks. But in Keynes' theory, a stable interest rate is important to preclude bearish speculative demands for money (the people that demand money because they expect interest rates to rise and so securities prices to go down).

2010. We propose a *modified* version of Taylor rule that includes a proxy for the international interest rate. This modification represents an important innovation with respect to the reviewed literature. Although one cannot really prove the existence of a convention, the results provide new evidence on BCB's behavior and might support the argument that the so called *pro-conservative* convention justifies BCB monetary policy. It is worth to note that our approach is essentially empirical, rather than theoretical.

This paper contains four sections in addition to this introduction. Sections 2 and 3 undertake a review of the literature on the Keynesian concept of convention and on Taylor rule, respectively. In section 4, we present our model, and estimate BCB's reaction function using our *modified* version of Taylor rule. Based on estimated results, we argue that the empirical evidence might corroborate the pro-conservative convention thesis. Section 5 brings our conclusions.

2 Keynes' concept of convention and the Brazilian interest rate

The concept of convention plays an essential role in Keynes' theory given his understanding that in a capitalistic society some relevant political, social and economic variables are uncertain. According to Davidson (2002), Keynes implicitly assumes that an *entrepreneurial economy* is characterized by a *nonegordic* stochastic process. In it, "decision makers 'know' that they cannot reliably predict the future on the basis of any statistical analysis of past market data" (Davidson, 2002, p. 52). Agents' behavior is based on expectations they form by "creating" the inexistent information they need to make their decisions. Particularly, current knowledge is not sufficient to determine the mathematical expectation of the yield of an *investment*. [3] Convention is fundamental in this context: it is one of the devices deployed to circumvent such difficulties.

---

[3] Keynes uses the term "investment" to designate not only the purchase (or own production) of capital assets, but also the purchase of financial assets, as of shares in the stock market (e.g., 1936, pp. 157-158).

Following Orléan (1986), Dupuy (1989) argued that Keynes formulated two "definitions" of convention. The first one appears in chapter 12 of *The General Theory* to explain how evaluation of existing "investments" is made in the stock exchange, as reflected in the price of shares:

> [i]n practice we have tacitly agreed, as a rule, to fall back on what is, in truth, a *convention*. The essence of this convention (…) lies in assuming that the existing state of affairs will continue indefinitely (…). This does not mean that we really believe that the existing state of affairs will continue indefinitely (Keynes, 1936, p. 152; italics in the original).

Keynes (ibid., p. 148) explained that this "definition" of convention is as a consequence of the weak confidence in forecasts of the future, because they are based on "facts about which our knowledge is vague and scanty". Having to act without knowing what the future is likely to be, agents need to assume some hypothesis about the future, which is, in fact, a convention: " the chief of which is to assume, contrary to all likelihood, that the future will resemble the past" (Keynes, 1973, p. 124).

The propensity to follow the majority or average opinion is what Orléan (1986) and Dupuy (1989) consider Keynes' second "definition" of convention: "[t]he psychology of a society of individuals each of whom is endeavoring to copy the others leads to what we may strictly term a *conventional* judgment" (Keynes, 1937, p. 214; italics in the original). This concept of convention or example of conventional behavior is firstly mentioned in *The General Theory* to describe the logic of financial speculation, metaphorically illustrated by the beauty contest "in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most corresponds to the average preferences of the competitors as a whole" (1936, p. 156). In such situations where common references are not provided to the agents, as prevails in the financial markets, Keynes (1937, p. 214) prescribed that the only rational behavior is to follow the others: "[k]nowing that our own individual judgment is worthless, we endeavor to fall back on the judgment of the rest of the world which is perhaps better informed". In sum, "imitation" (Dupuy, 1989) or "informational mimetism" (Orléan, 1986; 1999) is Keynes' second "definition" of convention.

In chapter 15 of *The General Theory* ("The Psychological and Business Incentives to Liquidity"), Keynes eventually concludes that "[i]t might be more accurate, perhaps, to say that the rate of interest is a highly conventional, rather than a psychological, phenomenon" (1936, p. 203). As a matter of fact, a monetary policy that public opinion perceives as having an experimental nature or being easily subject to change may not achieve the target level of the interest rate. Instead, it "may prove easily successful if it appeals to public opinion as being reasonable and practicable and in the public interest, rooted in strong conviction, and promoted by an authority unlikely to be superseded" (ibid., p. 203).

As mentioned before, Keynes' financial convention is precarious and thus can be liable to drastic changes. Keynes emphasized the link between convention being short-lived and it being built upon a precarious basis of knowledge. However, conventions are not *always* fragile and can be long-lived. Keynes asserted that "[*a*]*ny* level of interest which is accepted with sufficient conviction as *likely* to be durable *will* be durable" (ibid., p. 203; italics in the original), a proposition further reinforced by the following statement:

> (…) it [the rate of interest] may fluctuate for decades about a level which is chronically too high for full employment; – particularly if it is the prevailing opinion that the rate of interest is self-adjusting, so that the level established by convention is thought to be rooted in objective grounds much stronger than convention (…) (ibid., p. 204).

The concept of convention may be useful to explain the long-lasting high level of Selic, as proposed by Bresser and Nakano (2002), Nakano (2006), Erber (2008a, 2011), Modenesi (2008), Chernavsky (2007, 2008), Corrêa (2011) and Oreiro (2012).[4] Since 1995, Brazilian inflation has been under control (average of 7.5% p.y. from 1995 to 2010). In 1999, the exchange rate anchor was abandoned and current account deficit was offset. After 2000, government managed to achieve primary surplus that nearly peaked 4% of GDP in 2005. Such positive results were expected to produce a *substantial* cut in Selic rate, but they did not. The economic fundamentals seem not to be the reason why Selic remained (and still remains) so high. There must be other

---

[4] For the debate on the so called "problem of the interest rate" in Brazil, see Modenesi and Modenesi (2012).

reasons to explain this awkward fact, and the concept of convention may help us find them.

Bresser-Pereira and Nakano (2002) originally suggest that a convention has been established according to which "after a long period of a persistently high interest rate, it is natural that a fear of reducing it arises and grows to a point of becoming a convention. This is a perverse convention indeed, and needs to be overcome" (p. 169, our translation).

Nakano (2006) argued that the (too) slow process of Selic reduction that started in 2005 could only be justified by BCB's acceptance of a convention according to which: i) Selic nominal rate floor, although considerably high, should remain around 14% p.y.; and ii) monetary policy should be based on a Taylor rule, aligned with the New Consensus on Monetary Policy (NCMP), in order to smooth interest rate movements. It is implicit to Nakano's argument the idea that, having put inflation under control by imposing a high interest rate policy, economic agents, BCB among them, came to share a convention that lower interest rate levels (in line with the rates of low-inflationary economies) would jeopardize the economically and socially costly process of price stabilization initiated with the Real Plan. The memory of the undesirable consequences of chronic and extremely high inflation is believed to have arisen the socially shared feeling that lowering the interest rate would represent the threat of hard old times returning. So, given that uncertainty makes it foolish to believe that one can forecast the real consequences of faster cuts in interest rates, agents eventually came to share the convention that keeping the interest rate at a high level was the best course of action.

We agree with Correa (2010) that this convention has the three main features of a general concept of convention as proposed by Dequech (2009, 2011): social sharing, since the understanding that Selic rate must remain high is clearly a socially shared pattern of thought; conformity with the conformity of others, which implies that agents agree to the high level of Selic, partially at least, because others also do; and arbitrariness, meaning that, given the lack of knowledge or the uncertainty as to the consequences of lowering Selic faster, agents prefer to take the slow course.

Erber (2008a, 2008b, 2011) took an innovative approach when stated that Brazilian excessively tight monetary policy can only be understood from the perspective of

political economy. The question is not merely macroeconomic, but the result of a coalition of interests revolving around the maintenance of interest rate level so high. The overvaluation of real is another pillar of the coalition of interests sustaining BCB conservatism: "[t]he exchange rate appreciation is the Siamese-sister of high interest rates". As Erber (2011, p. 16) pointed out, the long-lasting appreciation of real has significantly benefited importers, consumers and enterprises; and the two sisters act in the benefit of "companies that are able to access external credit and all who want to send resources abroad, either for investment (especially commodity producers) as interest, profits and dividends". Such a convention benefits not only the agents of the financial markets, the "rentiers" and financial institutions, providing them with high earnings derived from high interest rate payments, but also the BCB itself, which collects as a benefit the reputation of being able to achieve his targets.

Chernavsky (2007, 2008) also suggested the high level of Selic relates to a convention that has been established by the BCB and public debt holders, seeking to obtain the highest payoffs possible. In this context, self-referencing logic – rather than economic fundamentals – is the basis for determining Selic.

Finally, as pointed out by Stiglitz (2008), monetary policy-making has historically been subject to "fads and fashions". In Keynesian terms, we may properly say that anti-inflationary policy has been marked by different conventions according to which a specific monetary regime is seen as the best one and offers a simple way – the use of a single instrument – to control inflation.

In fact, the history of monetary regimes has three paradigmatic moments. The gold standard was the conventional policy of the late 19th and early 20th centuries. In the 1970's and early 1980's, it was replaced by the use of monetary aggregates targets – prescribed by Friedman's monetarism. Since the 1990's, IT (and the belief that interest rate is the *only* instrument apt to curb inflation) has become the conventional regime prescribed by the NCMP. None of those regimes is rooted in solid theoretical grounds or robust empirical evidence. Nevertheless, they all represent, at their turn, a socially shared belief as to *the* correct way of conducting monetary policy.

3   The Taylor Rule: a Brief Review

A keystone of the NCMP, the Taylor rule holds that central banks should determine interest rates aiming at achieving an (explicit or implicit) inflation target and keeping GDP growth rate near is potential level. NCMP represents the new conventional way of understanding the macroeconomic phenomena and thus offers the new conventional way of dealing with macroeconomic issues (e.g. inflation and unemployment) (Blinder, 1981; 1997; Taylor, 2000; Allsopp e Vines, 2000; Romer, 2000). It has emerged from the growing popularity of IT and the eventual acceptance that, even where such regime is not adopted, the main instrument of monetary policy still is the interest rate, and no longer the monetary aggregates of some decades ago, as proposed by Friedman's monetarism.

Taylor (1993) suggests that the conduct of monetary policy should be modeled by a feedback rule that (positively) relates the basic interest rate to output gap and to deviations of actual inflation rate from its target. He proposes that the Federal Reserve determines the FED Funds rate in accordance with the following reaction function:

$$i_t = \alpha_1 + \alpha_2(\pi_{t-1} - \pi^*) + \alpha_3 y_t, \ \ \alpha_1 = \pi_{t-1} + \bar{i} \qquad (1)$$

Where: i_t is FED Funds rate; $\bar{i}$ is long-run equilibrium real interest rate; π_{t-1} is inflation rate (past year); π^* is inflation target; and y_t is percent deviation of GDP from its trend. Considering that the real GDP trend in the USA (between the first quarter of 1984 and the third quarter of 1992) was of 2.2%, with an inflation target of 2%, the author holds that equation (1) should show the following parameters:

$$i_t = \pi_{t-1} + 2 + 0.5(\pi_{t-1} - 2) + 0.5 y_t \qquad (2)$$

According to equation (2), the FED Funds rate raises when: inflation increases above the (2% per year) target; and/or GDP rises above its trend (target). When both rates – inflation and GDP growth – are equal to their respective targets, interest rate is maintained (by construction) at 4% p.y. (or 2% in real terms). A rise in inflation produces a (positive) response more than proportionate to interest: higher inflation results in an amplified real interest rate. Taylor revealed he had chosen the coefficients of equation (2) based on informal judgment, and did not hide his surprise in finding that they represented fairly well the interest rate trajectory from 1987 to 1992.

Despite providing an accurate description of the actual behavior of the FED Funds rate, Taylor rule does not incorporate what orthodoxy stresses as a stylized fact – which we may properly call a convention – concerning contemporary monetary policy conduct: central banks tend to calibrate basic interest in a smooth and continuous way. In fact, monetary authorities are usually contrary to interest rate shocks: inflation and/or GDP deviations from their targets do not usually lead to drastic and immediate reaction from monetary authorities, who prefer adjusting them gradually, instead (Goodfriend, 1987; Mankiw and Miron, 1991; Rudebusch, 1995; Thorton, 2004).

According to orthodox theory, two of main reasons for the high degree of serial correlation in interest rates are: the fear that abrupt movements in interest may lead to crises in the financial markets (Goodfriend, 1991); and the uncertainty regarding the effects of interest rate variations (Sack, 2000). In the first case, central banks act gradually in order to avoid a financial crisis resulting from an interest rate shock. In the second case, due to imperfect knowledge about the monetary policy transmission mechanism, central banks base their decisions on a sequential trial-and-error process that would smooth down interest rate movements. Clarida, Galí and Gertler (1999) proposed a major modification to Taylor's rule (1993) to incorporate that convention, by adding a smoothing term (or an autoregressive component) that may capture the relation between the (current) interest rate and its past values. Thus, the (current) interest rate equals its lagged value, plus a Taylor component, as represented in equations (3) and (4):

$$i_t = \alpha_1 i_{t-1} + (1 - \alpha_1) i_t^* \qquad (3)$$

$$i_t^* = \alpha_2 + \alpha_3 (\pi_{t+1}^E - \pi^*) + \alpha_4 y_{t+1}^E \qquad (4)$$

$$\alpha_1 \in (0,1), \; \alpha_2 = \pi^* + \bar{i}, \; \alpha_3 > 1, \alpha_4 > 0$$

Replacing (3) by (4), we have:

$$i_t = \alpha_1 i_{t-1} + (1 - \alpha_1)\left[\alpha_2 + \alpha_3 (\pi_{t+1}^E - \pi^*) + \alpha_4 y_{t+1}^E\right] \qquad (5)$$

Parameter α_1 represents the degree of *smoothing* of interest rate changes. The higher is its value, the greater is the the interest rate inertia (or serial correlation). One should note that equation (5) refers to a more general formulation than Taylor's original proposition: if $\alpha_1 = 0$, equation (5) is reduced to equation (1). In this case, interest rate

is adjusted immediately: there is no smoothing. In opposition, if $\alpha_1 \to 1$, interest rate comes near a first-order autoregressive process. BCB's reaction function is similar to this case, as we will show in section 4. If $\alpha_3 < 1$ or $\alpha_4 < 0$, equation (5) is said to be destabilizing both inflation and the GDP (Clarida, Galí and Gertler, 2000). In the first case, the central bank let real interest rate decline as inflation rises. In the second case, monetary policy is pro-cyclical: a rise in GDP growth (in relation to its potential level) is accompanied by a drop in interest.

Equation (5) represents a forward-looking rule as opposed to Taylor's (1993), which is backward-looking. According to (5), interest rate rises in response to a rise in inflation expectation (π_{t+1}^E) and in the expected output gap (y_{t+1}^E). This formulation is more explicit in acknowledging the fact that lags in the transmission of monetary policy (Friedman, 1948) require central banks to adopt a prospective behavior. It is indeed a more general formulation, that allows monetary authorities for forming their expectations based on a wider set of information, and not just on the lagged values of the studied variable. However, this is not a substantial difference, as in the absence of a reliable antecedent indicator for inflation its lagged values may be a good proxy for future inflation.

Clarida, Galí and Gertler (1999) apply equation (5) to the USA economy over the period 1960-1996. Table 1 shows the values of the parameters estimated for two sub-samples, the pre-Volcker era (between the first quarter of 1960 and the second quarter of 1979), and the Volcker-Greenspan era (between the third quarter of 1979 and the fourth quarter of 1996).

Table 1 – FED's Reaction Function: 1960: T1 to 1996: T4

Period	AR (1) (α_1)	Inflation (α_3)	GDP (α_4)
Pre-Volcker	0.68 (0.05)	0.83 (0.07)	0.27 (0.08)
Volcker-Greenspan	0.79 (0.04)	2.15 (0.40)	0.93 (0.42)

Note: Standard error in parentheses. Source: Clarida, Galí and Gertler (1999).

Clarida, Galí and Gertler (2000) conclude that in the era before Paul Volcker monetary policy was strongly accommodating. On average, the real interest rate declined as inflation expectations rose ($\alpha_3 = 0.83$). In contrast, in the Volcker and Alan Greenspan era, FED adopted a clearly pro-active attitude. On average, the real interest rate rose along with the inflation expectations ($\alpha_3 = 2.15$).

The aforementioned articles are main references in a wide literature which, however, is not of specific interest in this paper. The volume organized by Taylor (1999) provides a good overview of the extensive literature (mostly orthodox) on the subject. Arestis and Chortareas (2006, 2007), and Mihailov (2006) present a critical appraisal on the Taylor rule, based on empirical evidence respectively on the Euro area and the United Kingdom. Haight (2008) presents a Post Keynesian critique of what he correctly identifies as being the essence of Taylor rule – the proposition that interest rates should always be raised (reduced) proportionally more than a given rise (fall) in inflation rate. Atesoglu (2007, 2008, 2009), in his turn, introduces monetary policy rules consistent with Keynes' concept of *neutral* rate of interest[5]. Rochon and Setterfield (2007) examine Post Keynesian policy rules which are alternative to the Taylor rule.[6]

Especially after the adoption of IT, estimates of Taylor rule were made for the Brazilian economy, amongst which the works undertaken by Figueiredo and Ferreira (2002), Minella *et al.* (2002), Favero and Giavazzi (2002), Mendonça (2007), Gonçalvez and Fenolio (2007), and Modenesi (2011).[7]

In brief, Brazilian literature provides strong evidence that BCB's interest rate policy follows a Taylor rule. Since the adoption of IT in mid-1999, BCB has been acting proactively in regard to inflation. There is strong evidence that a rise in inflation generates a more than proportional response from Selic: the coefficient of inflation gap

[5] According to Keynes (1936, p. 243), the neutral rate of interest is "the rate of interest which prevails in equilibrium when output and employment are such that the elasticity of employment as a whole is zero."

[6] For a broader discussion on monetary policy rules and the NCPM, see Fontana and Palacio-Vera (2002), Rochon (2006), Arestis and Chortareas (2007), De-Juan (2007), and Cuaresma and Gnan (2007).

[7] Andrade and Divino (2001) use a sample ranging from 08/1994 to 03/1999. Salgado, Garcia and Medeiros (2005) deal with the period 07/1994-12/2000. Muinhos (2004) proposes a modification to Taylor rule by including the exchange rate – proposed by Ball (2000) – in a paper where he evaluates the Brazilian economy's pass through after the January 1999 devaluation. On the importance of the exchange rate to emerging economies that practice IT, see Mishkin (2000).

is greater than the unit. However, there is only weak evidence showing that BCB reacts counter-cyclically to the output gap, as it was expected. Only a few works have included this variable in their regressions. For instance, Minella *et al.* (2002) found that the output gap is not significant or does not have the expected sign. Gonçalvez and Fenolio (2007) and Modenesi (2011), in their turn, showed that BCB reacts to output gap: although the corresponding coefficient has the expected sign it is not strongly statistically significant. There is also evidence that the equilibrium interest rate is quite high and that BCB has been practicing a high degree of interest rate smoothing. However, the reviewed literature presents one major empirical problem: most papers use very small samples, ranging from (only) 28 to 71 observations[8], which definitely reduces the robustness of the results.

4   A Modified Version of Taylor Rule for 11 Years of Inflation Targeting (2000-2010)

4.1   Data base, functional form, and unit root test

The adoption of IT in June 21, 1999, represented an important structural break, resulting in deep changes in the conduct of monetary policy, which until then had been based on an exchange rate targeting regime (Modenesi, 2005, chap. 4 and 5). To enhance robustness, we excluded the first six months of IT adoption from our sample, which therefore covers the period from January, 2000, to December, 2010. Also, our sample contains 132 monthly observations, a number much higher than the average of observations contained the aforementioned works. Thus, our estimates are considerably robust.

With the purpose of evaluating BCB's behavior during the adoption of IT, we have estimated a backward-looking *modified* Taylor rule for the Brazilian economy. The term "modified" refers to an important innovation with respect to the reviewed literature, the

---

[8] Despite working with 71 observations, Mendonça (2007) includes the year 1999 in his sample. But including data of a period of transition between two different monetary regimes may have jeopardized the robustness of his results. As an exception, Modenesi (2011) works with a bigger sample (96 observations) that excludes the year 1999.

inclusion of a proxy for international interest rate in the original equation, resulting in model (I):

$$i_t = \alpha_1 i_{t-1} + (1 - \alpha_1) \left[\alpha_2 + \alpha_3 \overbrace{(IPCA_{t-1} - \pi_{t-1}^*)}^{Dipca} + \alpha_4 \overbrace{(Ind_{t-1} - Ind_{t-1}^*)}^{Dind} + \alpha_5 libor_t \right] \qquad (I)$$

Where: i_t is Selic rate (in month t); $IPCA_{t-1}$ is inflation (last 12 months before month t); π_{t-1}^* is inflation target (last 12 months before month t); Ind_{t-1} is industrial output growth rate (last 12 months before month t), used as proxy for GDP; Ind_{t-1}^* is potential industrial output growth rate (last 12 months before month t); and $libor_t$ is London interbank rate (in month t). All variables are in logarithmic form.[9]

The estimates of model (I) presented serial correlation in the residuals, as usually happens. This problem was overcome by introducing a second lag of the dependent variable, resulting in model (II):

$$i_t = \alpha_1 i_{t-1} + \alpha_2 i_{t-2} + (1 - \alpha_1 - \alpha_2) \left[\alpha_3 + \alpha_4 \overbrace{(IPCA_{t-1} - \pi_{t-1}^*)}^{Dipca} + \alpha_5 \overbrace{(Ind_{t-1} - Ind_{t-1}^*)}^{Dind} + \alpha_6 libor_t \right] \qquad (II)$$

Usually the constant term represents the equilibrium interest rate, but the usual interpretation does not apply here. In our model the equilibrium interest rate has been broken into two components: i) what we may call the *pure domestic* equilibrium interest rate (α_3) in equation (II); which must be added to ii) an *external* component, given by (a fraction of) the international interest rate ($\alpha_3 libor_t$). This innovative solution is due to accommodate the fact that in open small economies, like Brazil's, domestic interest rate are not set independently of the external rate (accordingly with the so called interest rate parity rule).

Table 2 shows the results of Augmented Dickey-Fuller (ADF), DF-GLS, and KPSS tests.[10] Given the well-known low power of unit root tests (Elder and Kennedy, 2001),

---

[9] Where $ln(y_t) = ln(y_t + 100)$. Note that the estimated coefficients represent the variable-elasticity of Selic. Selic is set by BCB. The index of industrial production and IPCA are provided by IBGE. The potential industrial output growth rate is given by the HP filter. Libor is the short-term interest rate of United Kingdom and is provided by Ipeadata.

[10] All tests have been made using the test equation with an intercept and without a trend. This choice is based on the observation of the graphics of the series, which does not present a clear trend (Elder and Kennedy, 2001).

we have performed three different tests to enhance robustness. In face of the provided set of evidence we will take all series as stationary (as found in the literature review).[11]

Table 2 – Unit Root Tests

Variable	ADF (Statistic t)	ADF-GLS (Statistic t)	KPSS (LM Statistic)
Selic	-2.430.142	-2.026433*	0.992916*
Dipca	-3.259937*	-3.202539*	0.323417
Dind	-2.952180*	-2.319252*	0.045902
libor	-1.221.146	-0.267400	0.687763**

Notes: *Reject H_0 at 5% level of significance. **Reject H_0 at 5% but not at 1% level. See Hamilton (1994). Source: Authors' elaboration.

4.2   Results

Table 3 shows the main results of the three variants of model (II). They differ only as to output gap lags (*Dind*): the first line shows its present value; the second line, its lagged value; and the last line, the second lag.

---

[11] At a first sight the results may not appear very conclusive. Notwithstanding, for all variables, at least one of the performed tests indicates stationarity. Considering the usual low power of those tests we can accept that all series are stationary.

Table 3 – Estimates of BCB's Reaction Function (AR(2)): 2000-2010

Model	AR (1) (α_1)	AR (2) (α_2)	Constant (α_3)	Dipca (α_4)	Dind (α_5)	Libor (α_6)	Adju. R^2
II.1: *Dind*	1.741124* (0.057716)	-0.774549* (0.053556)	-4.30635*** (2.346044)	0.786957* (0.280995)	0.234580 (0.181230)	0.933836** (0.425894)	0.994631
II.2: *Dind (-1)*	**1.727800*** **(0.058157)**	**-0.759561*** **(0.054423)**	**-4.30006*** **(2.440262)**	**0.795660*** **(0.291371)**	**0.315758†** **(0.217320)**	**0.843171*** **(0.455975)**	**0.994696**
II.3: *Dind (-2)*	1.710648* (0.059751)	-0.743240* (0.056317)	-4.31925*** (2.370368)	0.798397* (0.282513)	0.336203† (0.214742)	0.824242** (0.443743)	0.994723

Notes: Standard error in parentheses. * Significant at 1%. ** Significant at 5%. *** Significant at 10%. †
Significant at 15%. Source: Authors' elaboration.

Amongst the three variants of this model, (II.2) has the best statistical properties. Particularly, the Breusch-Godfrey test for serial correlation of residuals (LM) is more favorable to model (II.2) than to (II.3) (Table 4). Therefore, for analytical purpose, we have chosen model (II.2), hereafter simply referred to as "the model". It represents BCB's behavior quite fairly. Such high adherence results from a high adjusted R^2 (0.99), which was also found in the reviewed literature (between 0.92 and 0.98).

Table 4 – Breusch-Godfrey Test for Serial Correlation (LM): Model II Class

Model	Lags	F Statistics	Probability	Obs. R^2	Probability
I.1: *Dind*	2	1.684.850	0.196671	1.755.539	0.185182
II.2: *Dind (-1)*	**2**	**2.039.466**	**0.155757**	**2.119.101**	**0.145472**
II.3: *Dind (-2)*	2	3.601.762	0.060025	3.696.937	0.054512

Source: Authors' elaboration

As we have used a sample and an equation considerably different from the ones adopted in the reviewed literature, the results we have produced are also different. The main difference concerns the degree of inertia of interest rate changes, which is extremely high. As seen in section 3, interest rate inertia is measured by the weight of the parameters of autoregressive component(s). In the estimated model, the sum of the coefficients of both autoregressive terms is around 1 ($\alpha_1 + \alpha_2 = 0.97$), meaning a very high degree of interest rate autocorrelation. In the reviewed literature, the weight of the autoregressive component(s) is lower, ranging from 0.72 to 0.92.

A high degree of interest smoothing means reduced sensibility to the state of domestic economy. In other words, when setting Selic, BCB barely takes into account inflation (*Dipca*) and output (*Dind*) gaps. Intuitively, one can realize that, even in the face of a significant drop in inflation and/or a drastic slowing down of the economy, BCB acts very gradually, reducing interest much too slowly and by much too little.[12]

The insensitiveness of BCB gets more serious when it comes to the output gap. As found in the literature review, BCB seems not to pay much attention to it: output gap coefficient is statistically significant only at 15% percent level of significance and has very low magnitude ($\alpha_5 = 0.316$). The sensitiveness of BCB to inflation gap ($\alpha_5 = 0.796$) is highly statistically significant (at 1%). Similar results have also been achieved by Modenesi (2011). The novelty presented here is the evidence that BCB reacts to foreign interest rate when setting the basic interest rate. *Libor* coefficient presents relatively high magnitude ($\alpha_6 = 0.843$) and is statistically significant at 10% level of significance.

Finally, as long as the estimated model refers to variables in logarithm, the constant obtained above is meaningless. Howsoever, through a simple algebraic manipulation we can obtain what we call *pure domestic* equilibrium interest rate. It is positive and high (10.07), showing a very high level of what we define as the pure domestic equilibrium interest rate. As mentioned before, the usual interpretation of the constant term does not directly apply here: this level is lower than the one obtained in the reviewed studies,

---

[12] One should note that inertia is symmetric: a rise in inflation/output gap also does not cause an abrupt hike in Selic.

because we have controlled for foreign interest rates. The constant term high magnitude is a fundamental sign of conservatism that marks monetary policy in Brazil.

A number of simulations can illustrate the intuition behind our results. If inflation target is systematically achieved (*Dipca* = 0) and output systematically equals its potential (*Dind* = 0), Selic converges to 10.1% plus an *external* component, which is related to the actual level of *libor*, *ceteris paribus* (solid gray line in Graph 1).[13] Supposing that both inflation and output gaps and also Libor equal zero (*Dipca = Dind = libor = 0*, for all *t*), Selic converges to 10.1%, *ceteris paribus* (dashed line in Graph 1). Alternatively, when both inflation and output gaps equals zero and libor equals 4.0% (Dipca = *Dind* = 0 and *libor* = 4.0%, for all *t*), Selic converges to 13.8%, *ceteris paribus* (solid black line). For instance, to achieve the (average) level of interest rates set in developing countries during the analyzed period, around 6.0% p.y., a permanent and huge inflation gap of 9,5% would be needed, *ceteris paribus* (i.e., *Dipca* = - 9.5%, for all *t*, given the actual behavior of *Dind* and *libor*). Alternatively, it would be necessary a huge and perennial output gap of 25.0%, *ceteris paribus* (i.e., *Dind* = -25.0%, for all *t*, given the actual behavior of *Dipca* and *libor*).

Graph 1 – Simulations of Selic for *Dipca = Dind = 0*
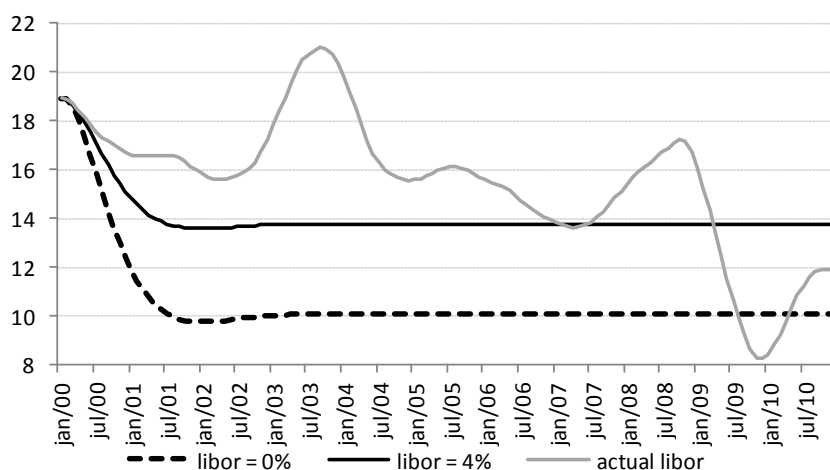
Source: Authors elaboration.

---

[13] The simulations presented here assume the constancy of all relevant parameters of BCB's reaction function (model II.2).They do not constitute a model for forecasting Selic. From now on, the terms *Selic*, *Dind*, *Dipca* and *libor* refer to the level and not to the logarithmic form.

Briefly, one may say that, as long as the pro-conservative convention prevails, Selic rate will hardly be reduced in a satisfactory way. Massive and chronic deflation or recession would be needed if Selic were to reach a reasonable level.

5   Conclusion

The present study reinforces and expands the results achieved by Modenesi (2011), with the novelty that evidence shows that BCB reacts to foreign interest rates when setting Selic. This means that BCB has reduced autonomy when setting its rate. In this sense, Selic is endogenous not only to domestic conditions (inflation and output gaps), but also to foreign interest rate (measured by Libor).

Summing up, our results might corroborate the argument that BCB policy is ruled by a pro-conservative convention substantiated in the adoption of a Taylor rule (aligned with NCMP) with three distinctive features: 1) high degree of interest rate smoothness; 2) high *pure domestic* equilibrium interest rate; and 3) high interest rate differential. Items (2) and (3) largely explain the overvaluation of real, a key element to ensure price stabilization in Brazil during the analyzed period.

Our results also seem to contradict the current widespread idea that Brazilian equilibrium interest rate has recently experienced a sharp decline. Accordingly, Selic cuts may be mostly a reflection of the *abnormal* decline of foreign interest rates that followed the subprime crisis. In other words, according to our model, the argument that the decline in the basic interest rate results from improvements in the fundamentals of Brazilian economy may be fallacious.[14] BCB reacts more intensively to changes in foreign interest rates than to changes in output and in inflation gaps. Recent cuts in Selic

---

[14] We do not argue that if and when foreign interest rates return to their normal levels Selic will eventually converge to its average. Evidence shows that BCB has changed its policy in President Dilma's term, which has begun in January, 2011. For instance, BCB uses other instruments besides Selic, especially the use of credit control. At the same time policy mix also seems to have changed. Fiscal policy has been tightened in order to open space for a more flexible monetary policy. The prevailing of this new policy mix will imply changes in the parameters of BCB's reaction function.

are mostly related to the decline in foreign interest rates – keeping the interest rate differential roughly constant. In a few words, BCB has not changed its behavior and one can say that it still sets Selic based on the so called pro-conservative convention.

6 References

Allsopp, C., and D. Vines. "The assessment: Macroeconomic policy." *Oxford Review of Economic Policy* 16, no. 4 (2000): 1-32.

Andrade, J.P., and J.A. Divino. "Optimal rules for monetary policy in Brasil." Texto para Discussão 806, Instituto de Pesquisa Econômica Aplicada (Ipea), 2001.

Arestis, P. and G. Chortareas. "Monetary policy in the euro area." *Journal of Post Keynesian Economics* 28, no. 3 (2006): 371-94.

_____. "Natural equilibrium real interest rate estimates and monetary policy design". *Journal of Post Keynesian Economics* 29, no. 4 (2007): 621-43.

Atesoglu, H. S. "The neutral rate of interest and a new monetary policy rule." *Journal of Post Keynesian Economics* 29, no. 4 (2007): 689-97.

_____. "Monetary policy rules and U.S. monetary policy." *Journal of Post Keynesian Economics* 30, no. 3 (2008): 403-8.

_____. "Taylor and Keynesian monetary policy rules." *Journal of Post Keynesian Economics* 31, no. 3 (2009): 485-92.

Ball, L. "Policy rules and external shocks." NBER Working Paper series 7910, 2000.

Blinder, A.S. "Monetarism is obsolete." *Challenge*, Sep-Oct, 1981: 35-43.

_____. "A Core of macroeconomic beliefs." *Challenge*, Jul-Aug, 1997: 36-44.

Bresser-Pereira, L.C. and Y. Nakano. "Uma Estratégia de Desenvolvimento com Estabilidade." *Revista de Economia Política* 22, no. 3 (2002): 146-180.

Chernavsky, E. *Sobre a construção da política econômica: uma discussão dos determinantes da taxa real de juros no Brasil.* Dissertação (Mestrado), São Paulo, Brasil: Universidade de São Paulo, 2007.

_____. "Taxa natural e convenções: uma discussão dos determinantes da taxa real de juros no Brasil." Proceedings of the XIII Encontro de Economia Política, 2008.

Clarida, R., Galí, J., and M. Gertler. "The Science of Monetary Policy: A New Keynesian Perspective." CEPR Discussion Papers 2139, 1999.

_____. "Monetary Policy Rules And Macroeconomic Stability: Evidence And Some Theory." *The Quarterly Journal of Economics* 115, no. 1 (2000): 147-180.

Correa, L. *Convenções Financeiras e Taxa Básica de Juros no Brasil*. Ph.D. Thesis presented at Unicamp, 2010.

Cuaresma, J. C. and Gnan, E. "The natural rate of interest: Which concept? Wich estimation method? Which policy conclusions?". *Journal of Post Keynesian Economics* 29, no. 4 (2007): 667-88.

Davidson, P. *Financial Markets, Money and the Real World*. Cheltenham: Edward Elgar, 2002.

De-Juan, O. "The conventional versus the natural rate of interest: Implications for central bank autonomy". *Journal of Post Keynesian Economics* 29, no. 4 (2007): 645-66.

Dequech, D.. "Institutions, social norms, and decision-theoretical norms." *Journal of Economic Behavior* 72, no. 1 (2009): 70-78.

_____. "Financial conventions in Keynes' theory: the stock exchange." *Journal of Post Keynesian Economics* 33, no. 3 (2011): 469-90.

Dupuy, J.P. "Convention and Common Knowlegde." *Revue Économique* 40, no. 2 (1989): 361-399.

Elder, J., and P.E. Kennedy. "Testing for Unit Roots: What Should Students Be Taught?" *Journal of Economic Education* 32, no. 2 (2001): 137-146.

Erber, F. "Development projects and growth under finance domination – the case of Brazil during the Lula years (2003-2007)." *Revue Tiers Monde* 195, no. 3 (2008a): 597-629.

_____. "The Evolution of Development Conventions." XII International Joseph A. Schumpeter Society Conference, (2008b).

_____. "As convenções de desenvolvimento no Brasil: um ensaio de economia política." *Revista de Economia Política* 31, no. 1 (2011): 31-55.

Favero, C.A., and F. Giavazzi "Why are Brazil's Interests Rates so High?" Working Paper 224, Università Bocconi, Innocenzo Gasparini Institute for Economic Research, 2002.

Figueiredo, F.M.R., and T.P. Ferreira. "Os Preços Administrados e a Inflação no Brasil." Trabalhos para Discussão 59, Banco Central do Brasil, (2002).

Fontana, G. and Palacio-Vera, A. "Monetary policy rules: what are we learning?". *Journal of Post Keynesian Economics* 24, no. 4 (2002): 547-68.

Friedman, M. "A Monetary and Fiscal Framework for Economic Stability." *The American Economic review* 38, no. 3 (1948): 245-264.

Gonçalvez, C.E.S., and F.R. Fenolio. "Ciclos eleitorais e política monetária: evidências para o Brasil." *Pesquisa e Planejamento Econômico* 37, no. 3 (2007): 465-87.

Goodfriend, M. "Interest Rate Smoothing and Price Level Trend-Stationary." *Journal of Monetary Economics* 19, no. 3 (1987): 335-348.

_____. "Interest Rate and the Conduct of Monetary Policy." Carnegie-Rochester Conference Series on Public Policy 34, (1991): 7-30.

Haight, A.D. "A Keynesian angle for the Taylor rule: mortgage rates, monthly payment illusion, and the scarecrow effect of inflation." *Journal of Post Keynesian Economics* 30, no. 2 (2007): 259-77.

Hamilton, J.D. *Time Series Analysis*. Princeton: Princeton University Press, 1994.

Hayeck, F. "Notes on the Evolution of Systems of Rules of Conduct." In F. Hayeck (ed.), *Studies in Philosophy, Politics and Economics*. Chicago: University of Chicago Press, 1967: 66-81.

Hicks, J.R. *Economic Perspectives*. Oxford: Oxford University Press, 1977.

Keynes, J.M. *The General Theory of Employment, Interest and Money*. London: Macmillan, 1936.

_____. "The general theory of employment." *The Quarterly Journal of Economics* 51, no. 2 (1937): 209-223.

_____. "Some Economic Consequences of a Declining Population." In D. Moggridge (ed.), *The Collected Writings of John Maynard Keynes*, vol. XIV. London: Macmillan, 1973: 124-33.

Mankiw, N.G., and J.A. Miron. "Should the FED Smooth Interest Rates? The case of Seasonal Monetary Policy." Carnegie- Rochester Conference Series on Public Policy 34, 1991: 41-70.

Mendonça, H.F. "Metas de inflação e taxa de juros no Brasil: uma análise do efeito dos preços livres e administrados." *Revista de Economia Política* 27, no. 3 (2007): 431-51.

Minella, A., Freitas, P.S., Goldfajn, I. and M.K. Muinhos. "Inflation targeting in Brazil: Lessons and challenges." Trabalhos para Discussão 53, Banco Central do Brasil, 2002.

Mihailov, A. "Operational independence, inflation targeting, and UK monetary policy." *Journal of Post Keynesian Economics* 28, no. 3 (Spring 2006): 395-421.

Mishkin, F. "Inflation targeting in emerging markets countries." NBER Working Paper Series 7618, 2000.

Modenesi, A.M. *Regimes Monetários: Teoria e a Experiência do Real*. Barueri: Manole, 2005.

_____. "Convenção e Rigidez na Política Monetária: uma estimativa da função de reação do BCB (2000-2007)". Texto para Discussão no. 1351, Instituto de Pesquisa Econômica Aplicada (2008).

_____. "Conservadorismo e Rigidez na Política Monetária: uma estimativa da função de reação do BCB (2000-2007)." *Revista de Economia Política* 31, no. 3 (2011): 415-34.

Modenesi, A.M., and Modenesi, R.L. "Quinze Anos de Rigidez Monetária no Brasil: uma agenda de pesquisa." *Revista de Economia Política*, 32, no. 3 (2012): 389-411.

Muinhos, M.K. "Inflation targeting in an open financially integrated emerging economy: The case of Brazil." *Estudos Econômicos* 34, no. 2 (2004): 269-96.

Nakano, Y. "O regime monetário, a dívida pública e a alta taxa de juros." *Conjuntura Econômica* 59, no. 11. Rio de Janeiro: Fundação Getulio Vargas, 2005.

_____. "Antes que os populistas tomem conta." *Valor Econômico*, January 17, 2006: A-10.

O'Donnell, R. *Keynes: Philosophy, Economics and Politics*. London: Macmillan, 1989.

Oreiro, J.L. "Keynes e os juros." *Valor Econômico*, March 5, 2012: A-14.

Orléan, A. "Mimetism et antecipations rationelles: une perspective keyneésienne." *Recherche Économique de Louvain* 52, no. 1 (1986): 45-66.

_____. "Pour une approche cognitive des conventions économiques." *Revue économique* 40, no. 2 (1989): 241-272.

_____. *Le pouvoir de la Finance.* Paris: Odile Jacob, 1999.

Possas, M.L. "Racionalidade e Regularidades: Rumo a uma Integração Micro-Macrodinâmica." *Economia e Sociedade* 2, no. n.a. (1993): 59-80.

Ribeiro, A. "Ziguezague na política monetária." *Valor Econômico*, February 25, 2008: A-2.

Rochon, L.P. "The more things change… inflation targeting and central bank policy." *Journal of Post Keynesian Economics* 28, no. 4 (2006): 551-58.

Rochon, L.P. and M. Setterfield. "Interest rates, income distribution, and monetary policy dominance: Post Keynesians and the 'fair rate' of interest". *Journal of Post Keynesian Economics* 30, no. 1 (2007): 13-42.

Romer, D. "Keynesian macroeconomics without the LM curve." *Journal of Economic Perspectives* 14, no. 2 (2000): 149-69.

Rudebusch, G.D. "Federal Reserve Interest Rate Targeting, Rational Expectations and Term Structure.*" Journal of Monetary Economics* 35, no. 2 (1995): 245-274.

Sack, B.P. "Does the Fed Act Gradually? A VAR Analysis." *Journal of Monetary Economics* 46, no. 1 (2000): 229-256.

Salgado, M.J.S., Garcia, M.G.P., and M.C. Medeiros. "Monetary Policy During Brazil´s Real Plan: Estimating the Central Bank´s Reaction Function". *Revista de Economia Política* 59, no. 1 (2005): 61-79.

Taylor, J.B. "Discretion versus policy rules in practice." Carnegie-Rochester Conference Series on Public Policy 39, 1993: 195-214.

_____. (ed.) *Monetary Policy Rules*. Chicago: Chicago University Press, 1999.

_____. "Teaching modern macroeconomics at the principles level." *American Economic Review* 90, no. 2 (2000): 90-94.

Thorton, D.L. "The FED and Short-Therm Rates: Is it Open Market Operations, Open Mouth Operations or Interest Rate Smoothing?" *Journal of Banking & Finance* 28, no. 3 (2004) 475-98.

Vernengo, M. "Money and inflation" in P. Arestis, and M. Sawyer (eds.), *A Handbook of monetary Economics*. Cheltenham, UK: Edward Elgar, 2006.