Setting the interest rate for two outlier countries

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Abstract

Taking into account that Brazil and Turkey have the highest basic interest rates in the world, this analysis is concerned with the setting of the interest rate in these economies focusing on two main points: to evaluate if Taylor's rule is adequate for explaining the path of the interest rate in both economies; and to verify if the inflation targeting adopted in these countries has the characteristic of strict or flexible regime. The findings denote that both central banks have adopted a flexible inflation targeting and that there exists a strong persistence of the interest rate. Moreover, it is observed that the Central Bank of Brazil (CBB) makes use of a Taylor rule for defining the interest rate while the Central Bank of the Republic of Turkey (CBRT) does not. Finally, the CBRT has a more aggressive anti-inflationary policy than the CBB.

Key words: interest rate; Taylor's rule; inflation targeting; Brazilian economy, Turkish economy.

JEL classification: E52, E58.

1. Introduction

Two atypical cases of developing economies beckon our attention when the interest rates of several countries in the last decade are observed. The Brazilian and the Turkish economies have the highest basic interest rates in the world with a high degree of volatility (Kannan, 2008). After the publication of Taylor's article (1993), the development of structural models with the intention of capturing the behavior of central banks based on interest rate reaction functions became the focus of several researches. These analyses are relevant especially for countries where inflation targeting has been adopted because besides allowing the observation of the impacts on interest rate from inflation rate and output gap, Taylor's rule permits a reasonable forecast of the interest rate.

Most of the studies in regard to the analysis of a rule for interest rate take into account central banks of developed economies, particularly the cases of Federal Reserve and the European Central Bank.[1] The lack of literature for the case of emerging economies added to the anomalous environment in Brazil and Turkey motivates this study. Both economies have adopted inflation targeting, historically present two of the highest interest rates in the world, and use the interest rate as the main instrument in the management of the monetary policy. In brief, an analysis from these cases can verify if the adoption of inflation targeting is capable of achieving a low and stable inflation together with a decrease in the interest rate.

Therefore this analysis is concerned with the setting of the interest rate in Brazil and Turkey focusing on two main points: (i) to evaluate if Taylor's rule is adequate for explaining the path of the interest rate in both economies; and (ii) to verify if the inflation targeting adopted in these countries has characteristics of a strict or of a flexible regime.[2] This paper is organized as follows: the next section shows the main characteristics of the Brazilian and Turkish inflation targeting; section 3 makes an analysis of the reaction function applied for the cases of Brazil and Turkey and also a comparative analysis between them; and the last section presents the conclusion.

2. Inflation targeting in Brazil and Turkey

In a general way an inflation targeting regime is characterized by the definition of an inflation target with tolerance intervals. Such as in a principal-agent model, the inflation target is defined by governments (principal) and must be achieved by the central bank (agent). Moreover, the interest rate is the main instrument available for the central bank in the task for achieving the inflation target.

Although it is recognized that the main objective of the monetary policy under inflation targeting is to assure a low and stable inflation rate, the majority of central banks accommodate fluctuations in output and employment. The fact that the central bank's reaction function considers the output gap does not mean that inflationary bias will occur. The justification is that this monetary regime allows the use of discretionary policies without implying a loss of credibility. In short, a possible advantage from the

[1] See, Clarida, Galí, and Gertler (1998), Taylor (2000), Carstensen (2006), Belke and Polleit (2007).

[2] According to Svensson (2003), strict inflation targeting is one that neglects the real effects of the monetary policy in the short and medium term and focuses on only the inflation control; while flexible inflation targeting is one that maintains the search for price stability as the fundamental objective for monetary policy, but recognizes the necessity for stabilizing the business cycle.

use of inflation targeting is that if the target is credible, the public will adjust their expectations more quickly concerning the realization of the target thus contributing to a decrease in the interest rate.

The next two sections present the main characteristics of the Brazilian and Turkish inflation targeting, respectively.

2.1. Inflation targeting in Brazil

The inflation stability in the Brazilian economy is a result of the introduction of the Real plan in 1994. In the first period, from June 1994 to January 1999, the nominal anchor was based on a crawling peg system. After this period due to the change in the exchange rate regime to flexible, in June of 1999 the National Monetary Council determined inflation targeting as the new strategy for the monetary policy in Brazil.

The main points concerning the introduction of inflation targeting in Brazil are present in Decree No. 3088 of June 21:

• The inflation targets will be established on the basis of variations of a widely known price index;

• The inflation targets, as well as the tolerance intervals, will be set by the National Monetary Council on the basis of a proposal by the Finance Minister;

• Inflation targets for the years 1999, 2000, and 2001 will be set no later than June 30, 1999; for the year 2002 and subsequent years' targets will be set no later than June 30, two years in advance;

• The Central Bank is given the responsibility to implement the policies necessary to achieve the targets;

• The price index that would be adopted for the purposes of the inflation targeting framework will be chosen by the National Monetary Council on the basis of a proposal by the Finance Minister;

• The targets will be considered to have been met whenever the observed accumulated inflation during the period January-December of each year (measured on the basis of variations in the price index adopted for these purposes) falls within the tolerance intervals;

• In case the targets are breached, the Central Bank's Governor will need to issue an open letter addressed to the Finance Minister explaining the causes of the breach, the measures to be adopted to ensure that inflation returns to the tolerated levels, and the period of time that will be needed for these measures to have an effect; and

• The Central Bank will issue a quarterly inflation report that will provide information on the performance of the inflation targeting framework, the results of the monetary policy actions, and the perspectives regarding inflation.

One justification for the adoption of inflation targeting in the Brazilian economy was due to the expectation that this monetary regime could eliminate the uncertainty caused by the strong devaluation of currency in the beginning of 1999 and would recover a nominal anchor for the economy. Furthermore, the use of inflation targets guiding the public's inflation expectation could improve the central bank's control on inflation. In the case of convergence between inflation expectation and inflation target, denoting high central bank credibility, the task of reducing inflation can be accomplished without increasing the interest rate and thus does not imply an increase in sacrifice ratio.

The speech of the Governor of the Central Bank of Brazil (CBB) captures the essence for the use of inflation targeting:

"The option that has proven to be most efficient to conduct monetary

policy is the inflation targeting regime. This system has explicit targets for the monetary authority, which brings transparency to the targets being pursued and allows for reporting to society the absolute commitment to the control of inflation. It is a system that reduces the monetary authority's discretion, and is especially effective in eliminating the risks of political influence in policy decisions.[...] A key purpose of the inflation target regime is to coordinate inflation expectations. That contributes to fulfilling the targets and once the targets are achieved, credibility is enhanced." (Meirelles, 2003, p. 4)

Figure 1 shows the path of the inflation (measured by National Consumer Price Index (extended) – IPCA (official price index) accumulated in the last 12 months IPCA), of the interest rate (over/Selic rate - it is the weighted average of the rates traded in overnight repurchase agreements backed by government bonds registered in the Special System of Clearance and Custody), and the inflation targets adopted for Brazil.

Figure 1

Evolution of Inflation and interest rate (%)

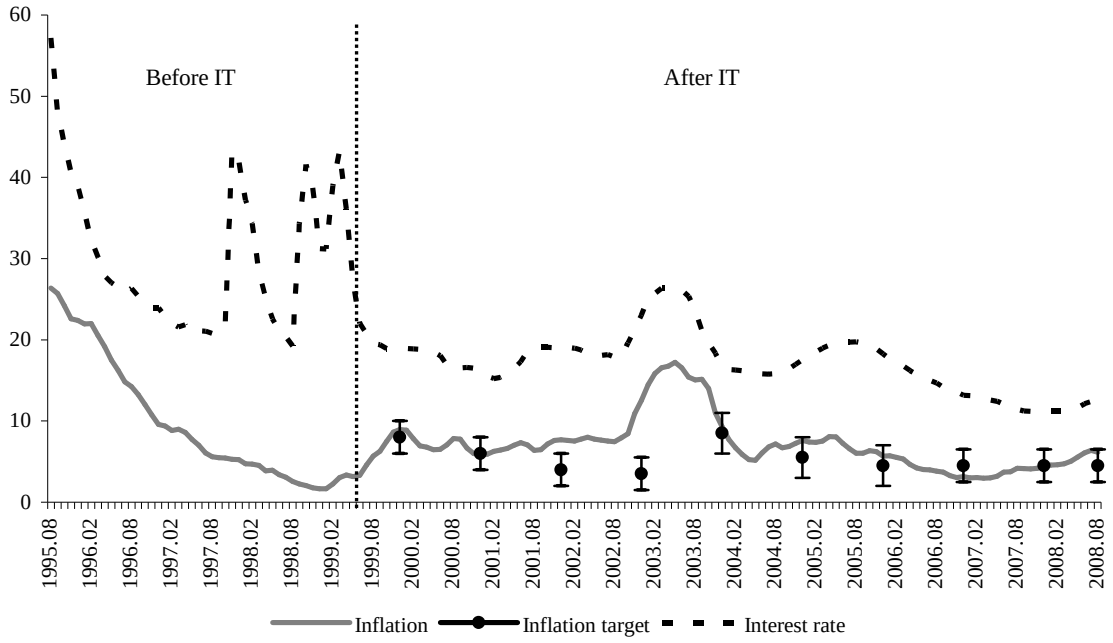


Figure 1 allows observing that after the adoption of inflation targeting both inflation and interest rate have similar paths. Before the adoption of inflation targeting the behavior of inflation and interest rate are not the same. The correlation between them was 0.37, but after inflation targeting it jumped to 0.87. A justification for this is that the interest rate became the main instrument of monetary policy in the search for the inflation target. Moreover it is observed that the inflation targets were not achieved in 2001 and 2002. The main reasons for these failures in the achievement of the targets were: instability in the American stock market, the losses incurred by the American companies, terrorism attack in USA, the announcement of electrical energy rationing, the fall of economic activity in the world, the crisis in the Argentine which in turn drove

away investment in emerging economies, the increase in administered prices,[3] and the speculative behavior during the presidential election.

The large part of the inflation in 2003 occurred in the first months caused by the same factors that accelerated the inflation in the previous year – strong deterioration of public expectation, strong currency devaluation, and high inflation. The environment of uncertainty with the external capital reflow and the increase in the interest rate from the second half of 2002 implied a retraction in the economic activity which abided in the first months of 2003. In the first quarter, the inflation achieved 5.1% (55% of total inflation for the year). However, the second semester is characterized by a reversion in the environment with recuperation of economic perspective with a relative low and stable inflation.

As a consequence of an environment marked by a fall in the inflation the CBB promoted successive cuts in the interest rate. The combination of a fall in the interest rate together with a favorable international environment and improvement in the trade balance implied an appreciation of the exchange rate which contributed to the convergence of the inflation expectation and the inflation target. These positive effects implied an increase in the economic activity and in December of 2004 the interest increased (17.75%) due to the new inflationary pressure. The inflation for the year was 7.6% which was very close to the upper limit of the inflation target (8%).

Due to the tight monetary policy adopted from the last quarter of 2004, the year of 2005 was characterized by a fall in the economic growth. The favorable external conditions together with the good trade balance result implied an appreciation of the exchange rate which in turn facilitated the convergence of inflation expectation and inflation targeting. Notwithstanding, the CBB adopted a conservative behavior and did not reduce the interest rate. Between January and May 2005, the interest rate increased 1.5 p.p. and after this remained stable at 19.75%. Only in the second semester of 2005 the CBB understood that the inflationary pressure was eliminated and adopted a strategy of reducing the interest rate.

For the first time since the adoption of inflation targeting the inflation in 2006 was lower than the inflation target, 3.14% and 4.5%, respectively. In 2007 the inflation corresponded to 4.46%, that is, 1.32 p.p. greater than the inflation observed in 2006. The main reason for this increase in the inflation was a result of the increase in the demand of the Asian countries for agricultural commodities.

In August 2007 the accumulated inflation in the year reached 6.17% and the inflation target was 4.5% together with a tolerance interval of ± 2. This result is a consequence of an imbalance between the expansion of domestic demand and supply under an environment marked by an increase in the agricultural commodities. Behind these prices increases there exists structural factors such as an increase in demand by China and India.

2.2. Inflation targeting in Turkey

Turkey in the last three decades had an environment characterized by high and volatile inflation, massive dollarization with instability in the financial sector, high public debt, and low and unstable economic growth. The weakness of the economy implied a strong inertia in the inflationary dynamic. Furthermore, the crisis from the second half of the 1990s (monetary crisis in 1994, Asian crisis in 1997, Russian crisis in

[3] Administered prices are prices defined by contracts and prices which are monitored depending on previous government authorization, for example, tax, public utility services, and petroleum derivatives.

1998, and financial crisis in 2001) contributed to an increase in economic vulnerability (CBRT, 2005).

Under this bad environment the search for price stability as the main objective of the monetary policy together with transparent rules and a nominal anchor for public expectations became necessary. After the financial crisis in 2001, the monetary policy suffered several modifications and some institutional changes were implemented. In brief, a flexible exchange rate regime and the main objective of central bank became the search for a low and stable inflation. Moreover, in April 2001, the Central Bank of the Republic of Turkey (CBRT) became independent (Law 4.651/2001 – CBRT).

Concomitant with the above-mentioned changes, in May 2001 the program named "Strengthening the Turkish Economy – Turkey's Transition Program" was launched. The main point was the high inflation and public debt which must be reduced through tight monetary and fiscal policies together with structural reforms. As a result inflation targeting was adopted.

According to Süreyya Serdengeçti, ex-governor of the CBRT, the success of inflation targeting in Turkey would depend on some preconditions, such as, central bank independence, strong financial sector, and absence of fiscal dominance. It is also relevant to note that the CBRT decided for a smooth transition in the direction of inflation targeting and in January 2002 adopted an implicit inflation targeting for the conduction of monetary policy. The main justification for this is that the government's fiscal discipline and the financial market stability still had not been achieved.

> "I would like to mention that the inflation targeting regime is not an end in terms of monetary policy, but on the contrary, a component of an uninterrupted 'evolution' process. So far, we have tried to strengthen the economy with the help of fiscal discipline and ongoing structural reforms. I believe the independence of the Central Bank and the enhanced transparency and accountability will be the main tools to cope with challenges as they were in the previous period." (Süreyya Serdengeçti - CBRT, 2006)

After 2002 the disinflation process positively affected the economy (positive economic growth rate and progress in financial stability). Nowadays the financial markets are less fragile and the country risk has been falling since 2001. Moreover, both nominal and real interest rates together with the volatility in the exchange rate are decreased. The integration of the Turkish economy with the international market is growing and thus promoting a greater competitiveness of the economy.

Figure 2 shows the path of inflation rate accumulated in the last 12 months (measured by CPI) and of the interest rate (International Money Rate) before and after the adoption of inflation targeting. In addition, the annual inflation target and the tolerance intervals are presented.

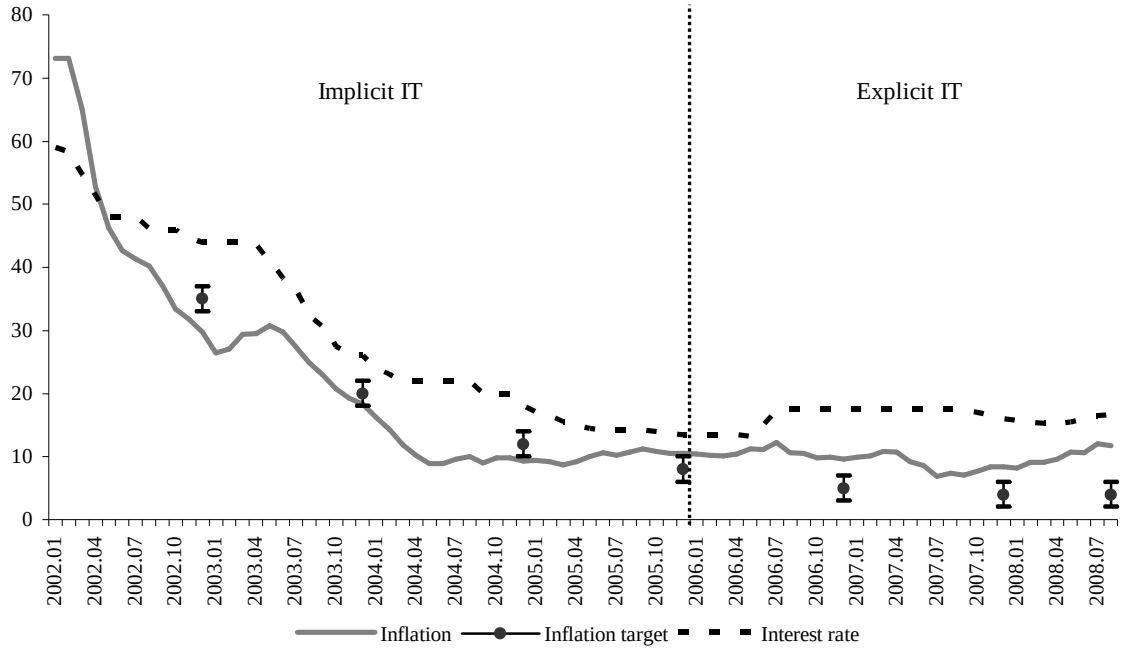
From the middle of 2002, the inflation and interest rate have decreased considerably and in 2006 and 2007 the inflation target was not reached. After the adoption of implicit inflation targeting the path of inflation and interest rate are similar. The correlation between these variables jumped from -0.26 (1998 to 2001) to 0.92 (2002 to 2005).[4]

From 2002 to 2006 the tight monetary and fiscal policies were implemented along with structural reforms (for example, introduction of new currency), institutional

[4] Due to the short sample in the period after adoption of explicit inflation targeting (January 1006 to August 2008) and the occurrence of economic turmoil, the correlation between the variables of -0.22 cannot be considered credible.

changes and adaptation to the flexible exchange rate. As a result, the implicit inflation targets were reached for four years consecutively contributing to a development of monetary policy credibility and the interest rate was reduced over time.

Figure 2
Evolution of Inflation and interest rate (%)



After the adoption of explicit inflation targeting,[5] the inflation targets were not reached. In according with the Inflation Report I-1007, the main reason for the failure in the achievement of the target in 2006 was in large measure the result of the increase in the agriculture prices. Moreover, the increase in the price of oil in the first half of 2006 and the devaluation of currency provoked an adverse impact on prices of energy. This negative environment forced the CBRT to raise its policy rate.

In December 2007 the inflation reached 8.39% above the upper limit (6% a.a.). Based on the Inflation Report I-2008 the failure of the central bank in achieving the inflation target was due to the increase in the administered prices and food prices. Furthermore the impact caused by the increase in the price of oil cannot be neglected. The bad economic environment did not stop and in June 2008 inflation reached 10.61%. Besides this the economy was experiencing difficulty in the international credit market and the economic activity is decreasing.

3. Taylor's rule for Brazil and Turkey

Due to the fact that both Brazil and Turkey have adopted inflation targeting as a guide for public expectation, presenting a history of high interest rate and the use of this

[5] "The main innovations in the full-fledged regime can be listed as follows: (i) Decisions were to be made on a voting basis in which the Monetary Policy Committee assumed the whole responsibility on setting the interest rates; (ii) A multi-year target horizon was set and medium term inflation forecasts were published in the new 'Inflation Report'; (iii) The CBRT committed to be accountable in case of sizeable deviations from the target." (Kaytanci, 2008, p. 4-5)

variable as the main instrument in the search for the inflation target, this section makes an analysis of their central banks' reaction functions based on Taylor's rule.

Besides the evaluation of several relevant macroeconomic variables (inflation, output gap, exchange rate, monetary aggregate) this analysis is also concerned with which type of inflation targeting is applied. In other words, it is possible to detect if the monetary regime is strict (focus only on inflation) or flexible (besides inflation a response to business cycle).

Taylor's rule applied in this study is based on Belke and Polleit (2007), that is,

(1) $$i_t = \rho i_{t-1} + (1-\rho)\left[\beta_0 + \beta_1 y_t + \beta_2(\pi_t - \pi^*)\right],$$

where i_t is the short term interest rate, y_t is the ouput gap, π_t is the inflation rate, π^* is the inflation target, β_1 are β_2 reflect the long-run weight of the variables output gap and the inflation rate, ρ is the smoothing parameter.

In addition to equation (1) the annual growth rate of money balances M3 (Δm_t) was introduced in the baseline model. The introduction of Δm_t allows us to verify if the increase of this monetary aggregate implies pressure on inflation (Altimari, 2001) and on output gap (Coenen *et al.*, 2001) and thus demands an increase in the interest rate. Hence,

(2) $$i_t = \rho i_{t-1} + (1-\rho)\left[\beta_1 + \beta_2 y_t + \beta_3(\pi_t - \pi^*) + \beta_4 \Delta m_t\right].$$

Clarida *et al*. (1998), and Ball (1999) included the nominal exchange rate (*EX*) in the rule for determining the interest rate. The idea is that some central banks increase the interest rate in response to a devaluation of currency. Notwithstanding, it is not clear if the central banks react in a direct manner to variations of the exchange rate and if the changes in the exchange rate impact on inflation and thus on the interest rate (Ball, 1999).

Calvo and Reinhart (2000) show that a large part of emerging economies that adopted flexible exchange rate regime use monetary policy for intervention in the exchange rate market. According to these authors, currency devaluations imply impacts not only on inflation but also on public debt due to the fact that part of it is indexed by exchange rate. Therefore a behavior is created known as "fear of floating", which in turn, justifies the introduction of the nominal exchange rate (*EX*) in Taylor's rule. Hence,

(3) $$i_t = \rho i_{t-1} + (1-\rho)\left[\beta_0 + \beta_1 y_t + \beta_2(\pi_t - \pi^*) + \beta_4 EX_t\right].$$

For the estimations of rules the Generalized Method of Moments (GMM) was adopted. The justification for the use of GMM is due to the fact that when OLS estimations have problems of serial autocorrelation, heteroskedasticity, or nonlinearity, which is typical in macroeconomic time series, this method implies consistent estimators for the regressions (Hansen, 1982; Baum *et al.*, 2003).

The choice of instrumental variables in GMM must obey two criteria (Caner, 2008): (i) the instrumental variable must be strongly correlated with the endogenous variables; and (ii) the instrument cannot be correlated with the structural errors, that is, the instrument must be an exogenous variable. For analyzing the quality of the instruments adopted in this study a standard J-test was performed. A better J-statistic indicates the greater the probability of the instruments being orthogonal and thus proper.

Taking into account the points above and the analyses made by Clarida *et al.* (2000); Ullrich (2003); and Belke and Polleit (2007), lags of: interest rate, departures of inflation from the target, monetary growth and exchange rate (when present in the model) were considered as instrument variables.

3.1. Analysis of the Brazilian reaction function

The data (monthly) in regard to the Brazilian economy were collected in the Central Bank of Brazil Web Site (www.bcb.gov.br) for the period July 1999 to August 2008 and corresponds to: interest rate (*i*) - over/Selic rate; departure of inflation (π) measured by IPCA accumulated in the last 12 months from annual inflation target (π^*) – that is - $(\pi - \pi^*)$; output gap (*y*) is the departure of natural log of GDP (at current price) deflated by IPCA from potential GDP;[6] monetary growth (*M3*) – annual growth rate of money balances M3; nominal exchange rate (*EX*) - R$/US$.

For avoiding the spuriousness problem in the estimations, unit root tests (Augmented Dickey-Fuller – ADF, Phillips-Perron – PP, and Kwiatkowski-Phillips-Schmidt-Shin - KPSS) were carried out.[7] The results indicate that, *y*, $(\pi - \pi^*)$, and *i* are I(0), while *M3* and *EX* are I(1).

Table 1 shows the estimations for the Brazilian Taylor's rule based on the three specifications. The positive relation regarding inflation and interest rate denotes that departures of inflation from the target provoke an increase in the basic interest rate. Notwithstanding, the coefficient concerning inflation in the three specifications suggests that the response of the CBB to departures of inflation from target is low ($\beta_2 < 1$). This result deserves attention because it is different from the original Taylor's rule where a $\beta_2 > 1$ assures that an increase in the nominal interest rate implies an increase in the real interest rate smoothing the impact caused by the departure of inflation from target (Belke and Polleit, 2007). Moreover, according to Ullrich (2003), a β_2 lower than 1 could indicate a loss of efficiency of the monetary policy. However, it is important to note that the reaction functions used are not specified for capturing demand or technological shocks (Giannone, Reichlin, and Sala, 2002).

The analysis concerning the output gap and the smoothing interest rate term is significant revealing a strong CBB reaction to the business cycles $(\beta_1 > 0)$. The strong response suggests that the CBB adopts a flexible inflation targeting.

It is important to highlight that the initial period considered in this analysis is characterized by a high inflation rate and three consecutive years with the inflation target were a failure (2001, 2002, and 2003). As a consequence, it is natural that departures of inflation from target contribute to an increase or stabilization (at a high level) of the interest rate. Furthermore, the output gap in the period did not present a motive for reduction in the interest rate. Therefore, there exist reasons that explain the inclination to increase/maintain the interest rate identified by the high coefficient of smoothing interest rate term in the specifications.

The introduction of monetary growth in the model (Eq(2)) neither presents statistical significance nor creates changes in the outcomes found in the first specification. On the other hand, the introduction of exchange rate in the third specification denotes a negative sign and a statistical significance that is consonant with the results found by Ball (1999), Taylor (2000), and Belke and Polleit (2007). In other words, an increase in inflation promotes an increase in the interest and consequently provokes an appreciation of the exchange rate thereby restraining the inflationary pressure. The high coefficient for β_4 indicates that for the Brazilian economy the

[6] It is the HP filtered natural log of GDP. Due to the fact that the HP filter decomposes a time series into a cyclical component and a trend, the HP trend is interpreted as the potential GDP.

[7] The tests are available on request from the authors.

variation of the exchange rate is relevant for the interest rate. Moreover the introduction of the exchange rate in the estimation did not eliminate the statistical significance of the other variables.

Table 1

Brazilian Taylor's rule estimations (GMM) - i

Regressors		Eq(1)	Eq(2)	Eq(3)
i_{t-1}	ρ	0.9167***	0.9187***	0.9301***
		[50.418]	[56.189]	[63.9370]
		(0.0182)	(0.0164)	(0.01455)
Constant	β_0	2.5367***	2.55402***	2.5014***
		[69.4788]	[79.7698]	[52.3999]
		(0.0365)	(0.0320)	(0.04774)
y	β_1	1.5272*	1.3918***	2.2174**
		[1.6429]	[1.6458]	[2.0060]
		(0.9296)	(0.8457)	(1.1054)
$\pi - \pi^*$	β_2	0.6696***	0.6768***	0.7181***
		[5.7392]	[6.0376]	[5.8755]
		(0.1167)	(0.1121)	(0.1222)
ΔM3	β_3		0.01515	
			[0.6001]	
			(0.0252)	
ΔEX	β_4			-2.0589**
				[-1.9263]
				(1.0689)
J-Statistic		0.1115	0.1374	0.1229
		p>0.95	p>0.95	p>0.95
Adj. R^2		0.9821	0.9822	0.9815
RMSE		0.109	0.121	0.099

Note: Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels, respectively. Standard error between parentheses and t-statistics between brackets.

The outcomes of the estimations in table 1 show that the coefficient of smoothing interest rate term is close to 1 and thus reveals a high persistence effect of the interest rate. In addition, the coefficient of inflation (β_2) is lower than the coefficient of output gap (β_1) in all specifications, which in turn denotes that the CBB takes into consideration both inflation and business cycles for decisions regarding interest rate. Finally the forecast error statistics given by the Root Mean Squared Error (RMSE) indicate that Eq(1) and Eq(3) are the better specifications.

3.2. Analysis of the Turkish reaction function

The Turkish data (monthly) were collected in the CBRT, Turkstat, and International Financial Statistics for the period January 2002 to August 2008 which corresponds to the time of implicit and explicit inflation targeting. The following variables were used: interest rate (*i*) – Interbank Money Rate; departure of inflation (π) measured by CPI accumulated in the last 12 months from annual inflation target (π^*) – that is - ($\pi - \pi^*$); output gap (*y*) is the departure of natural log of GDP (constant prices) from potential GDP; monetary growth (*M3*) – annual growth rate of money balances

M3; nominal exchange rate (*EX*) - YTR/US$.

The outcomes of the unit root tests[8] for the series which correspond to the above-mentioned variables denote that *y* and *EX* are I(0) while $(\pi - \pi^*)$, *i*, and *M3* are I(1).

Table 2 shows the estimations for the Turkish Taylor's rule based on the three specifications. The coefficients for departure of inflation from target are positive and significant in all specifications. Hence variation in the inflation provokes variation in the interest rate in the same direction. Over the period of implicit inflation targeting (2002 to 2006) the volatility of both inflation and interest rate were high. Under explicit inflation targeting the behavior of these variables is less volatile (exceptions are the middle of 2006 and the end of 2007).

Table 2

Turkish Taylor's rule estimations (GMM) - Δi

Regressors		Eq(1)	Eq(2)	Eq(3)
Δi_{t-1}	ρ	0.6057***	0.6010***	0.7202***
		[12.0489]	[29.5169]	[16.0219]
		(0.0503)	(0.0204)	(0.0450)
Constant	β_0	-0.0040	-0.0075***	-0.0169***
		[-1.5667]	[-4.7941]	[-4.1026]
		(0.0026)	(0.0016)	(0.0041)
y	β_1	0.0397*	-0.0388***	-0.0127
		[1.6593]	[-2.7572]	[-0.3602]
		(0.0239)	(0.0141)	(0.0353)
$\Delta\pi - \pi^*$	β_2	0.0564**	0.0506***	0.1956***
		[1.9651]	[5.0146]	[3.7615]
		(0.0287)	(0.0101)	(0.0520)
ΔM3	β_3		-0.0017***	
			[-3.1218]	
			(0.0005)	
EX	β_4			-0.5203***
				[-3.2090]
				(0.1621)
J-Statistic		0.1585	0.1720	0.1720
		p>0.95	p>0.95	p>0.95
Adj. R^2		0.2289	0.2289	0.0986
RMSE		0.040	0.043	0.040

Note: Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels, respectively. Standard error between parentheses and t-statistics between brackets.

The specifications in table 2 show distinct results in regard to the output gap. The first specification exhibits a positive and significant coefficient, that is, an increase in the output gap implies variations of the interest rate. However, with the introduction of the variation of the monetary growth (second specification) and the exchange rate (third specification), the sign of the coefficient β_1 became negative. Notwithstanding the

[8] The tests (ADF, PP, and KPSS) are available on request from the authors.

coefficient in the third specification is not statistically significant. Therefore it is not safe to make an affirmation based on this result.

The outcomes concerning the smoothing interest rate term reveal a strong persistence of the interest rate and are in accordance with those found by Aklan and Nargelecekenler (2008). The introduction of the monetary growth shows that the coefficient β_3 is negative and has statistical significance. Therefore, variation in the monetary growth may imply a decrease in the variation of the interest rate.

The use of the Taylor's rule with exchange rate as a reaction function of the CBRT has two main motives (Kaytanci, 2008): firstly, since 2002, the short term interest rate is the main instrument of the monetary policy; and secondly, the currency devaluation provokes an increase in imported goods. Due to the fact that the Turkish economy depends on the importation of raw material, the exchange rate has an important role on inflation and thus on interest rate. According to Berument and Gunay (2003) the exchange rate volatility is an important determinant of the interest rate, thus, as expected, the coefficient for the exchange rate is statistically significant and has negative sign (see table 2).

It is important to note that the period 2002 to 2005 is characterized by a systematic process of decreasing the interest rate. For the exchange rate, the behavior is asymmetric, however with an inclination for strong currency valuation (YTR/US$=1.60 in December 2002 and 1.35 in December 2005). After the adoption of explicit inflation targeting the currency valuation is more accentuated and less asymmetric (YTR/US$=1.17 in August 2008).

The result suggests that the CBRT does not use a Taylor's rule. It is important to highlight that the period in analysis is marked by several structural and institutional changes (adoption of flexible exchange rate regime, adoption of a new currency, etc.). This finding is not rare in the literature. According to Pongsaparn (2002, p. 16): "Although it appears that there is no explicit reaction function and interest rate has been accommodative, interest rate does have a role in influencing inflation and exchange rate."

3.3. A comparative analysis of the Brazilian and Turkish reaction functions

With the objective of verifying possible similarities and differences in regard to the use of the interest rate in the conduction of the Brazilian and Turkish monetary policy, this section makes a comparative analysis. It is important to stress that this comparison is possible because both countries have similar characteristics (see table 3): are developing economies, have adopted inflation targeting, use the interest rate as the main instrument of the monetary policy, use flexible exchange rate regime, adopted new currency, adopted strategy for improving the public debt profile, and have the highest interest rate in the world.

Due to the objective and for simplifying the comparison we decided to use the same set of variables present in the previous sections (4.1 and 4.2) with the series in level. Table 4 shows the outcomes for GMM estimations in regard to the Brazilian and Turkish Taylor's rule taking into account three specifications based on equations 1, 2, and 3. It is observed that in both economies the coefficient of smoothing interest rate term is quite high (close to 1) in all specifications. A possible justification for this result is that a high persistence of the interest rate is due to a period with considerable disinflationary process. Moreover, the practice of smoothing interest rate is based on the argument that strong adjustments of the interest rate could imply disastrous effects for the financial market. The high volatility in the interest rate could imply a difficulty in

the formation of expectations by economic agents thus impairing their decision-making. In addition, sudden changes in the interest rate may cause an imbalance between assets and liabilities of financial institutions. Besides this, the process for developing credibility explains the conservativeness of the central bank behavior in these countries.[9]

Table 3
Comparison Brazil and Turkey

	BRAZIL	TURKEY
Adoption of inflation targeting	1999	2002 (implicit IT) 2006 (explicit IT)
Inflation	8.94% Dec/1999 (target 8 %)	29.75% Dec/02 (target 35%) 9.65% Dec/06 (target 5%)
	6.17 % Aug/08 (target 4.5%)	11.76% Aug/08 (target 4%)
Interest rate	19% Dec/99	44% Dec/02 17% Dec/06
	12.92% Aug/08	16.75% Aug/08
Exchange rate (US$)	1.84 Dec/99	1.59 Dec/02 1.33 Dec/06
	1.61 Aug/08	1.17 Aug/08
Adoption of new currency	1994	2005
Adoption of flexible exchange rate regime	1999	2001
Strategy for improving public debt profile	2002	2001
Failure of inflation target	2001, 2002, and 2003	2006 and 2007

Sources: CBB and CBRT.

In a general way the coefficients for output gap are positive and statistically significant. As a consequence, there is no doubt that the central banks in both countries, besides being concerned with inflation, take into account the stabilization of the business cycles. The coefficients for the Turkish economy are greater than the coefficients for the Brazilian economy. This result might be a consequence of the structural and institutional changes in the period under analysis in Turkey. In regard to Brazil, it is important to note that the success in the control over inflation and the stabilization of the economy date from the introduction of the Real plan in 1994.

In agreement with the theoretical view, the coefficients for departure of inflation from its target are positive and statistically significant. Once again, the coefficients for the Turkish economy are greater than the Brazilian economy which in turn reveals a more aggressive policy against inflation by the CBRT than the CBB. Furthermore, it is observed that for Turkey the coefficient is greater than 1 in all specifications. Therefore, it is assured that an increase in the nominal interest rate implies an increase in the real interest rate and thus smoothing the shocks caused by departures of inflation from target.

[9] "In most new inflation targeting regimes, especially when initial inflation is high and a period of disinflation is required, inflation expectations are high and credibility is low." (Svensson, 2003, p.10)

Table 4

Brazilian and Turkish Taylor's rule estimations (GMM) - i

		BRAZIL			TURKEY		
Regressors		Eq(1)	Eq(2)	Eq(3)	Eq(1)	Eq(2)	Eq(3)
i_{t-1}	ρ	0.9167***	0.9333***	0.8680***	0.9707***	0.9724***	0.9572***
		[50.4175]	[80.5863]	[58.2726]	[125.5158]	[213.9112]	[192.3718]
		(-0.0182)	(-0.0112)	(-0.0149)	(-0.0077)	(-0.0045)	(-0.0050)
Constant	β_0	2.5367***	2.1561***	2.0310***	1.9501***	1.5151***	1.2273***
		[69.4788]	[13.3508]	[22.2768]	[6.9073]	[4.3989]	[5.3228]
		(-0.0365)	(-0.1615)	(-0.0912)	(-0.2823)	(-0.3444)	(-0.2306)
y	β_1	1.5272*	1.4598*	-0.4901	2.0934***	1.7227***	1.3599***
		[1.6429]	[1.8447]	[-1.1510]	[2.5367]	[3.9595]	[2.3554]
		(-0.9296)	(-0.7913)	(-0.4258)	(-0.8252)	(-0.4351)	(-0.5774)
$\pi - \pi^*$	β_2	0.6696***	0.7082***	0.5139***	1.1102***	1.6354***	1.1719***
		[5.7392]	[6.0999]	[7.6637]	[2.8146]	[4.2087]	[5.8836]
		(-0.1167)	(-0.1161)	(-0.0671)	(-0.3945)	(-0.3886)	(-0.1992)
M3	β_3		0.0200***			0.0024	
			[2.5695]			[0.5887]	
			(-0.0078)			(-0.0041)	
EX	β_4			0.7391***			2.1558***
				[6.6658]			[3.7477]
				(-0.1109)			(-0.5752)
J-Statistic		0.1115	0.1495	0.1299	0.1507	0.1872	0.1618
		(p>0.95)	(p>0.95)	(p>0.95)	(p>0.95)	(p>0.95)	(p>0.95)
Adj. R^2		0.9821	0.9796	0.9829	0.9880	0.9877	0.9889
RMSE		0.109	0.129	0.129	0.166	0.286	0.250
RMSE (subsample)		0.039	0.033	0.045	0.166	0.128	0.163

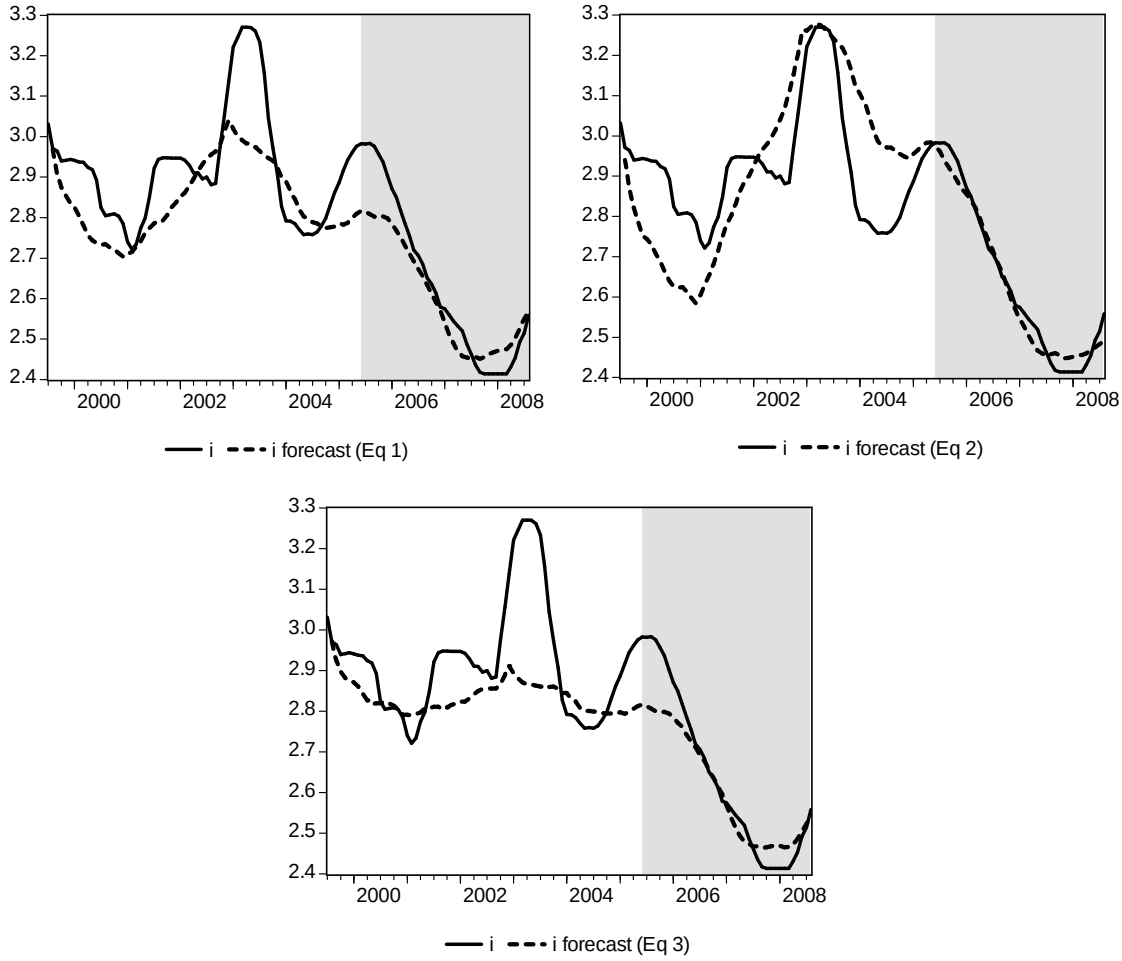
Note: Asterisks denote significance at the 1% (***), 5% (**) and 10% (*) levels, respectively. Standard error between parentheses and t-statistics between brackets. RMSE (subsample): Brazil - June 2005 to August 2008, and Turkey – June 2006 to August 2008.

The introduction of monetary growth in estimations of both economies increased the coefficient regarding inflation and decreased the coefficient of output gap. It is important to highlight that the monetary growth performs an important role from June 2005 in the determination of the interest rate in the Brazilian economy. Through the shaded area in figure 3 (Eq 3) it is possible to note that the use of monetary growth in Taylor's rule implies the best specification for forecasting the interest rate. This observation is confirmed by the RMSE test for the subsample period (see table 4).

Figure 3 shows that Taylor's rule, most of the time, undervalues the behavior of the interest rate, however it fits for periods without shocks. The response to the shocks in 2002 and 2005 is not captured in an adequate manner for specifications Eq(1) and Eq(3).

Figure 3

Brazil – Interest rate and forecast using Taylor's rule (out-of-sample) - GMM[10]



For the Turkish economy a continuous and accentuated reduction in the interest rate until the beginning of 2006 is observed in response to the adoption of implicit inflation targeting. After the adoption of explicit inflation targeting an increase in the interest rate is detected. The introduction of monetary growth became relevant in Taylor's rule from the middle of 2006 (see figure 4). Such as observed in the Brazilian case, the RMSE test strengthens the relevance of monetary growth in the subsample period (see table 4). Furthermore, in all specifications, the results of forecast from Taylor's rule undervalue the observed interest rate.

The coefficients for the exchange rate are positive and statistically significant for both countries. The introduction of this variable in the estimations promoted a decrease in the parameters of the smoothing interest rate term and of the output gap.

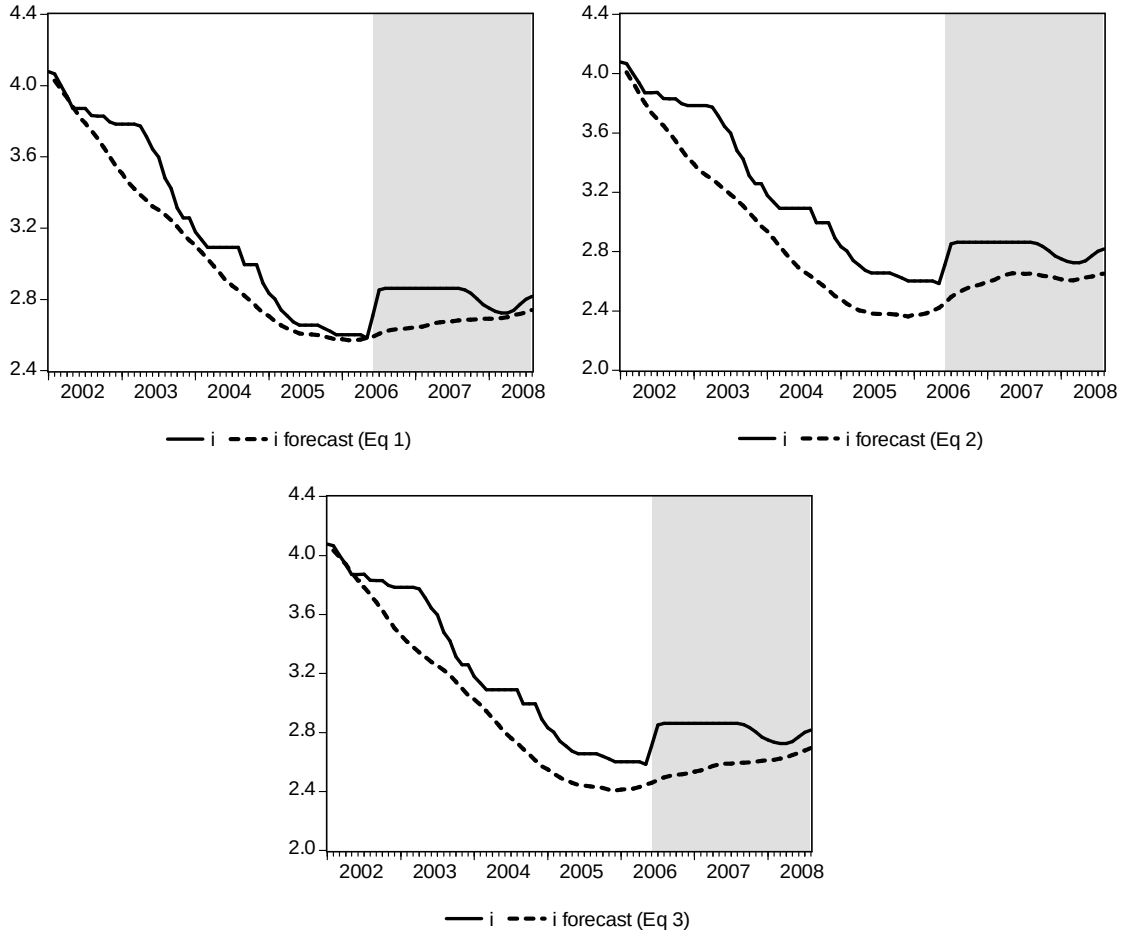
The strong process of currency valuation in the Turkish economy contributed to the control of the inflation and for systematic reduction of the interest rate in the period. Notwithstanding, in 2006 there was a strong currency devaluation due to the fall of foreign direct investment which affected all emerging economies. In response to the devaluation of currency and to the inflationary shock, the CBRT increased the interest rate from 13.25% in May 2006 to 17.50% in June 2006. In fact, when the Turkish Lyra was devaluated, the CBRT attempted to stop the movement through an increase in the

[10] According to Inoue and Kilian (2002) in-sample tests of predictability are at least as credible as the results of out-of-sample tests.

interest rate.

Figure 4

Turkey – Interest rate and forecast using Taylor's rule (out-of-sample) - GMM



An overshooting of the exchange rate occurred in the Brazilian economy in 2002 due to the presidential electoral crisis which implied an increase in the interest rate. Further, in 2005, the CBB increased the interest rate in response to the beginning of the American crisis which promoted a devaluation of the dollar in relation to the other currencies.

Taking into account the whole period, it is observed that specification Eq(1) is that which represents the best capacity of forecasting for both economies. However, when the subsample period is considered the monetary growth becomes relevant for forecasting the interest rate and thus cannot be neglected in the future studies.

In brief, it is possible to conclude that, except for the period of crisis, Taylor's rule explains well the behavior of the Brazilian interest rate. On the other hand, for the Turkish economy Taylor's rule undervalues the interest rate and does not capture the main oscillations which in turn suggest that the CBRT does not make use of this rule for defining the interest rate.

4. Concluding remarks

The results for the Brazilian economy denote that the CBB makes use of a Taylor's rule for defining the interest rate. Notwithstanding, this rule is not adequate for

periods where shocks on economy are observed (for example presidential electoral crisis in 2002/2003 and the devaluation of the dollar in 2005). It is observed that the CBB reacts to departures of inflation from target and to an increase in output gap increasing the interest rate. The statistical significance for the coefficients regarding output gap indicates that the CBB is concerned with the business cycles. It is important to note that the high coefficient for β_4 reveals that the variation in the exchange rate is not negligible in the rule for determining the interest rate.

In regard to the Turkish economy, the results indicate that although the main objective of the CBRT is the price stability with a decreasing interest rate, it does not use Taylor's rule in an explicit way. The coefficients for variation in the departure of inflation from inflation target are positive thus revealing the occurrence of variations in the interest rate as a response. In regard to the output gap the results are not conclusive. On the other hand, the introduction of variations of monetary growth and of exchange rate is relevant in the determination of the interest rate.

The comparative analysis for Brazil and Turkey allowed identifying that both central banks have adopted a flexible inflation targeting and that there exists a strong persistence of the interest rate. The high smoothing effect in the interest rate denotes that the central banks are concerned with the reduction of the interest rate volatility which in turn contributes to improve public expectations and central bank credibility.

Although the adjustment of Taylor's rule to the observed interest rate in Turkey is not well fit, the high coefficients in the estimations indicate that the CBRT has a more aggressive anti-inflationary policy than the CBB. The introduction of the monetary growth showed an important role of this variable for forecasting the interest rate in the last years for both economies. Finally, it is important to note that in spite of the high interest rates in these economies, a systematic reduction of them is observed thus indicating a movement of convergence with the interest rates practiced in other countries.

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