International Business Research; Vol. 15, No. 8; 2022
ISSN 1913-9004 E-ISSN 1913-9012
Published by Canadian Center of Science and Education

Credibility, Inflation Targets and Interest Rate: Long-Term Results for Brazil

Augusto César Klassen Amorim Alves de Lima[1], & Ricardo Ramalhete Moreira[2]

[1] Brazilian Institute of Geography and Statistics, Vitória, Espírito Santo, Brazil

[2] Federal University of Espírito Santo, Vitória, Espírito Santo, Brazil

Correspondence: Augusto César Klassen Amorim Alves de Lima, Brazilian Institute of Geography and Statistics, Vitória, Espírito Santo, Brazil.

Received: May 25, 2022 Accepted: July 11, 2022 Online Published: July 25, 2022

doi:10.5539/ibr.v15n8p70 URL: https://doi.org/10.5539/ibr.v15n8p70

Abstract

This study carried out an empirical investigation into the relationship between the credibility of monetary policy – measured based on seven indicators – and the necessary variation of interest rates to control inflation, replicating the methods proposed by Mendonça and Souza (2007), extending them for the period 1999-2020. The results obtained confirm the hypothesis that higher levels of credibility allow the Central Bank to control inflation with lower interest rate increases. Furthermore, evidence was found that, although the credibility indicators show a better adjustment relative to the data – indicating a *forward-looking* nature in the conduction of basic interest rates –, among the reputation indicators, short-run inflationary results have a stronger weight in the decisions of monetary policy, suggesting that public expectations with short-memory remain relevant in the sample period.

Keywords: monetary policy, credibility, inflation targets, inflation expectations

1. Introduction

In June 1999, Brazil adopted the inflation targeting regime as an anchor of expectations for its monetary policy. Since then, despite the various crises (political and economic) faced by the country, inflation has been controlled at the cost of declining interest rates (Selic gradually dropped from 19.5% pa in 1999 to 2% pa in 2020), which shows a gain in the effectiveness of monetary policy in the long run. In this context, credibility plays a fundamental role in shaping expectations and controlling inflation.

By examining different monetary policy regimes, Mishkin (1999) found the relationship between credibility gains – in its broadest sense, via the adoption of transparent rules that restrict the discretionary performance of central banks – and long-term gains. In particular, the author listed several advantages inherent to the inflation targeting system, highlighting the fact that it is an explicit numerical target, easily understood by society as a whole, which gives great transparency to monetary policy. Such characteristics reduce the possibility of a temporally inconsistent policy and allow, according to the author, to guide the public debate towards the consensus that an economy with more stable prices in the long term is preferable to merely transitory short-term gains, based on a discretionary conduct of monetary policy.

The reputation of a monetary authority in public opinion takes time to build and, depending on the country's macroeconomic situation, it may take decades to consolidate an image associated with institutional commitment to achieving and maintaining price stability. Central banks in countries that are in a context of persistent inflation – as in Brazil before the Real Plan – face the challenge of the inflationary memory of economic agents, which not only contributes to the inertia of inflation but also makes it difficult to anchor expectations in the targets established by the monetary authority. Therefore, in such circumstances, greater rigor in the determination of interest rates is expected, which justifies the conservatism of central banks that are still incipient in the search for price stability. On the other hand, once the initial barriers have been overcome and the perception that the monetary authority is committed to stabilizing inflation in the long run consolidated, the policy gains greater flexibility to deal with short-term shocks, requiring smaller and less frequent rate hikes in response to short-term price increases.

King (1996) argued that disinflation is conducted sparingly, over several periods, so that inflation converges to a lower level in the long run. In an inflation targeting regime, the strategy consists of setting targets below current market expectations in the short term in order to lead the process of formation of agents' forecasts over time towards an expected level for inflation that is lower than previously observed. By building its reputation and the consequent gain in credibility, a Central Bank that gradually drives inflation to lower levels over the years manages to reduce inflation at the cost of smaller variations in output in the short term – there is a reduction in monetary policy social costs. Therefore, with greater credibility, the Central Bank can vary the interest rate with less intensity and frequency in the face of increases in inflation triggered by supply shocks – there is greater flexibility in the conduct of monetary policy –, imposing less sacrifice on the product in the short term, while central banks without consolidated reputation – and without credibility – are more often pressured to raise interest rates, even in the face of temporary price increases.

Mendonça and Souza (2007) estimated the credibility of monetary policy for the period between July 1999 – right after the adoption of the inflation targeting regime – and February 2006, based on seven indicators. Furthermore, the authors carried out an empirical investigation in order to analyze the effects caused by the variation in credibility on the variations in interest rates.[1] The results obtained by the study adhere to the hypothesis that greater credibility would enable to control inflation with lower interest rate increases.

In order to study the reputation and credibility of monetary policy in Brazil – as well as its effects on the determination of interest rates – for the period between July 1999 and December 2020, this work replicated the methods applied in Mendonça and Souza (2007), in order to contribute with an update of the results obtained by the authors, and testing their robustness for the recent period.

In addition to this introduction, the article is divided into five other sections, where literature review and the indicators used in this study are presented, their analysis for Brazil, the empirical analysis of the effects of measured credibility on interest rates and, finally, the conclusion.

2. Literature Review

Kydland and Prescott (1977) and Barro and Gordon (1983) are commonly related to the origin of the "rules versus discretion" debate, which would persist over decades ahead as a relevant issue of study. The assumption according to which the monetary authority's credibility and reputation have an important influence on the monetary policy's effectiveness in shaping inflation rates has inspired several empirical works, which investigated such relations.

For example, and particularly for the Brazilian economy, Sicsú (2002) and Mendonça and Souza (2007) – both published after the adoption of the inflation targeting regime in Brazil (1999) – used the measurement of credibility indexes as a tool to evaluate the ability of the Central Bank in anchoring inflationary expectations to the announced targets. The findings were consistent with the theory, thereby bringing evidence that certain attributes like credibility, the reputation of a commitment to sound practices, the institutional governance and the monetary authority's transparency would be associated with the observed performance in controlling inflation.

Moreira (2013), in turn, proposed the application of a Dynamic Stochastic General Equilibrium (DSGE) Model with a Central Bank's endogenous and non-linear credibility, in order to analyze the monetary policy conduction and the reaction from macroeconomic variables to different types of shocks, but focusing on shocks to the interest rate. The simulation results indicated that a lower monetary policy credibility creates a constraint to the Central Bank, which has more obstacles to accommodate supply shocks or to stimulate output, given the higher sensitivity of the inflation dynamics to the past inflation levels – that is, a higher inflationary inertia degree.

Furthermore, according to Moreira (2013), the past path and the building process of credibility are relevant factors for the Central Bank's performance over time. The initial level of credibility can explain why some central banks, in comparison to others, are subject to more instability, even if conditioned to similar monetary regimes and structural shocks.

Besides, Montes and Bastos (2014) estimated Generalized Method of Moments (GMM) regressions, as well as Vector Autoregressive (VAR) models, based on credibility and reputation indexes, so as to infer on the role of

[1] The relationship between the credibility measured by the indicators and the basic interest rate of the economy was investigated from two perspectives: i) the target for the interest rate established by the Monetary Policy Committee of the Central Bank (Copom), which will be represented in this work by SELICBC variable; and ii) the basic interest rate practiced in the financial market, which undergoes operational intervention by the Central Bank to adhere to the goal established by the Copom, represented by the SELICM variable.

such attributes to lower the inflationary bias and the associated needed cost to tame the inflation rate in an emerging economy. The empirical results pointed to a relevant role of the Central Bank's reputation in building the inflation targeting regime's credibility. Moreover, the work achieved evidence that a rise in credibility allows the Central Bank to manage the daily market liquidity in a more efficient way.

In turn, Levieuge, Lucotte and Ringuedé (2015) analyzed the relationship between the monetary policy credibility and the interest rate volatility for 18 emerging economies, including Brazil, which adopted the inflation targeting regime. Firstly, they proposed a measure of credibility based on an index considering the difference between the inflationary expectations and the official target announced by the monetary authority. In sequence, EGARCH models were estimated and it indicated an inverse relationship between the monetary policy credibility and the interest rate volatility. Therefore, in consistency with the theory, the findings pointed to the reduction of needed interest rate adjustments as a consequence of a rise in credibility.

Some recent works also have empirically evaluated – and also with the use of indexes – the building dynamics of credibility, as well as its effects on the whole economy. Chansriniyom, Epstein and Nalban (2020) used a semi-structural model and achieved results showing that positive inflation deviations from the official targets are followed by higher costs than what were observed under negative inflation deviations – thereby leading to a high inflation inertia degree. In turn, Issler and Soares (2022) studied the assumption that when the Brazilian Central Bank has more credibility the public expects it to react in consistency with its own announcements. To do so, the authors used monthly data for inflationary expectations available in the Focus Bulletin (Survey), from Jan/2007 to Apr/2017. The evidence was in favor of the existence of credibility in 65% of the sample.

3. Credibility Indicators

The first four indicators presented (Cecchetti & Krause, 2002; Sicsú, 2002; Mendonça, 2004) have their calculation based on the concept of credibility, defined by Faust and Svensson (1998), as being negatively related to the distance between the expectations of the private sector regarding the future course of inflation and the inflation target announced by the monetary authority – this is a *forward-looking* perspective. In turn, the other three indicators presented are based on the concept of reputation – *backward-looking perspective* – , which considers the past course of the results achieved by the monetary policy. Reputation considers the deviations of inflation observed in relation to the target (Mendonça & Souza, 2007).

Considering an inflation target of 2%, as well as the deviations between the inflation target and the expected inflation, Cecchetti and Krause (2002) proposed the following credibility index:

$$\mathrm{CI_{CK}} = \begin{cases} 1 & \text{if} \quad E(\pi) \leq \pi^* \\ 1 - \frac{1}{0,2-\pi^*}[E(\pi) - \pi^*] & \text{if} \quad \pi^* < E(\pi) < 20\% \\ 0 & \text{if} \quad E(\pi) \geq 20\% \end{cases} \tag{1}$$

In equation (1), $E(\pi)$ is the inflation expected by the market and π^* is the inflation target center. The index varies between 0 and 1, assuming the maximum value (maximum credibility) when the expected annual inflation is less than or equal to the target. The index decreases linearly as the expected inflation increases. The authors attributed a zero degree of credibility to cases in which the inflation expectation assumes values from 20% pa.[2]

Sicsú (2002), in turn, formulated an index (CI_S) that expresses credibility on a scale that, originally, can vary in the interval]-∞; 100]. However, seeking to make the values returned by the formula more compatible with the other indexes, Mendonça and Souza (2007) divided the index by 100:

$$\mathrm{CI_S} = \left\{ \frac{100 - \left[\frac{|E(\pi)-\pi^*|}{\pi^*_{MAX} - \pi^*} \times 100 \right]}{100} \right\} \tag{2}$$

In equation (2), π^*_{MAX} it is the upper bound of the inflation target and π^* is the center of the target. The index penalizes credibility due to deviations from the inflation expectation in relation to the center of the target. If the inflation expectation reaches one of the margins (lower or higher) of the announced target, the credibility attributed will be zero, and it may even assume negative values if the expectation extrapolates one of the target's

2 The CI_{CK} formulators argue that, faced with an expectation of inflation above 20%, the monetary authority loses its ability to control inflation.

margins.[3] As inflation expectations converge to values closer to the center of the target, credibility increases, reaching 1 (maximum credibility) if the expectation is equal to the center of the announced target.

Based on an CI_S adaptation, Mendonça (2004) proposed the CI_M in order to restrict the magnitude of the value returned by the index, so that credibility only varies between 0 and 1 – less complicated to interpret when compared to an index which can tend to infinity. The CI_M is calculated based on equation (3), where π^*_{MAX} and π^*_{MIN} are, respectively, the upper and lower limit of the inflation target, and π^* is the center of the target. The index decreases proportionally with the increase in the distance between the center of the target and the market's inflation expectation, reaching zero when the expectation equals one of the limits (no credibility) and 1 (maximum credibility), when the expectation equals to the central goal.

$$CI_M = \begin{cases} 1 & \text{if} \quad E(\pi) = \pi^* \\ 1 - \frac{E(\pi) - \pi^*}{\pi^*_{MAX} - \pi^*} & \text{if} \quad \pi^*_{MIN} < E(\pi) < \pi^*_{MAX} \\ 0 & \text{if} \quad E(\pi) \geq \pi^*_{MAX} \text{ or } E(\pi) \leq \pi^*_{MIN} \end{cases} \quad (3)$$

The monetary authority has no absolute control over prices in the economy – they derive from decentralized decisions by private agents – which may explain the failure to comply with the targets set for inflation. In order to overcome this problem, the Central Bank can adopt a range for the target in bands, which provides greater flexibility and transparency for the conduct of monetary policy. Based on the belief that agents are rational and that small deviations of inflation from the center of the target would not justify rigorous losses in credibility – and proportional to the deviations –, Mendonça and Souza (2007) proposed another index (CI_A), this time based on CI_{CK}, by Checchetti and Krause (2002). The CI_A does not penalize deviations from the central target that do not exceed the limits determined by the target, so that credibility is maximum (CI_A = 1) when the inflation expectation is within the established limits ($\pi^*_{MIN} \leq E(\pi) \leq \pi^*_{MAX}$). On the other hand, the credibility measured by the index decreases linearly when inflation expectations go beyond one of the target limits, equaling to zero (no credibility) when the inflation expectation reaches 0% or 20%, values considered critical in the index calculation.[4]

$$CI_A = \begin{cases} 1 & \text{if} \quad \pi^*_{MIN} \leq E(\pi) \leq \pi^*_{MAX} \\ 1 - \frac{E(\pi) - \pi^*_{MAX}}{0{,}2 - \pi^*_{MAX}} & \text{if} \quad \pi^*_{MAX} < E(\pi) < 20\% \\ 1 - \frac{\pi^*_{MIN} - E(\pi)}{\pi^*_{MIN}} & \text{if} \quad 0\% < E(\pi) < \pi^*_{MIN} \\ 0 & \text{if} \quad E(\pi) \geq 20\% \text{ or } E(\pi) \leq 0\% \end{cases} \quad (4)$$

The calculation of the presented indexes depends on the availability of data on market expectations for future inflation, which is not always the reality for countries, which may not have such information. In order to enable the study of the credibility of monetary policy in these cases, Mendonça and Souza (2007) designed three indicators based on the concept of reputation, which does not depend on expectational data, but only on the historical series of observed inflation, allowing the measurement of the results obtained – in terms of deviations of inflation from the target – over time. The authors justified the solution based on the argument that reputation can be considered an inducer of credibility, given its dependence on the monetary authority past behavior.

Mendonça and Souza (2007) formulated reputation indicators based on the premise that it can be measured by the sum of reputations obtained over time. To calculate the reputation (R) attributed to each period, the authors determined a formula similar to the one used to calculate the CI_A, just substituting inflation expectations for the actual inflation (π_{OBS}), as shown in equation (5).[5]

[3]Under the assumption of symmetry of target tolerance limits, the credibility measured by the index will be negative in cases where inflation expectations are above the upper limit or below the limit.

[4]Like the $CI_{CK,}$ the CI_A also considers 20% a critical value for inflation, based on the argument that, at this level, the Central Bank would have great difficulties in controlling inflation. On the other hand, inflation at 0% represents a flagrant risk of deflation perceived by economic agents, a phenomenon that is difficult to deal with by conventional instruments of monetary policy.

[5]Reputation (R) consists of a discrete variable, measured for each period t.

$$R = \begin{cases} 1 & \text{if} \quad \pi^*_{MIN} \leq \pi_{OBS} \leq \pi^*_{MAX} \\ 1 - \frac{\pi_{OBS} - \pi^*_{MAX}}{0{,}2 - \pi^*_{MAX}} & \text{if} \quad \pi^*_{MAX} < \pi_{OBS} < 20\% \\ 1 - \frac{\pi^*_{MIN} - \pi_{OBS}}{\pi^*_{MIN}} & \text{if} \quad 0\% < \pi_{OBS} < \pi^*_{MIN} \\ 0 & \text{if} \quad \pi_{OBS} \geq 20\% \ \text{or} \ \pi_{OBS} \leq 0\% \end{cases} \tag{5}$$

Based on this reputation measure, Mendonça and Souza (2007) developed three new credibility assessment methods: i) reputation index based on its average (RI_A); ii) index based on weighted reputation (RI_W); and iii) index based on reputation by moving average (RI_{MA}).

The RI_A consists of the arithmetic mean of the reputation, being the total number of periods t that make up the historical series. Its formula is presented in equation (6).

$$RI_A = \left\{ \frac{\sum_{i=1}^{n} R_i}{n} \right\} \tag{6}$$

In turn, RI_W measures credibility based on the weighted average of the reputations (R) obtained over time, for each period t. The weights of these parcels are assigned in a way directly proportional to the proximity to the current period (t). In other words, reputations measured in more recent periods have a greater weight in the index calculation. The weighting (p_i) varies in the interval] 0, 1], being obtained by the ratio between k_i (decreasing position in relation to t) and n (total number of measured reputations). The RI_W calculation is presented in equation (7).

$$RI_W = \left\{ \frac{\sum_{i=1}^{n} (R_i \times p_i)}{\sum_{i=1}^{n} p_i} \right\}, \text{ where } \quad p_i = \frac{k_i}{n} \tag{7}$$

Finally, the RI_{MA} measures current credibility based on a moving average of reputation over the last d lagged periods.[6]

$$RI_{MA_t} = \left\{ \frac{R_t + R_{t-1} + \cdots + R_{t-d+1}}{d} \right\} \text{Similarly,}$$

$$RI_{MA_t} = \left\{ RI_{MA_{t-1}} + \frac{R_t - R_{t-d}}{d} \right\} \tag{8}$$

The RI_{MA}, among the indicators based on the concept of reputation, is the one that tends to have greater volatility, given that the time interval considered for its calculation is constant – equal to the number of lags d –, while the other reputation indexes consider the entire historical series available to the researcher, since its beginning – the past time interval used to calculate these indicators is increasing. The longer time base increases the credibility inertia measured by the RI_A and RI_W, whereas the RI_{MA} depends only on more recent periods.

4. Analysis of Credibility Indicators for Brazil

The inflation targeting regime in Brazil uses the *Broad Consumer Price Index* (IPCA) as a reference. The goals are established by CMN (National Monetary Council) in June of each year for a horizon of two to three years – such as the goal for 2023, which was determined on June 25, 2020, through Resolution 4,831 –, with the objective of anchoring the expectations of economic agents regarding the future course of monetary policy. The scheme uses tolerance ranges and achievement of the target is assessed at the end of each year. The inflation targets, as well as the observed annual inflation, are presented in Table 1.

The database used to calculate the indicators was extracted from the *Time Series Management System* (SGS), available on the official website of the Central Bank of Brazil (2020b). In this work, the following data were used: i) annual inflation targets and their tolerance limits; ii) annualized monthly inflation series[7]; and iii) daily series of market expectations for inflation accumulated at the end of the current year. All series used in this work were worked on a monthly basis.

[6] In this work, six lags were used to calculate the RI_{MA}, as Mendonça and Souza (2007) did in their original article.

[7] The series extracted from the SGS receives treatment that consists of calculating the geometric mean of monthly inflations in the year up to the month of observation, and then the data is annualized.

Table 1. Inflation targets and observed inflation (1999-2020)

Year	Target (%)	Band (p.p.)	Lower and Upper Limits (%)	Observed inflation (IPCA % pa)
1999	8	2	6-10	8.94
2000	6	2	4-8	5.97
2001	4	2	2-6	7.67
2002	3.5	2	1.5 - 5.5	12.53
2003*	8.5	0.5	8-9	9.3
2004*	4.5	2.5	3-8	7.6
2005	5.1	lower: 3.1 upper: 1.9	2 - 7	5.69
2006	4.5	2	2.5 - 6.5	3.14
2007	4.5	2	2.5 - 6.5	4.46
2008	4.5	2	2.5 - 6.5	5.9
2009	4.5	2	2.5 - 6.5	4.31
2010	4.5	2	2.5 - 6.5	5.91
2011	4.5	2	2.5 - 6.5	6.5
2012	4.5	2	2.5 - 6.5	5.84
2013	4.5	2	2.5 - 6.5	5.91
2014	4.5	2	2.5 - 6.5	6.41
2015	4.5	2	2.5 - 6.5	10.67
2016	4.5	2	2.5 - 6.5	6.29
2017	4.5	1.5	3 - 6	2.95
2018	4.5	1.5	3 - 6	3.75
2019	4.25	1.5	2.75 - 5.75	4.31
2020	4	1.5	2.5 - 5.5	4.52

* The open letter, dated 01/21/2003, established adjusted targets of 8.5% for 2003 and 5.5% for 2004. For January 2003 a target of 4% was considered, with bands of 2.5%, while the target shown in the table was valid for the rest of the year.

According to Mendonça and Souza (2007), the inflation target consists of a contract between the monetary authority and society as a whole – renewed annually – so that the expectations considered for measuring credibility must refer to the current contract. For this reason, the credibility indexes based on a forward-looking perspective – $CI_{CK,}$ CI_S, CI_M and CI_A – use the series of market expectations for inflation accumulated at the end of the current year as a variable.[8]

Mendonça and Souza (2007) observed that, at each beginning of the year, expectations – and, consequently, the *forward-looking* credibility indicators – show a break in the pattern in relation to the previous year. This can be interpreted as evidence that economic agents reorient their expectations for inflation in convergence with the current target for the new year, which reinforces the argument that the performance of the monetary authority in the contract for the previous year is relevant to anchoring expectations. In order to verify the authors' hypothesis, the percentage change – in absolute terms – of the inflation expectation – accumulated at the end of the current year – was calculated for each month in relation to the previous one.[9] As shown in Table 2, for most years, January presented percentage variations substantially higher than those observed for the other months of each year, which is evidence of the rupture observed by Mendonça and Souza (2007).

[8]The series is extracted from the Central Bank's SGS on a daily basis. To be used in the indicator calculations – on a monthly basis – the data receive treatment that consists of calculating the average of daily observations in the month. In addition, it is important to note that data referring to market expectations are only available as of January 2000, which enabled the calculation of *forward-looking* ratios only from that year onwards. On the other hand, the indexes based on the concept of *reputation* – backward-looking – could be calculated from July 1999, as they only depend on the inflation observed and the target.

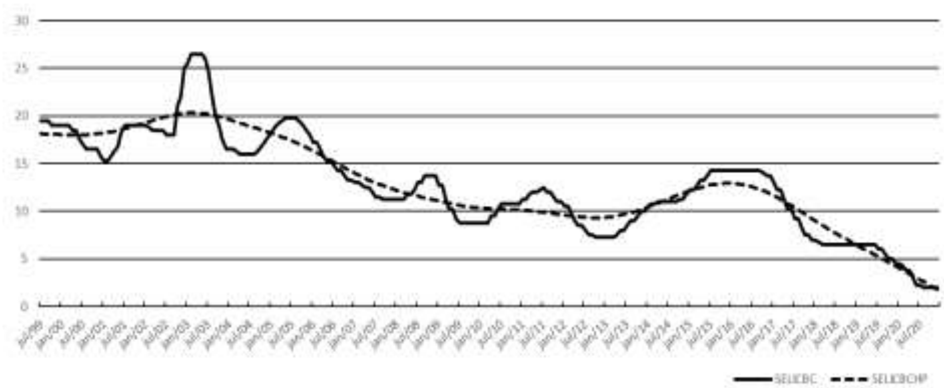
[9]The formula used to calculate the variation was $\left|\frac{E(\pi)_t}{E(\pi)_{t-1}} - 1\right|$.

Table 2. Inflation expectations at the end of the current year – Percentage change (absolute) from the previous month [a]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2000		1.42%	**3.43%**	2.54%	2.89%	**3.47%**	1.36%	2.47%	2.87%	1.00%	0.71%	0.71%
2001	**30.14%**	1.44%	0.37%	6.17%	8.69%	**10.13%**	8.30%	8.07%	3.55%	1.49%	5.95%	4.72%
2002	**35.19%**	0.41%	4.03%	7.15%	2.98%	0.07%	6.18%	7.65%	6.40%	12.95%	24.85%	**25.42%**
2003	2.63%	4.29%	3.61%	0.19%	1.47%	3.28%	**9.83%**	**8.72%**	1.79%	1.34%	2.48%	2.53%
2004	**35.32%**	1.65%	0.53%	2.01%	2.10%	**7.71%**	5.20%	1.86%	1.80%	1.80%	0.11%	2.30%
2005	**22.32%**	0.06%	1.51%	4.84%	4.05%	2.75%	**7.33%**	5.50%	3.25%	0.91%	3.99%	3.40%
2006	**19.04%**	0.96%	1.72%	2.19%	3.34%	4.17%	8.36%	2.34%	**12.62%**	7.80%	2.88%	1.85%
2007	**29.61%**	2.42%	2.57%	1.70%	4.83%	0.13%	2.83%	2.87%	5.62%	2.19%	0.00%	**6.84%**
2008	3.76%	1.18%	0.39%	5.39%	10.01%	**14.25%**	**10.95%**	1.15%	2.68%	0.30%	2.40%	3.65%
2009	**21.22%**	2.98%	**5.38%**	4.55%	0.85%	1.94%	3.29%	2.93%	1.69%	0.19%	0.78%	0.56%
2010	**6.81%**	5.50%	4.94%	5.39%	4.89%	0.11%	3.46%	4.46%	2.81%	3.41%	6.15%	**6.22%**
2011	**6.02%**	4.82%	2.45%	**5.74%**	0.87%	1.45%	1.11%	0.12%	2.77%	0.69%	0.32%	0.45%
2012	**18.60%**	0.66%	0.07%	2.90%	1.20%	3.29%	2.00%	**4.39%**	3.50%	2.22%	0.37%	3.05%
2013	0.13%	**2.15%**	0.74%	0.52%	1.25%	0.74%	0.80%	0.77%	0.81%	0.06%	0.21%	**1.55%**
2014	**4.57%**	0.50%	3.54%	**4.46%**	0.25%	0.51%	0.05%	2.45%	0.19%	2.10%	0.06%	0.57%
2015	5.96%	**6.68%**	**9.62%**	3.66%	1.65%	5.17%	4.49%	1.57%	0.72%	4.04%	4.23%	4.16%
2016	**33.07%**	**6.16%**	0.84%	4.52%	1.50%	3.23%	0.28%	0.43%	0.45%	4.21%	2.91%	4.25%
2017	**26.60%**	5.90%	7.01%	3.33%	2.58%	7.78%	8.29%	3.57%	**10.44%**	2.12%	2.00%	6.93%
2018	**37.94%**	3.11%	5.25%	3.69%	0.16%	**10.48%**	6.92%	0.24%	1.06%	4.99%	6.02%	9.23%
2019	**7.21%**	3.63%	0.45%	2.59%	2.23%	4.91%	1.89%	2.81%	5.02%	5.75%	1.60%	**14.24%**
2020	7.77%	6.89%	6.79%	23.39%	**27.67%**	5.91%	5.65%	0.01%	14.93%	**33.61%**	27.09%	27.45%
Mean	18%	3%	3%	5%	4%	4%	5%	3%	4%	4%	5%	6%

[a] The table cells in black and with white letters indicate the largest percentage change in expectations in one month in the year compared to the previous month. The cells in dark gray and with bold characters, in turn, indicate the second largest variation in expectations in the year. Finally, cells in light gray indicate the third largest variation in the year.

Since the adoption of the inflation targeting regime in June 1999, the basic interest rate has been declining, gradually falling from 19.5% in 1999 to 2% in 2020 (Graph 1).[10] Muinhos and Nakane (2006) suggested that the calculation of the trend can be used to estimate the neutral interest rate. In turn, Perrelli and Roache (2014) presented empirical evidence of a significant reduction in the neutral interest rate in recent decades for the Brazilian case. The authors highlighted as a relevant factor the impact of transparency – inherent to the inflation targeting regime – on expectations and on the neutral interest rate.



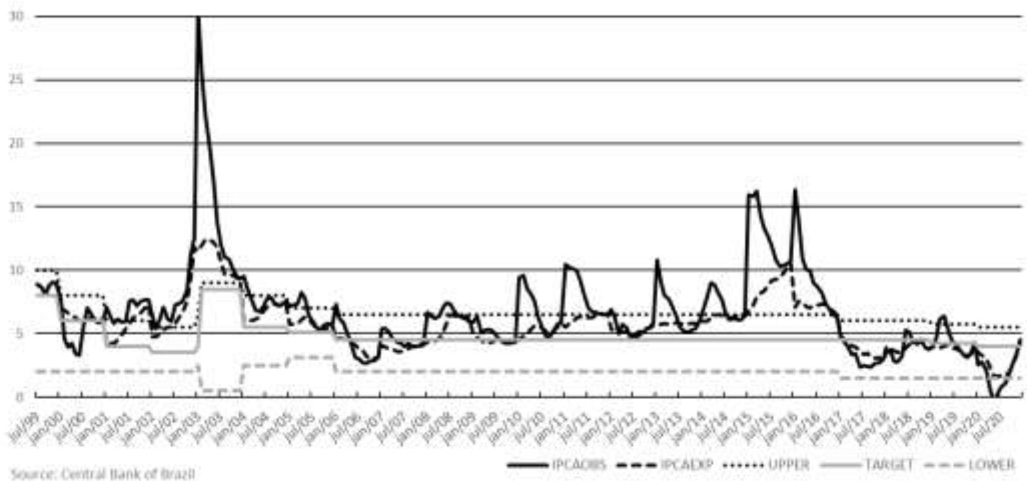
Graph 1. Basic interest rate and its trend (Selic target in % anual)

Source: Prepared by the authors.

Parallel to the downward trend in the basic interest rate – shown in Graph 1 –, it can be seen in Graph 2 that inflation was under relative control, lying within the limits established for most of the sample period.[11]

[10] The trend of the target for the interest rate (SELICBCHP) was estimated based on the application of the HP filter (Hodrick-Prescott).

[11] Of the 258 observations that make up the sample, the inflation observed exceeded the limits established by the target by 122 observations. However, the 2001-2003 and 2014-2016 trienniums account for more than half of these violations (62).



Graph 2. Inflation trajectory, expectations and targets (annualized IPCA, in %)

Source: Prepared by the authors, based on Central Bank data.

The trienniums 2001-2003 and 2014-2016 were the periods in which inflation showed less adherence to the target, which was captured by most of the indicators calculated in this article. According to Minella, Freitas, Goldfajn and Muinhos (2002), in 2001 and 2002 the Brazilian economy experienced several shocks – of domestic and external origin –, such as the energy crisis, the September 11 attacks and the Argentine crisis, events that contributed to the depreciation of Real in 2001. In 2002, the environment of uncertainty – caused by the elections that year – regarding the future course of macroeconomic policies, triggered a new wave of depreciation of the Real, taking inflation to 12.53% – data shown in Table 1. Monetary policy had to aggressively deal with unfavorable expectations throughout 2003.[12]

In turn, the 2014-2016 triennium was marked by several events that increased uncertainty in the Brazilian economy. Factors related to political instability, deterioration of public accounts and the end of the commodity cycle – which began in the 2000s – contributed to the increase in inflation in those years.[13] In addition to high inflation, there was a retraction in real output in 2015 and 2016, further aggravating the economic situation.[14]

The sampling period for this work ends in December 2020, the year in which one of the biggest pandemics recorded in history occurred. The world economy has suffered a strong deterioration, especially due to the need for social isolation to contain the spread of the coronavirus. In Brazil, deaths from the disease approached 200,000 within the sample.[15] The Brazilian economy suffered a strong retraction in the year (-4.06%), which was reflected in the country's average unemployment rate (13.5%). In order to mitigate the harmful effects of the crisis on output in the short term, expansionary macroeconomic policies were implemented, such as the granting of emergency aid and strong monetary expansion, in a context in which the basic interest rate reached a record level of 2% pa. Despite the stimuli – monetary and fiscal – and the increase in food prices, the inflation observed in 12 months – as well as expectations – was below the lower target band throughout much of the year – from April to September, with deflation in April and May of, respectively, 0.31% and 0.38% – which was captured, in particular, by the CI_S, CI_A and RI_{MA} indexes.

Based on the CI_{CK} (Graph 3), one can observe a high degree of credibility attributed for most of the sample period – of the 252 observations for the index, 232 had a measured credibility greater than 0.8. The result is a

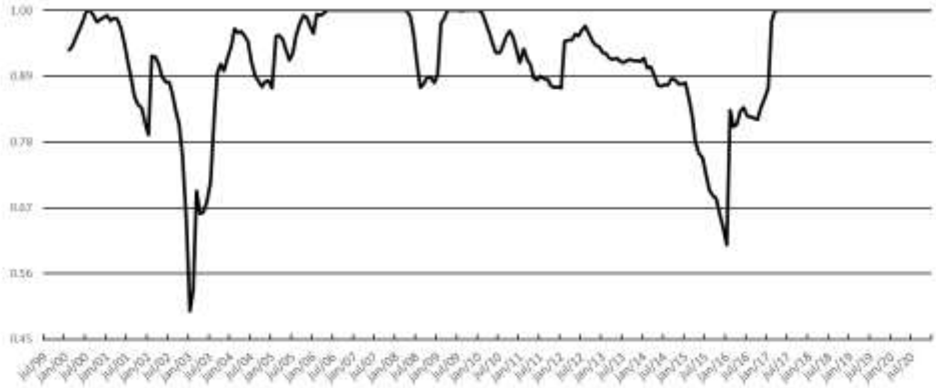
[12]Inflation expectations exceeded the upper limit of the target throughout 2003 (Graph 2). The Central Bank adopted high interest rates that year – substantially above the trend shown in Graph 1. The target for the Selic rate reached 26.5% in February 2003.

[13]Accumulated inflation reached the mark of 10.67% in 2015 – the data is shown in Table 1. The Central Bank reacted with successive interest rate hikes – the Selic target reached 14.25% in July of that year.

[14]In 2015 and 2016, the product suffered a real retraction of, respectively, 3.55% and 3.28%. In this biennium, the product had an accumulated reduction, in real terms, of 6.71%.

[15]According to data from the Ministry of Health of Brazil (2020), Brazil registered 194,949 deaths caused by covid-19 in 2020.

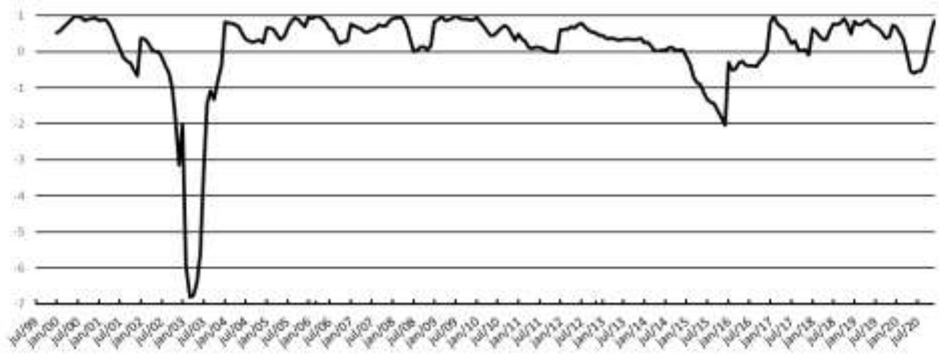
reflection of how the CI_{CK} is calculated. The index does not penalize when the expectation for inflation is lower than the central target, which means that periods of low inflation are not captured, such as 2020, which did not have the months of deflation captured by the index. In addition, the large interval between the central target and the adopted critical point of 20% – after which the credibility attributed is null – favors the result indicated by the indicator, especially if the target established for inflation is low.



Graph 3. CI_{CK} Trajectory

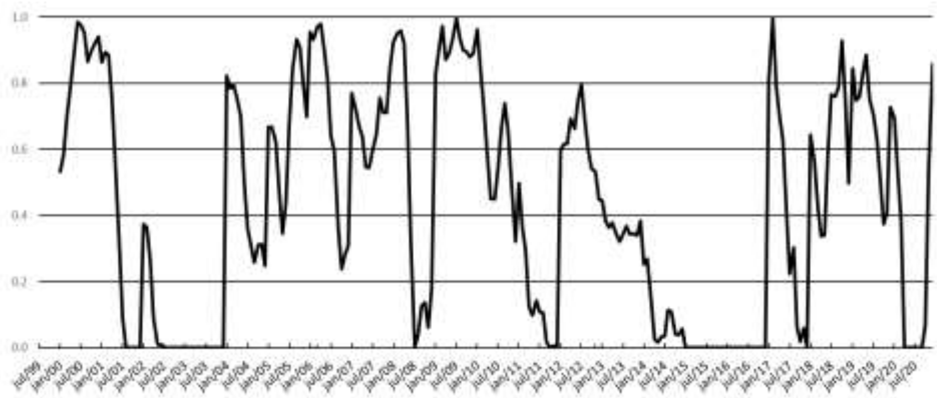
Source: Prepared by the authors.

Regarding the CI_S and the CI_M (Graphs 4 and 5), the distinction between them consists in the fact that the CI_S admits negative values for credibility. Since the CI_M is an adaptation of the CI_S, both penalize with zero credibility – or less than zero, in the case of the CI_S – any violations to the interval established by the inflation target, which explains the lower values for credibility indicated by these indexes. More than half of the observations had a measured credibility of less than 0.5 for the two indexes.



Graph 4. CI_S Trajectory

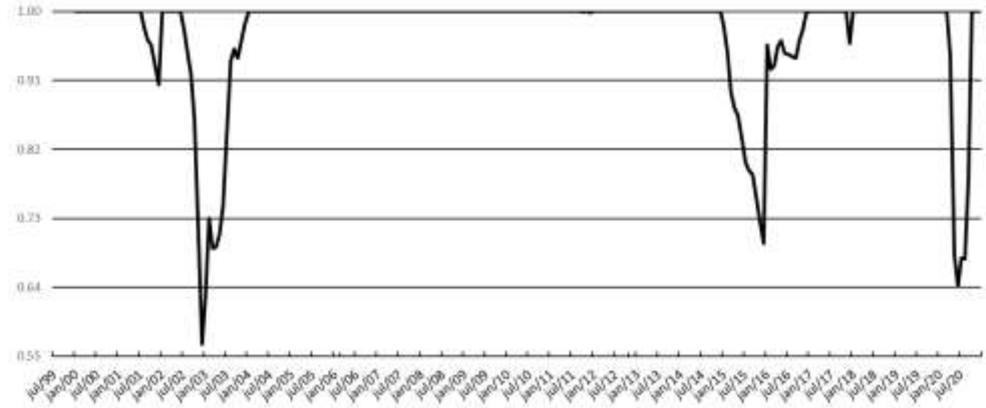
Source: Prepared by the authors.



Graph 5. CI_M Trajectory

Source: Prepared by the authors.

In turn, the CI_A (Graph 6) was designed based on the argument that economic agents are rational and are aware that the monetary authority does not have absolute control over the determination of prices in the economy – pricing derives from private decisions. Therefore, the index does not penalize deviations in inflation expectations from the center of the target that are restricted to the interval between the established limits. For this reason, the index showed maximum credibility ($CI_A = 1$) in 196 of the 252 observations – which corresponds to 77.8% of the sample period. However, despite the high credibility values attributed by the index, periods of low inflation were captured – it can be noted that, for the year 2020, the index penalized violations of the range established by the target – due to the calculation structure of the index, which penalizes violations above and below the target range.

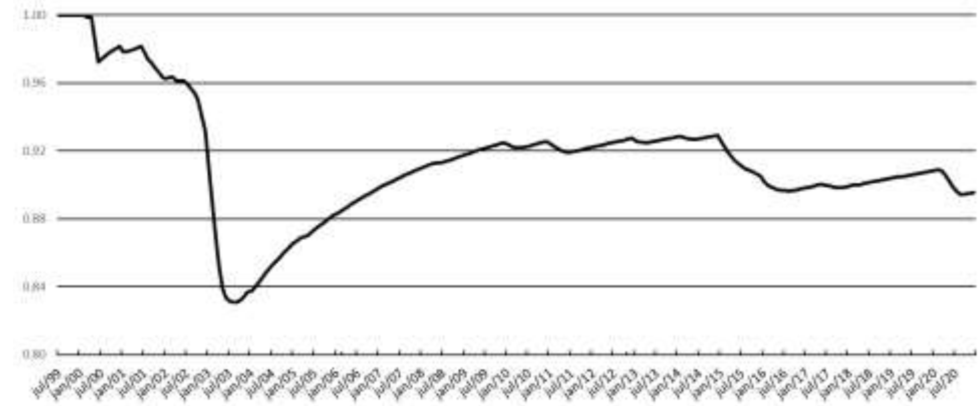


Graph 6. CI_A Trajectory

Source: Prepared by the authors.

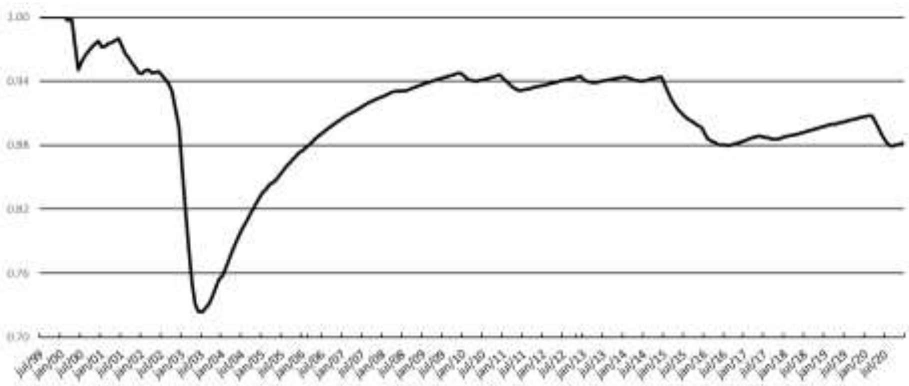
The RI_A, RI_W and RI_{MA} indexes (Graphs 7, 8 and 9) depend on the same reputation function (R), with a structure very similar to the CI_A's – whereas the CI_A uses expectation data for inflation, the R function uses the data referring to observed inflation. What fundamentally distinguishes reputation indexes is their sensitivity to past and present information. While RI_A does not weight the reputation estimated for past periods, RI_W gives greater weight to more recent periods. In turn, the RI_{MA} assumes that economic agents have a short memory and only consider the most recent periods to support their expectations, which makes the RI_{MA} more volatile in relation to other reputation indexes.

Graphs 7 and 8 show that the RI_A and RI_W have stable and very similar behavior over time, which is understandable, given that the weight of the most recent periods is considerably lower than the aggregate weight of the rest of the historical series of observed inflation. The RI_W has a less smoothed curve than the RI_A, since it gives greater weight to more recent periods – the index considers that the most recent information has a greater role in the formation of expectations. Both indexes return high credibility values – an average greater than 0.90 for the two indexes –, which is explained by the combination of the inertia caused by the information passed with the very structure of calculation of the reputation function (R) which, as the CI_A, does not penalize deviations from the center of the target that do not exceed any of the limits established by the target.



Graph 7. RI_A Trajectory

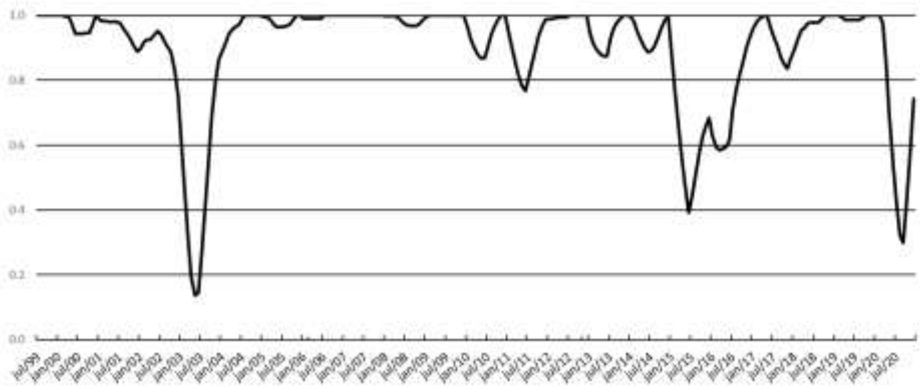
Source: Prepared by the authors.



Graph 8. RI_W Trajectory

Source: Prepared by the authors.

Finally, the RI_{MA} (Graph 9) presents a more volatile behavior in relation to the other reputation indexes because it does not consider information prior to the periods included in the lag fixed for its calculation – in this study, six lags were used. This is the reputation index whose behavior most closely resembles that of credibility – based on a *forward-looking* perspective.



Graph 9. RI_{MA} Trajectory

Source: Prepared by the authors.

In general, the indexes captured a drop in credibility in the most critical periods that make up the sample – the trienniums 2001-2003, 2014-2016 and the year 2020. Table 3 presents the annual averages of each index calculated in this work. It is interesting to note that the years identified as being those with less credibility are mostly the same for the RI_{MA} and for the *forward-looking* indexes (CI_{CK}, CI_S, CI_M and CI_A), while the RI_A and RI_W captured the crises with a delay in relation to the other calculated indexes.

Table 3. Credibility indexes – annual average [a]

	CI_{CK}	CI_S	CI_M	CI_A	RI_A	RI_W	RI_{MA}	Mean
1999	-	-	-	-	1	1	1	1
2000	0.98	0.83	0.83	1.00	0.99	0.98	0.97	0.94
2001	0.90	0.21	0.36	0.98	0.97	0.97	0.96	0.76
2002	0.82	-0.51	0.09	0.92	0.96	0.94	0.90	0.59
2003	0.78	-3.49	0.00	0.82	0.85	0.76	0.45	0.02
2004	0.92	0.51	0.51	1.00	0.85	0.80	0.97	0.79
2005	0.96	0.67	0.67	1.00	0.87	0.85	0.98	0.86
2006	1.00	0.67	0.67	1.00	0.89	0.89	0.99	0.87
2007	1.00	0.68	0.68	1.00	0.90	0.92	1.00	0.88
2008	0.93	0.44	0.44	1.00	0.91	0.93	0.98	0.81
2009	1.00	0.91	0.91	1.00	0.92	0.94	1.00	0.95
2010	0.95	0.62	0.62	1.00	0.92	0.94	0.93	0.86
2011	0.89	0.15	0.15	1.00	0.92	0.93	0.88	0.70
2012	0.95	0.63	0.63	1.00	0.92	0.94	1.00	0.87
2013	0.92	0.36	0.36	1.00	0.93	0.94	0.94	0.78
2014	0.88	0.10	0.10	1.00	0.93	0.94	0.94	0.70
2015	0.72	-1.15	0.00	0.83	0.91	0.91	0.60	0.40
2016	0.83	-0.32	0.00	0.95	0.90	0.88	0.72	0.57
2017	1.00	0.41	0.42	1.00	0.90	0.89	0.93	0.79
2018	1.00	0.62	0.62	1.00	0.90	0.89	0.97	0.86
2019	1.00	0.68	0.68	1.00	0.91	0.90	0.99	0.88
2020	1.00	0.03	0.26	0.87	0.90	0.89	0.65	0.66

Source: Prepared by the authors.

[a]The shaded values indicate the six lowest averages in the period for each index.

5. Empirical Analysis

Mendonça and Souza (2007) developed an experiment to investigate the effects of monetary policy credibility on interest rate variations. According to the authors, since the basic interest rate is the main instrument that the Central Bank has to control inflation, a greater degree of credibility would increase the adherence of economic agents' expectations to the target announced by the monetary authority, so that it would be able to influence expectations, giving greater flexibility to the conduct of policy. The practical consequence of credibility translates into lower interest rate volatility. In a scenario where expectations are aimed at an increase in inflation in relation to the target, the Central Bank would be able to control inflation with smaller increases in the interest rate, redirecting market expectations to the original target. Therefore, there would be a lower social cost for controlling inflation.

In this work, the methods proposed by Mendonça and Souza (2007) in their original article were reproduced – for a sample with more recent data, referring to the period from July 1999 to December 2020. The authors of the original work conducted their investigation based on two models, estimated by the *Ordinary Least Squares (OLS)* method, presented in equations (9) and (10):

$$\Delta \mathrm{SELICBC}_t = \alpha + \beta\, \Delta \mathrm{IPCADES}_t - \Delta \mathrm{CI}_t + \varepsilon_t \quad (9)$$

$$\Delta \mathrm{SELICM}_t = \alpha + \beta\, \Delta \mathrm{SELICM}_{t-1} - \Delta \mathrm{CI}_t + \varepsilon_t \quad (10)$$

Mendonça and Souza (2007) based the conception of their models on a presumed chain of events – convergent with what the theory and practices of economic policy postulate – for the relationships between the variables. Deviations from the expectations of economic agents in relation to the target (IPCADES)[16] require a reaction from the Central Bank in terms of raising the target for the basic interest rate (SELICBC)[17], given the lag that occurs between the execution of the policy by the monetary authority and its effects on the inflation. In turn, Central Bank's open market trading desk, guided by the target determined at a Copom meeting, takes the

[16]$\mathrm{IPCADES}_t = \mathrm{E}(\pi)_t - \pi_t$, where $\mathrm{E}(\pi)_t$ is the market expectation – in the month – for the accumulated inflation, in its annualized form, until the end of the current year; π_t is the target for accumulated inflation at the end of the current year.

[17]*S*ELICBC: The annualized Selic target considered for each month was the one determined by the Copom at the first meeting of the respective month – if there was more than one. In the months in which there was no Copom meeting, the target of the previous month was used (Central Bank of Brazil, 2020a).

appropriate measures so that the Selic/Over interest rate practiced in the market (SELICM)[18] is effectively adherent to the target, in order to pursue the fulfillment of the established objectives.

The model presented in equation (9) seeks to assess the relationship between changes in credibility – measured by the indexes presented in the second section of this paper – and changes in the target for the Selic rate, using the deviations of inflation expectations from the target as a variable of control for the model. In parallel, the model referring to equation (10) estimates the average variation of the market Selic as a function of variations in credibility measured by the indexes, with the market Selic itself, lagged by one period, the model's control variable.[19] For both models, the estimated coefficient related to the credibility index is expected to have a negative sign, confirming the theory that increases in credibility reduce interest rate variations necessary to control inflation.

The empirical analysis began with the performance of unit root tests, in order to avoid the occurrence of spurious relationships in the results obtained when estimating the models. Therefore, the following unit root tests were performed: i) Augmented Dickey-Fuller (ADF, t test); ii) Phillips-Perron (PP, Z test); and iii) DF-GLS, by Elliot, Rothenberg and Stock (1996). The number of lags for each series was defined based on the Schwarz criterion (the results are shown in Table 4).[20]

The results of the three tests for the CI_{CK}, CI_S, CI_M and CI_A indicators, as well as for the IPCADES series, indicate level stationarity. The RI_{MA} index and the series SELICBC have a level unit root, according to the results of the PP test, whereas the ADF and DF-GLS tests rejected the null hypothesis. The RI_W series presented unit root, in level, for all tests. The RI_A index and the SELICM series had the null hypothesis rejected in only one of the three tests, indicating a level unit root. However, all series tested in first difference had the null hypothesis rejected in the three tests performed. This result allows the series to be worked in first difference, in the same way as Mendonça and Souza (2007) did in their original article.

Table 4. Unit root tests [a]

Series	Level			Series	1st Difference		
	ADF	PP	DF-GLS		ADF	PP	DF-GLS
CI_{CK}	Stationary	Stationary	Stationary	DCICK	Stationary	Stationary	Stationary
CI_S	Stationary	Stationary	Stationary	DCIS	Stationary	Stationary	Stationary
CI_M	Stationary	Stationary	Stationary	DCIM	Stationary	Stationary	Stationary
CI_A	Stationary	Stationary	Stationary	DCIA	Stationary	Stationary	Stationary
RI_A	Stationary	Unit root	Unit root	DRIA	Stationary	Stationary	Stationary
RI_W	Unit root	Unit root	Unit root	DRIW	Stationary	Stationary	Stationary
RI_{MA}	Stationary	Unit root	Stationary	DRIMA	Stationary	Stationary	Stationary
SELICM	Unit root	Unit root	Stationary	DSELICM	Stationary	Stationary	Stationary
SELICBC	Stationary	Unit root	Stationary	DSELICBC	Stationary	Stationary	Stationary
IPCADES	Stationary	Stationary	Stationary	DIPCADES	Stationary	Stationary	Stationary

Source: Prepared by the authors.

[a]The degree of significance used is 5%.

Granger's temporal precedence tests were also performed[21] in order to verify the assumptions that supported the models. As already presented in this section, the models assume that changes in expected deviations for inflation (IPCADES) precede changes in the Selic target (SELICBC), and that changes in these precede changes in the Selic practiced in the market (SELICM).

[18]SELICM: Average daily interest rate – annualized – which remunerates operations backed by government bonds registered in the Special System for Settlement and Custody (SELIC). The series, obtained from Institute of Applied Economic Research (2020) database, was used in its accumulated form for each month. The series was calculated using the following equation:

$\text{SELICM}_t = 100 \times \left\{[\prod_{i=1}^{n}(1 + day\ i\ Selic\ Over\ rate)]^{252/n} - 1\right\}$, where it n corresponds to the number of observations of the daily rate in the month t.

[19]The market Selic (SELICM) has a first-order autoregressive structure.

[20]The statistics for each unit root test performed are presented in the appendix (Table A.1). For all tests, a significance level of 5% was considered.

[21]All Granger causality tests performed are presented in Table A.3 of the appendix, as well as the results obtained by Mendonça and Souza (2007), for comparison purposes.

Determining the appropriate number of lags for carrying out the Granger causality tests is not a settled issue in the literature. Maddala (1992) argued that there is a wide variety of methods available to the researcher to determine the optimal number of lags in a model, suggesting that there may be some arbitrariness in the choice. On the other hand, Gujarati (2011) highlighted the method's sensitivity to the number of lags, which requires caution. Davidson and MacKinnon (1993) and Mills (1993), in turn, proposed to identify the number of lags before running the tests. Mendonça and Souza (2007), in particular, chosen to use 12 lags, based on the argument of Davidson and MacKinnon (1993) that choosing a larger number of lags would be the best procedure, given that few lags could cause bias due to the omission of relevant variables, while the inclusion of irrelevant variables – the burden inherent in choosing large lags – would be less problematic. In the present work, we also chose to use 12 lags, based on the above-mentioned arguments.

In convergence with the result found by Mendonça and Souza (2007), the variables DSELICBC and DSELICM presented bilateral causality with a statistical significance of 1%. The probability of rejection is lower for the hypothesis that DSELICBC does not cause DSELICM, in Granger's sense, there being no reason to reject the hypothesis that DSELICBC precedes DSELICM – as the theory predicts. The precedence of the variable DIPCADES in relation to DSELICBC was also not confirmed – unlike the result found by Mendonça and Souza (2007), which adhered to the theory. Again, bilateral causality was obtained as a result with statistical significance of 1%, but this time, the probability of rejection is lower for the hypothesis that DSELICBC does not cause DIPCADES. At first, it cannot be said that the theory has been compromised, given the low values – and the proximity between them – for the probabilities of rejection of the hypotheses. Therefore, the results for these tests were inconclusive.

The precedence relationships between credibility indexes and variations in Selic target and market rates were also investigated. The models assume the existence of precedence of variations in credibility indexes in relation to variations in Selic rates. For the DSELICBC variable, Mendonça and Souza (2007) found evidence that the DCICK and DCIA series preceded it, which converges with the theory. However, this article found bilateral causality between DCICK and DSELICBC – with a statistical significance of 1%. The precedence of the DCIA variable in relation to the DSELICBC was confirmed, but with a statistical significance of 10% – Mendonça and Souza (2007) had found the same result with a significance of 1%, that is, there was a weakening of the evidence. For the DSELICM variable, the results indicated the precedence of the DCICK variable, with a statistical significance of 1% – unlike the original article, which presented a result of independence between the series, that is, none of the test hypotheses had been refuted –, as well as confirmed the precedence of the DCIA variable, with a statistical significance of 1% – the same result of the original work. For the other variables, there is no evidence of precedence in relation to changes in interest rates. Therefore, based on Granger's causality tests, the indexes with greater adherence to the theory are the CI_{CK} and the CI_{A}.

Given the objective of investigating the relationship between the credibility of monetary policy – measured by the indexes presented – and the effort required for the Central Bank to control inflation – in terms of interest rate variations –, econometric models were estimated – along the lines of those presented in equations (9) and (10) – for each of the credibility indicators.

The selection of models was based on the analysis of cross-correlograms, on the analysis of residuals and on the principle of parsimony, seeking to maintain consistency with economic theory.[22] The number of lags was specified based on the Schwarz criterion. For the regressions referring to the Selic target (SELICBC), the variable DIPCADES with one lag had better explanatory power, in terms of adjustment and significance of the coefficient, than with other tested lags – the authors of the original article used the variable with two lags –, which justifies its use in this configuration as a control variable for the models in Table 5. In turn, the regressions referring to the market Selic (SELICM) were performed according to a first-order autoregressive structure – in the same way as the authors of the original work –, with the variable $DSELICM_{(-1)}$ being the control variable for the models shown in Table 6. Both control variables had statistically significant coefficients at 1%, and a positive sign, for all estimated models – in line with the theory –, exercising the function of controlling the changes in the models, in order to evidence the statistical relationships between the explained variables – DSELICBC and DSELICM – and the explanatory variables introduced in the models. Based on the theory presented throughout this section, it is expected that the coefficients referring to the other explanatory variables – variations in credibility indexes – show a negative sign.

[22]The heteroskedasticity and serial correlation statistics of the models are shown in Table A.2 of the appendix.

The use of a control variable common to all models allows comparing their degree of explanation based on the criterion of the highest coefficient of the adjusted R^2. For the variable DSELICBC, when the effect of DIPCADES is controlled, the credibility indexes that best explain the variations in the Selic target are the CI_S (30.50%) and the CI_{CK} (28.15%) – in contrast to the results presented in the original work, according to which the CI_A (56.58%) and the RI_{MA} (53.46%) presented the best adjustments. At a lower level, the CI_A showed an adjustment of 18.70%. Among the indexes whose calculation is based on the concept of reputation (*backward-looking*), the RI_{MA} was the one with the best fit (17.68%) – despite its coefficient having a lower significance than the other indicators of the genre –, corroborating the result found by Mendonça and Souza (2007). The indexes that presented the worst adjustments were, respectively, the RI_W (15.19%), the RI_A (13.58%) and the CI_M (11.67%) – confirming the result of the original article.

Also with regard to the models shown in Table 5 – referring to the DSELICBC variable –, it is possible to observe that all credibility indexes included in the model raised the adjustment coefficient in relation to the model that used only the control variable as a regressor – in the model mentioned, the value of the adjusted R^2 coefficient is only 9.73% – showing the improvement in the adjustment with the inclusion of the indexes. The analysis of the indexes based on the Schwarz criterion indicated that the most parsimonious models were obtained with the CI_S (1.32) and CI_{CK} (1.36) indexes, followed by the RI_{MA} (1.47). As in the original work, the CI_M (1.56) had the worst performance.

The models in Table 6, referring to the market Selic, can also be compared using the criterion of the best adjusted R^2 coefficient, since they were structured with a common control variable – DSELICM lagged by one period. Again, the models with the best fit were CI_{CK} (71.46%) and CI_S (68.55%), followed by CI_A (66.88%), RI_{MA} (66.73%), RI_W (66.14%) and RI_A (66.13%), which showed very similar degrees of adjustment. It is important to highlight that the model specified based on the CI_M was not able to establish a significant relationship with the market Selic and, in addition, all models referring to the indexes calculated based on the concept of reputation presented one of the coefficients with a positive sign, converging with the results obtained by Mendonça and Souza (2007).[23] On the other hand, the result found by the authors indicated, among all tested indexes, the best fit for the model referring to the CI_A (75.20%), which was not confirmed in this work. Furthermore, as observed in the regressions for the Selic target, each of the indexes included in the model with the control variable – among those for which a statistically significant relationship was found with the market Selic – promoted an increase in the R^2 coefficient adjusted – the model that used only the control variable as a regressor had the lowest adjusted R^2 coefficient, with a value of 63.94% – which shows the improvement in the adjustment with the inclusion of the indexes. The performance classification of the indexes using the Schwarz information criterion presented the same order as the one performed using the highest adjusted R^2 criterion: CI_{CK} (0.21), CI_S (0.26), RI_{MA} (0.32), RI_W (0.33) and RI_A (0.33).

All regressions shown in Tables 5 and 6 were globally significant at the 1% level (F-statistic). With the exception of the Selic market regressions by reputation indexes – where some coefficients diverge from the theory – all the coefficients of the other models showed a negative sign, evidencing the inverse relationship between increased credibility and interest rate variations. Only three of the models shown had coefficients related to the measures without statistical significance: the two regressions shown based on the CI_A had only one coefficient – among those related to the index in the model – with statistical significance (at a level of 10% in both models); the RI_{MA}, in the market Selic regression, presented only one of the coefficients with statistical significance (at a 10% level). The models' t-statistics were calculated with the Newey-West correction, in order to deal with heteroscedasticity and serial correlation problems.

The index that showed the best overall performance was the CI_{CK}, whose precedence in relation to the market Selic was evidenced by the Granger causality test – with a statistical significance of 1% –, as well as by the fact that it figured between the two indicators whose models presented the best adjustments, both in the Selic target regression and in the market Selic regression. The CI_S also showed a good degree of adjustment – compared to the others – for the two regressions, but its precedence was not evidenced by the causality tests in relation to any of the concepts of the Selic rate. The RI_{MA} remains the reputation index with the best fit among the indexes of its type – confirming the result obtained by Mendonça and Souza (2007) –, but its adjustment is only slightly higher than that of the other reputation indicators, in addition to observing a lower significance of the coefficient related

[23]Mendonça and Souza (2007) argued that the CI_M punishes any deviation from inflation expectations that exceed the range announced by the monetary authority with a total loss of credibility. As for the positive coefficients in the models referring to reputation indexes, the authors justified the result based on the idea that these indicators contain past information, given that the positive coefficients are associated with lagged variations in the indicators.

to the index in the model, when compared to the models related to the RI_A and RI_W. Finally, despite evidence obtained that the CI_A precedes the Selic target and market rates, in the sense of Granger – with statistical significance of 10% and 1%, respectively – this study cannot confirm the superiority of the index compared to the others, in terms of the fit of models. In both regressions, the CI_A had the third best fit, and, in both cases, it presented only one of the coefficients – among those related to the index, in the model – statistically significant, at 10% in both cases. The result diverges from that found by Mendonça and Souza (2007), whose work not only indicated evidence of precedence of the CI_A in relation to the two concepts of the Selic rate – target and market, with statistical significance of 1% in both cases –, but it also indicated that the models referring to the index presented the best fits, in the two regressions.

Table 5. Estimated models for DSELICBC[a]

Dependent variable: Selic target (1st difference) – DSELICBC										
Index	Estimated coefficients (t-Statistic – Newey-West)[b]						N	F-Statistic	Adjusted R^2 (%)	Schwarz Criterion
	Intercept	$DIPCADES_{t-1}$	$Index_t$	$Index_{t-1}$	$Index_{t-2}$	$Index_{t-3}$				
	-0.0659 (-0.7765)	0.3259 (3.0374)***	-	-	-	-	250	27.83***	9.73	1.54
CI_{CK}	-0.0647 (-1.3428)	0.2184 (4.6773)***	-5.9871 (-3.3708)***	-	-5.6484 (-3.4069)***	-	249	33.38***	28.15	1.36
CI_S	-0.0656 (-1.3856)	0.3536 (4.2212)***	-0.4999 (-8.8734)***	-	-	-0.2979 (-4.9607)***	248	37.13***	30.50	1.32
CI_M	-0.0659 (-0.8640)	0.3125 (2.9895)***	-0.3390 (-1.7263)*	-	-	-0.5089 (-2.4719)**	248	11.88***	11.67	1.56
CI_A	-0.0672 (-0.8729)	0.3355 (4.0399)***	-3.0538 (-1.2174)	-	-2.2487 (-1.9106)*	-2.6586 (-1.2856)	248	15.20***	18.70	1.50
RI_A	-0.0799 (-1.0297)	0.3273 (3.5837)***	-33.5730 (-2.4880)**	-	-	-	250	20.57***	13.58	1.52
RI_W	-0.0758 (-0,9882)	0.3219 (3.4367)***	-21.0521 (-2.7315)***	-	-	-	250	23.30***	15.19	1.50
RI_{MA}	-0.0716 (-1.3537)	0.3382 (4.5987)***	-	-3.5456 (-1.7673)*	-	-	250	27.73***	17.68	1.47

Source: Prepared by the authors.

[a] All variables were used in 1st difference.

[b] The number of lags was specified based on the Schwarz criterion.

***, ** and * It is rejected to the degree of 1%, 5% and 10% of significance, respectively.

Table 6. Estimated models for DSELICM[a]

Index	Dependent variable: Selic market (1st difference) - DSELICM									
	Estimated coefficients (t-Statistic – Newey-West)[b]						N	F-Statistic	Adjusted R^2 (%)	Schwarz Criterion
	Intercept	$DSELICM_{t-1}$	$Index_t$	$Index_{t-1}$	$Index_{t-2}$	$Index_{t-3}$				
	-0.0106 (-0.5360)	0.7914 (14.6093)***	-	-	-	-	256	453.11***	63.94	0.36
CI_{CK}	-0.0186 (-1.1294)	0.7058 (18.7781)***	-2.7812 (-2.8070)***	-1.8699 (-3.0071)***	-2.0532 (-3.0605)***	-	249	156.20***	71.46	0.21
CI_S	-0.0161 (-0.9619)	0.7596 (29.9063)***	-	-0.2098 (-4.7127)***	-	-	250	272.39***	68.55	0.26
CI_A	-0.0142 (-0.7491)	0.7847 (20.9873)***	-	-1.6112 (-1.5658)	-	-0.4694 (-1.8673)*	248	167.24***	66.88	0.34
RI_A	-0.0075 (-0.4568)	0.7855 (16.8795)***	-34.6328 (-2.5841)**	43.0662 (3.7712)***	-	-	256	166.96***	66.13	0.33
RI_W	-0.0095 (-0.5676)	0.7834 (17.6577)***	-19.1382 (-2.8396)***	22.5369 (3.8432)***	-	-	256	167.04***	66.14	0.33
RI_{MA}	-0.0097 (-0.5195)	0.8058 (17.4967)***	-	-	-2.3088 (-1.8360)*	2.5619 (1.5995)	254	170.13***	66.73	0.32

Source: Prepared by the authors.

[a] All variables were used in 1st difference.

[b] The number of lags was specified based on the Schwarz criterion.

***, ** and * It is rejected to the degree of 1%, 5% and 10% of significance, respectively.

Note: The DCIM series was not able to establish any significant relationship with the proposed model, in convergence with the results presented by Mendonça and Souza (2007).

6. Conclusion

The empirical analysis showed an inverse relationship between the increase in the credibility of monetary policy and the average variations of the Selic rate – target and market. The result ratified, for an updated sampling period, in comparison with that adopted in Mendonça and Souza (2007), the hypothesis that higher levels of credibility allow the monetary authority to control inflation with less fluctuations in interest rates, thus reducing costs arising from the real effects of monetary policy. Furthermore, it can be observed that, in convergence with the results obtained by Mendonça and Souza (2007), the RI_{MA} remains, among the reputation indexes, the one with the best performance, reinforcing the authors' argument that the memory over the process of building credibility by economic agents in the country is short.

The argument became even more consistent when we considered that the reputation indicators had performances that were very close to each other, and lower than those of the other indexes, which suggests a reduced explanatory power – through reputation – for the behavior of interest rates. The credibility indexes based on expectations (*forward-looking*) performed better.

The evidence obtained in this article has some implications in terms of monetary policy for Brazil. First, despite the observed trend of long-term reduction in basic interest rates throughout the sample, the role of public expectations continues to be a management tool in itself, and fundamental for the mitigation of the *trade-off* in eventual processes of disinflation in the face of shocks, in particular supply shocks. Second, with regard to the role of the historical performance of inflationary dynamics on the construction of credibility, the short-run results have a high weight, as captured by the best adjustment of the RI_{MA} among the reputation indexes. This suggests that there is room for institutional and expectation management improvements by the Central Bank, together with the CMN's target setting strategy, which in theory would be accompanied by a better relative adjustment of credibility indexes vis-à-vis reputation, and among the latter the best relative fit of the RI_A and RI_W indicators.

Such results, if observed in future replications, could indicate expected gains of a *forward-looking* nature, as well as lower degrees of inflationary inertia in the country.

Finally, based on the sample used for this investigation, the CI_{CK} was the index that showed the best overall performance, appearing between the two indicators with the best adjustment, in addition to having its precedence evidenced by the Granger causality test – with statistical significance of 1% – in relation to the market Selic.

References

Barro, R. J., & Gordon, D. (1983). Rules, Discretion and Reputation in a Model of Monetary Policy. *Journal of Monetary Economics, 12,* North-Holland, 101-121. https://doi.org/10.1016/0304-3932(83)90051-X

Cecchetti, S., & Krause, S. (2002). *Central bank structure, policy efficiency, and macroeconomic performance: exploring empirical relationships*. Federal Reserve Bank of St. LouisReview, july/august, 47-59. https://doi.org/10.20955/r.84.47-60

Central Bank of Brazil. (2020a). *Interest rate policy decisions: historical interest rates set by the Copom meeting and evolution of the Selic rate*. Retrieved from https://www.bcb.gov.br/controleinflacao/historicotaxasjuros

Central Bank of Brazil. (2020b). *Time Series Management System (SGS)*. Retrieved from https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries

Chansriniyom, T., Epstein, N. P., & Nalban, V. (2020). *The Monetary Policy Credibility Channel and the Amplification Effects in a Semi-structural Model*. IMF Working Papers. N. 2020/201, September 25. https://doi.org/10.5089/9781513557717.001

Davidson, R., & Mackinnon, J. G. (1993) *Estimation and Inference in Econometrics*. Oxford Economic Press, Nova York.

Elliot, G., Rothenberg, T. J., & Stock, J. H. (1996). Efficient tests for an autoregressive unit root. *Econometrica, 64,* 813-826. https://doi.org/10.2307/2171846

Faust, J., & Svensson, L. E. O. (1998). *Transparency and credibility: monetary policy with unobservable goals*. NBER, Mar. 1998, Working paper n. 6.452. https://doi.org/10.3386/w6452

Gujarati, D. N., & Porter, D. C. (2011) *Econometria básica*. Tradução: Denise Durante, Mônica Rosemberg, Maria Lúcia G. L. Rosa; Revisão: Claudio D. Shikida, Ari Francisco de A. Junior, Márcio Antônio Salvato. 5. ed. Porto Alegre: AMGH.

Institute of Applied Economic . (2020). *Macroeconomics database.* Retrieved from http://www.ipeadata.gov.br

Issler, J. V., & Soares, A. F. (2022). Central bank credibility and inflation expectations: a microfounded forecasting approach. *Macroeconomic Dynamics,* 1-21. Cambridge University Press. https://doi.org/10.1017/S1365100522000207

King, M. A. (1996). How Should Central Banks Reduce Inflation? – Conceptual Issues. *Economic Review, Federal Reserve Bank of Kansas City, 81*(QIV), 25-52.

Kydland, F. E., & Prescott, E. C. (1977). Rules Rather than Discretion: the Inconsistency of Optimal Plans. *Journal of Political Economic, 85*(3), 473-492. https://doi.org/10.1086/260580

Levieuge, G., Lucotte, Y., & Ringuedé, S. (2015). *Central bank credibility and the expectations channel: Evidence based on a new credibility index*. NBP Working Papers 209, Narodowy Bank Polski, Economic Research Department. https://doi.org/10.2139/ssrn.2561774

Maddala, G. S. (1992) *Introduction to Econometrics* (2nd ed.). MacMillan, New York.

Mendonça, H. F. de (2004). Mensurando a credibilidade do regime de metas inflacionárias no Brasil. *Revista de Economia Política, 24*(3), 344-350. https://doi.org/10.1590/0101-35172004-1618

Mendonça, H. F. de, & Souza, G. J. G. (2007). Credibilidade do Regime de Metas para inflação no Brasil. *Pesquisa e Planejamento Econômico, 37*(2), Aug.

Mills, T. C. (1993). *The Econometric Modelling of Financial Time Series*. Cambridge University Press.

Minella A., Freitas, P. S. de, Goldfajn, I., & Muinhos, M. K. (2002). *Inflation Targeting in Brazil: Lessons and Challenges*. Central Bank of Brazil, BIS Papers 19, p. 106-133. https://doi.org/10.2139/ssrn.353660

Ministry of Health of Brazil (2020). Coronavirus Panel. Retrieved from https://covid.saude.gov.br/

Mishkin, F. S. (1999). International Experiences with Different Monetary Policy Regimes. *Journal of Monetary Economics, 43*(3), 579-606. https://doi.org/10.1016/S0304-3932(99)00006-9

Montes, G. C. & Bastos, J. C. A. (2014). Effects of reputation and credibility on monetary policy: Theory and evidence for Brazil. *Journal of Economic Studies, 41*. https://doi.org/10.1108/JES-11-2012-0158

Moreira, R. R. (2013). The Central Bank's endogenous and non-linear credibility in a dynamic stochastic general equilibrium model: theory and a small computational simulation. *International Journal of Computational Economics and Econometrics, 3,* 2-10. https://doi.org/10.1504/IJCEE.2013.056263

Muinhos, M. K., & Nakane, M. I. (2006). *Comparing Equilibrium Real Interest Rates: Different Approaches to Understand Brazilian Rates*. Brazilian Central Bank, Working Paper Series, n. 101, 1-32.

Perrelli, R., & Roache, S. K. (2014). *Time-varying neutral interest rate: The case of Brazil*. IMF Working Paper, N. 14/84. https://doi.org/10.5089/9781484385210.001

Sicsú, J. (2002). Expectativas inflacionárias no regime de metas de inflação: uma análise preliminar do caso brasileiro. *Economia Aplicada, 6*(4).

Appendix A

Table A.1. Unit root test results

Series	ADF[1]	PP[2]	DF-GLS[3]	ADF	PP	DF-GLS	I(n)
	Level			1st Difference			
CI_{CK}	-3.1461**	-3.0205**	-3.164**	-13.0623***	-13.0623***	-12.9116***	I(0)
CI_S	-4.0895***	-3.6212***	-4.0346***	-13.0299***	-13.2131***	-12.9263***	I(0)
CI_M	-4.3696***	-4.0076***	-4.3589***	-12.9185***	-12.6786***	-12.2389***	I(0)
CI_A	-4.7394***	-4.2314***	-4.6859***	-12.4049***	-12.3395***	-12.4056***	I(0)
RI_A	-3.1272**	-2.4948	-1.8211	-4.5315***	-4.8695***	-4.5651***	I(1)
RI_W	-0.6229	-0.6715	-2.2761	-5.6345***	-5.0648***	-5.6501***	I(1)
RI_{MA}	-3.8467***	-0.8671	-3.7166***	-5.4359***	-5.5446***	-5.3269***	I(0)
SELICM	-1.5137	-1.5438	-3.9043***	-6.0913***	-5.927***	-3.5539***	I(1)
SELICBC	-3.8595**	-1.428	-3.853***	-5.1786***	-9.5133***	-5.2449***	I(0)
IPCADES	-2.7398***	-2.4988**	-3.1866**	-13.0514***	-12.9253***	-12.9177***	I(0)

Source: Prepared by the authors.

*** and ** It is rejected to the degree of 1% and 5% of significance, respectively.

[1] Augmented Dickey-Fuller (ADF) test. The number of lags used for each series was defined according to the Schwarz criterion (SC). For the CI_{CK}, CI_M, CI_A, RI_A and RI_{MA} series, the constant was used. For the SELICBC series, constant and trend were used. For the other series, neither constant nor trend was used.

[2] Phillips-Perron test, with lag applied to Bartlett Kernel. For the CI_{CK}, CI_M, CI_A and RI_A series, the constant was used. For the other series, neither constant nor trend was used.

[3] Dickey-Fuller GLS test. The number of lags used for each series was defined according to the Schwarz criterion. For the DRIMA and DIPCADES series, the constant was used. For the others, constant and trend were used.

Table A.2. Heteroskedasticity and serial correlation tests

Dependent Variable	Index	N	White test *(F-statistic)*	Breusch-Godfrey LM test [1] *(F-statistic)*
DSELICBC	-	250	9.0485***	47.1908***
	CI_{CK}	249	8.5728***	26.7698***
	CI_S	248	4.7724***	17.0500***
	CI_M	248	1.8992*	44.2710***
	CI_A	248	5.1673***	33.1178***
	RI_A	250	5.2006***	41.5619***
	RI_W	250	4.4525***	38.7091***
	RI_{MA}	250	4.5026***	36.4667***
DSELICM	-	256	13.6627***	0.8147
	CI_{CK}	249	3.4017***	1.5167
	CI_S	250	4.1789***	0.7877
	CI_A	248	2.6025***	0.1966
	RI_A	256	3.6789***	0.1219
	RI_W	256	3.0801***	0.1293
	RI_{MA}	254	3.1966***	0.1383

Source: Prepared by the authors.

[1] Tested with 2 temporal *lags*.

***, ** and * It is rejected to the degree of 1%, 5% and 10% of significance, respectively.

Table A.3. Granger's Time Precedence Test

	Null hypothesis	N	F-Statistic	Probability	Mendonça and Souza (2007) N	F-Statistic	Probability
Selic target (DSELICBC)	DSELICM does not Granger Cause DSELICBC	245	4.7137	8.00E-05	67	2.9403	0.0048
	DSELICBC does not Granger Cause DSELICM		16.4833	9.00E-25		8.1530	0.0000
	DIPCADES does not Granger Cause DSELICBC	239	2.9336	0.0009	61	2.4058	0.0209
	DSELICBC does not Granger Cause DIPCADES		3.7183	4.00E-05		1.8653	0.0738
	DCICK does not Granger Cause DSELICBC	239	2.4369	0.0055	61	2.2834	0.0278
	DSELICBC does not Granger Cause DCICK		3.3792	0.0002		1.3166	0.2519
	DCIS does not Granger Cause DSELICBC	239	1.9537	0.0298	61	2.0477	0.0483
	DSELICBC does not Granger Cause DCIS		8.791	1.00E-13		6.6626	0.0000
	DCIM does not Granger Cause DSELICBC	239	0.7644	0.6866	61	0.4061	0.9517
	DSELICBC does not Granger Cause DCIM		1.3471	0.1938		1.5732	0.1440
	DCIS does not Granger Cause DSELICBC	239	1.7329	0.0616	61	4.6264	0.0002
	DSELICBC does not Granger Cause DCIA		1.4461	0.1470		1.3556	0.2320
	DRIA does not Granger Cause DSELICBC	245	3.0178	0.0006	67	1.4926	0.1654
	DSELICBC does not Granger Cause DRIA		8.9708	6.00E-14		5.4770	0.0000
	DRIW does not Granger Cause DSELICBC	245	2.9944	0.0007	67	1.4511	0.1819
	DSELICBC does not Granger Cause DRIW		9.0684	4.00E-14		5.5703	0.0000
	DRIMA does not Granger Cause DSELICBC	245	1.1913	0.2905	67	1.0042	0.4621
	DSELICBC does not Granger Cause DRIMA		2.5413	0.0037		5.3619	0.0000
Selic market (DSELICM)	DCICK does not Granger Cause DSELICM	239	3.4076	0.0001	61	1.5628	0.1474
	DSELICM does not Granger Cause DCICK		1.3687	0.1827		0.7448	0.6995
	DCIS does not Granger Cause DSELICM	239	4.2735	5.00E-06	61	3.3340	0.0025
	DSELICM does not Granger Cause DCIS		8.0059	2.00E-12		4.6224	0.0002
	DCIM does not Granger Cause DSELICM	239	1.0341	0.4187	61	0.6249	0.8069
	DSELICM does not Granger Cause DCIM		1.7378	0.0606		1.9582	0.0595
	DCIA does not Granger Cause DSELICM	239	2.5864	0.0032	61	3.1505	0.0038
	DSELICM does not Granger Cause DCIA		1.3173	0.2101		1.1459	0.3566
	DRIA does not Granger Cause DSELICM	245	4.5182	2.00E-06	67	1.8257	0.0750
	DSELICM does not Granger Cause DRIA		6.1003	3.00E-09		3.6156	0.0010
	DRIW does not Granger Cause DSELICM	245	4.4574	2.00E-06	67	1.7814	0.0835
	DSELICM does not Granger Cause DRIW		6.1794	2.00E-09		3.6643	0.0009
	DRIMA does not Granger Cause DSELICM	245	1.6933	0.0696	67	1.6325	0.1192
	DSELICM does not Granger Cause DRIMA		2.1260	0.0164		3.0204	0.0039

Source: Prepared by the authors.

[a]For 12 temporal *lags*.