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Monetary policy credibility and inflation in an emerging economy

Cleiton Silva de Jesus
State University of Feira de Santana

Thiago Rios Lopes
Federal University of Sergipe

Silvana Dantas Guimarães
State University of Feira de Santana

Abstract

In this paper, we investigate the relationship between monetary authority credibility and inflation in Brazil. We apply four credibility indices, which are available in the literature, to extract one factor using principal components methodology. This factor is considered a proxy to monetary policy credibility. The VAR approach is utilized to empirically investigate the dynamic relationship between credibility and inflation. The principal result of this paper suggest that the Brazilian monetary authority has lost credibility in recent years, specifically since 2010, and that an improvement in the level of credibility may reduce the rate of inflation.

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Contact: Cleiton Silva de Jesus - cleiton.uefs@gmail.com, Thiago Rios Lopes - thiagohenriquerios@gmail.com, Silvana Dantas Guimarães - siil.guimaraes@gmail.com.
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1. Introduction

The efficient management of economic policy depends on the policymaker˘s ability to take into account public expectations regarding the future. In relation to monetary policy, one of the ways the political authorities shape the expectations of economic agents is by establishing a credible inflation target. The modern economic literature argues that credibility reduces uncertainty, improves private sector perceptions about central bank behavior, increases monetary policy effectiveness and reduces inflation volatility.

Since the 1990s, many developed and developing countries have adopted an inflation targeting (IT) regime as an anchor for monetary policy. The main goal of this regime is to create and maintain a macroeconomic environment with low and stable inflation. Empirical evidence available in Gon´alves and Salles (2008) indicates that anIT regime is beneficial for developing economies. According to the authors, emerging countries that adopted this regime reduced the level of inflation and the volatility of growth compared to emerging countries that did not. The empirical model developed by de Mendon´a and Souza (2012) also suggests that implementing an IT regime can be a good strategy in emerging economies.

In 1999, Brazil, the largest economy in Latin America, adopted anIT regime when the country suffered a currency crisis (see Bogdanski, Tombini and Werlang, 2000). Since then, the average rate of inflation, as measured by the Consumer Price Index, has fluctuated around 6.9% per year, and on four occasions (in 2001, 2002, 2003 and 2015) the monetary authority failed to achieve its principal goal. Currently, the inflation target core in Brazil is 4.5% per year with a tolerance interval of 2%.

The main purpose of this paper is to investigate the impact of the Brazilian monetary authority˘s credibility over the period between 2003 and 2015. This research forms part of the rules versus discretion debate, popularized in the academic literature following the works of Kydland and Prescott (1977) and Barro and Gordon (1983). In this approach, it is hard to control an inflationary process when the monetary authority has a poor reputation and low credibility. Reputation is linked to the central bank˘s past behavior, while credibility depends on economic agents˘ beliefs about the effectiveness of the policymaker˘s announced goals. Thus, any improvement in the reputation of the highest monetary authority, also improves its level of credibility, and a combination of reputation and credibility helps to reduce the social cost of a disinflationary policy, in terms of a decrease in output and rising unemployment.

This paper is divided into five sections, including this introduction. Section 2 contains a review of the literature regarding monetary policy credibility and presents four indexes. In section 3, an alternative index of credibility is calculated by extracting a factor using the principal components method, which reflects the latent variable of interest. In section 4, we specify the vector autoregressive (VAR) models and, through these models, we analyze how inflation responds to monetary authority credibility shocks. The main results of the paper are summarized in Section 5.

2. Literature review

The 1980s were marked by a paradigm shift in relation to monetary policy conduct. In this context, the price stability objective has to be understood as the central bank˘s main goal. Based on this perspective, several studies emphasized the importance of central bank reputation and credibility in monetary policy (Kydland and Prescott, 1977; Barro and Gordon, 1983; Backus and Driffill, 1985; Blanchard, 1985; Cukierman, 1985; Barro, 1986; Cukierman and Meltzer, 1986; Rogoff, 1987 and Blinder, 2000). In general, this literature suggests that the monetary authority˘s reputation and credibility are important elements in minimizing problems of time-inconsistency and inflationary bias.

The main point of this approach is that if the monetary authority has not committed to the announced policy in the short term it will use its discretionary power to explore the trade-off between inflation and unemployment/output. If the central bank desires an output level above its potential level and, to this end, implements a discretionary monetary policy, the resulting equilibrium (suboptimal) will persistently maintain inflation above the target (inflation bias) and society will not reap any benefits in terms of output and unemployment (Clarida, Galº and Gertler, 1999).

Because credibility is crucial to the proper functioning of monetary policy, researchers have devoted efforts to this issue by constructing indexes that quantitatively represent central bank credibility. One of the first such indicators was proposed by Cecchetti and Krause (2002) using the Cukierman and Meltzer (1986) definition. According to this definition, credibility should be based on the difference between the inflation rate promised by policymakers and the one defined by public expectation. The Cecchetti and Krause (2002) index is defined as follows:

$$IC(1) = \begin{cases} 1 & if E(\pi) \leq \pi_t \\ 1 - \frac{1}{0{,}2 - \pi_t} - \pi[E(\pi) - \pi_t] & if \pi_t < E(\pi) < 20\% \\ 0 & if E(\pi) \geq 20\% \end{cases} \quad (1)$$

Where E ((ψ) is the public˘s expected inflation rate and (ψ)is the inflation target pursued by the central bank. This index demonstrates that, if the inflation expectation is less than or equal to the target, its value is equal to 1 (full credibility). However, if the inflation expectation falls between the target and 20% per year, the index is between 0 and 1, where the nearer the value to 1, the more credibility. Finally, if inflationary expectations exceed 20% per year, the central bank credibility is null.

Sicsß (2002), in turn, proposes the following credibility index that according to the author is better applied to the Brazilian economy:

$$IC(2) = 100 - \left\{ \frac{|E(\pi) - \pi_t|}{\pi^*_{tMAX} - \pi_t} .100 \right\} \quad (2)$$

where $\pi^*_{tMAX}$is the maximum that the inflation target can achieve. Note that the denominator indicates the tolerance for the inflation target. Thus, when the index approaches 100 points, economic agents believe that the target will be achieved; when it approaches zero, they understand that future inflation will be close to one of the limits (maximum or minimum) established by the government. On the other hand, when the index has a negative result, this equates to saying that market agents do not believe the target will be achieved, even when taking account of the confidence interval.

Given Cukierman and Meltzer˘s (1987) definition of credibility and the suggestion made by Svensson (2000), de Mendon´a (2007) proposed a credibility index similar to Sicsß˘s (2002), but normalized between 0 and 1. The index proposed by de Mendon´a (2007) is as follows:

$$IC(3) = \begin{cases} 1 & if \quad E(\pi) = \pi_t \\ 1 - \frac{1}{\pi^*_{tMAX} - \pi_t} [E(\pi) - \pi_t] & if \quad \pi^*_{tMIN} < E(\pi) < \pi^*_{tMAX} \\ 0 & if \; E(\pi) \geq \pi^*_{tMAX} \text{ ou } \pi^*_{tMIN} \geq E(\pi) \end{cases} \quad (3)$$

Note that this index has a value between 0 and 1 if expected inflation falls within the maximum and minimum limits (π^*_{tMAX}, π^*_{tMIN}) established for each year. When the expected

inflation is identical to the inflation target, the index reaches its maximum value (one), but decreases in a linear manner, as the inflation expectation deviates from the announced target. When inflation expectations exceed the maximum and minimum limits, the index assumes its minimum value (zero).

Based on the indicators presented above, Nahon and Meurer (2009) propose an index that uses elements from the other three indexes, but with certain modifications: theirs has a maximum value when the expected inflation is lower than the inflation target˜s upper limit. On the other hand, when the expected inflation exceeds 20%, credibility is zero, and the index decreases linearly between these limits.

$$IC(4) = \begin{cases} 1 & if \quad \pi^{*}_{tMAX} \geq E(\pi) \\ 1 - \frac{1}{\pi^{*}_{tMAX} - \pi_t} \left[E(\pi) - \pi^{*}_{tMAX} \right] & if \quad \pi^{*}_{tMAX} < E(\pi) < 20\% \\ 0 & if \quad E(\pi) \geq 20\% \end{cases} \qquad (4)$$

As we can see, the indexes attempt to measure the credibility of the monetary policy implemented by the central bank. It should be noted that, while the Cecchetti and Krause index (2002) seeks to consider certain international parameters, the Sicsß (2002), de Mendon´a (2007) and Nahon and Meurer (2009) indexes seek to make certain adaptations to the Brazilian case. However, it does not seem reasonable to assume that an indicator such as this best reflects monetary policy credibility in Brazil. In an attempt to take into account all the information from each of the indicators, we decided, as we will see in the next section, to construct an index that captures most of the possible variance in these four indexes[1].

The individual performance of each index described in this section is shown in the Figure AI in the Appendix.

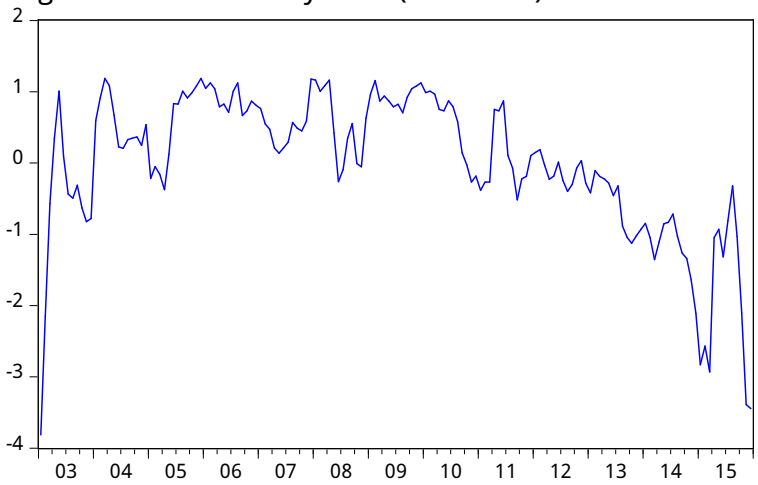
3. The credibility index: a multivariate approach

The four indexes presented in the previous section were calculated for the period between January 2003 and December 2015. The inflation target imputed for each period and tolerance interval is the inflation target (measured by the IPCA) set by the National Monetary Council (CMN) for the next 12 months. The inflation expectation is the average expectation of accumulated IPCA for the next 12 months, collected by the Central Bank of Brazil (CBB) and available at www.ipeadata.gov.br.

After grouping these four indicators, we extracted a factor that best represents the latent variable of interest: monetary authority credibility. Factor analysis is a multivariate technique that allows us to synthesize the relationships between a set of variables in order to identify `common factors_ (HAIR et al, 2006). The method for the extraction of factors was the principal component, because the aim is to acquire the lowest number of factors that explain the maximum variance of the original data. Those factors with eigenvalues greater than one were extracted. This resulted in the extraction of only one factor, which explains 77% of indicator variance. The scores obtained from the extraction of this factor are presented in the following graph.

[1]Nahon and Meurer (2009) propose another index, which the authors call "ratio of credibility": the ratio between the upper limit of the inflation target and expectations. We also calculated this index, but found that the correlation between the ratio of credibility and the Nahon and Meurer (2009) index for the period studied in this article is very high (>99%). It is worth noting that the main results obtained in the empirical analysis that follows did not alter when the ratio of credibility was considered in the calculations.

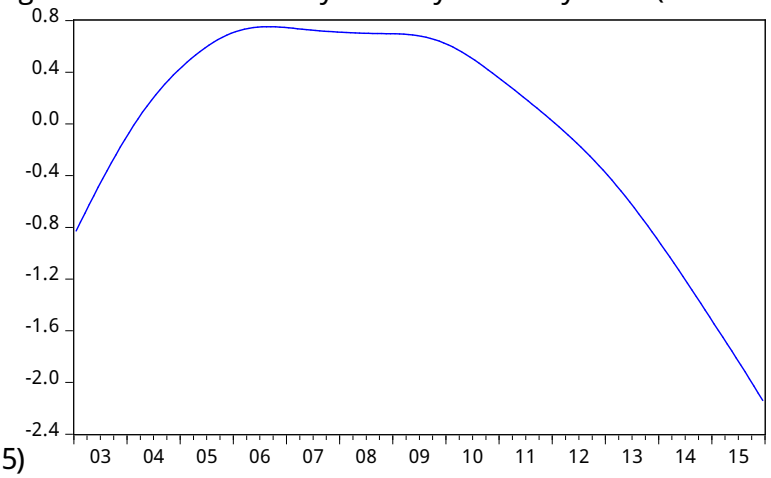
Figure 1. CBB credibility index (2003-2015)



Source: Compiled by the authors.

In order to more clearly understand the long-term behavior of this monetary authority credibility index, we decided to extract the series trend using the Hodrik-Prescott.

Figure 2.Trend for monetary authority credibility index (2003-2015)



Source: Compiled by the authors.

From this graph, we can visually identify three distinct periods: i) 2003-2005, marked by gains in credibility; ii) 2006-2009, in which the previously acquired credibility was maintained; and iii) 2010-2015, characterized by deteriorating credibility. This periodization is compatible with rigor in monetary policy conduct, which can either be inferred through neutral interest rate estimates (Gon´alves, 2015) or by analyzing the CBB˘s preference parameters (Curado and Curado, 2014). It is well known that the first Lula administration was characterized by a conservative monetary policy, which contributed to a fall in inflationary expectations and again in credibility. The difference between expected inflation and its target, for example, moved from 3.47% in January of 2003 to -0.05% in December of 2005.However, the 2008-09 international crisis and the change in command of both the Government and the CBB in 2011, resulted in monetary policy management that gave greater weight to the level of economic activity and less weight to the difference between current (and expected)inflation and the inflation target. Associated with this, a higher degree of interventionism in economic activities (with an expansionist fiscal policy) and the end of the growth cycle driven by consumption and commodities may have negatively impacted on market expectations of inflation and, consequently, damaged monetary policy credibility.

4. Empirical evidence

The effect of monetary authority credibility on inflation is ascertained using the following VAR model:

$$y_t = A_0 + \sum_{i=1}^{k} A_i y_{t-i} + e_t \quad (5)$$

where A_0 is a vector composed of constants, A_i is the coefficient matrix, y_t is the vector of endogenous variables, e_t is the vector with the error terms and k is the number of lags. In the benchmark specification the variables included in the model were:

Inflation: the Consumer Price Index (IPCA) accumulated over twelve months, calculated and available from the Brazilian Institute of Geography and Statistics (IBGE).

Credibility: the variable calculated in the previous section using multivariate analysis.

Output gap: the percentage deviation from the economic activity index (IBC-Br) around its trend. The original data is seasonally adjusted, calculated and available from the CBB. We used the Hodrik-Prescott filter to calculate its trend.

Exchange rate: the first difference of the nominal exchange rate Real/Dollar. The nominal exchange rate series was extracted from the CBB.

We also decided to perform two alternative VAR model specifications, replacing the variable output gap with two other variables useful for capturing the pressure of aggregate demand on price dynamics: the unemployment gap and the level of capacity utilization. The first variable was calculated based on the monthly unemployment rate, seasonally adjusted, in metropolitan areas, available from the IBGE. The series trend was calculated in the same way as the output trend. The second estimate is the percentage level of industry capacity utilization, seasonally adjusted, calculated and available from the Getßlio Vargas Foundation (FGV).

The VAR approach assumes that all the series included in the model are stationary (ENDERS, 2014). Thus, the first step in the analysis is to check whether the series are, in fact, stationary. We used three tests: the Augmented Dickey-Fuller (ADF), the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) and the Phillips-Perron (PP). In the ADF test, the lag length was based on the Schwarz information criterion, with the maximum number of lags $k_{max} = int[12(N/100)^{1/4}]$.In the PP and KPSS tests the bandwidth was Newey-West (using the Bartlett kernel spectral estimation method). When they were statistically significant, we included one deterministic trend (T) and one constant (C) in all the tests. The results are summarized in Table I.

Table I. Unit root tests

	ADF test				KPSS test				PP test			
	Lag	Test	Specific	Result	Band	Test	Specific	Result	Band	Test	Specific	Result
CREDIBILITY	0	-3.09	-	I(0)	8	0.40	C, T	I(1)	0	-3.09	-	I(0)
INFLATION	12	-1.25	C, T	I(1)	10	0.30	C	I(0)	7	-2.60	C	I(0)
OUTPUT GAP	2	-4.25	-	I(0)	9	0.03	C	I(0)	3	-3.37	C	I(0)
∇(EXCHANGE)	0	-8.30	-	I(0)	3	0.07	C, T	I(0)	2	-8.35	-	I(0)
UNUMP GAP	0	-2.42	-	I(0)	9	0.04	C	I(0)	6	-2.94	-	I(0)
CAPACITY	3	-1.82	C	I(1)	9	0.23	C	I(0)	6	-1.49	C	I(1)

Source: Author estimates.

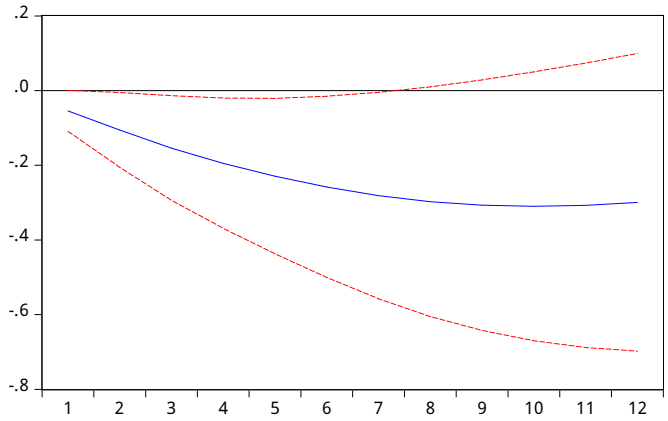
We note that the six series are stationary, since at least one of the tests suggested this result. The lag order of the VAR model was based on traditional Akaike (AIC), Schwartz (SC) and Hannan-Quinn (HQ) information criteria. Considering six as the maximum lag, the SC and HQ criteria suggested a VAR model with two lags, while the AIC criterion suggested one with six (see Appendix). We chose to estimate the VAR model with two lags, since this was suggested by two of the three criteria used and because a model with few lags is preferable to a model with many lags[2].

The Lagrange Multiplier test suggested that the VAR model with two lags presented residual autocorrelation (see Appendix). This result implies the need for caution in our analysis of the confidence interval of the estimated coefficients. The stability test suggested that the benchmark model is stable (see Appendix) and the dynamic analysis is valid. Since the parameters of the VAR model are not generally interpretable, we followed the standard literature (see, for example, Stock and Watson, 2001) and focused on the impulse-response functions and the variance decomposition of the forecast errors. However, we used the generalized impulse-response functions (see Pesaran and Shin, 1998) in order to eliminate the problem caused by the order of the endogenous variables in the traditional VAR model specifications (Cholesky decomposition).

Although the VAR model with four variables provides 16 different generalized impulse-response functions, we chose to focus only on the function that shows the impact of a credibility shock on inflation. This impact is shown in Figure 3. The red line is the point response to the shock over 12 months, while the dotted lines show the 95% confidence interval calculated by the Monte Carlo method with 10,000 repetitions.

[2] It is well known that in a VAR model the degree of freedom rapidly decreases with the inclusion of more lags. In a model with four endogenous variables, one constant and two lags, for example, 36 parameters are estimated.

Figure 3. Impulse response: standard specification



Source: Compiled by the authors.

A positive shock to monetary authority credibility negatively affects inflation, both at the time that the shock occurs and in subsequent periods. However, this response is only statistically significant until the eighth period. The result remains valid, in terms of both generalized impulse response functions and statistical significance, even when we specify a model with three or four lags, and when we include two other variables in the model, both together and separately: inflationary expectations and basic interest rate (the monetary policy variable). The generalized impulse response functions of these alternative specifications can be seen in Appendix (Figure AIII). In the bivariate VAR model specified by de Mendon´a and Galveas (2013) it is possible to find evidence that an increase in monetary policy credibility index reduces the rate of inflation in Brazil[3].When we ran the model using each one of the four credibility indexes described in the literature review (see Appendix, Figure AIV) the main conclusion was just observed for two indexes: a positive shock to monetary authority credibility index negatively affects the observed inflation. To the models with the other two this response remained negative, but was not inside the 95% confidence interval.

The analysis of the forecast variance decomposition of inflation for 25 periods demonstrated (Table 2) that, as time passes, monetary authority credibility has more impact on inflation explanation. This reaches 29.6% in the twenty-fifth period, as opposed to just over 0.12% of the exchange rate and 6.5% of the output gap. This exercise suggests that the dynamics of inflation really do depend on monetary authority credibility, and that this dependency is higher over the medium term.

Table II. Variance decomposition of Inflation

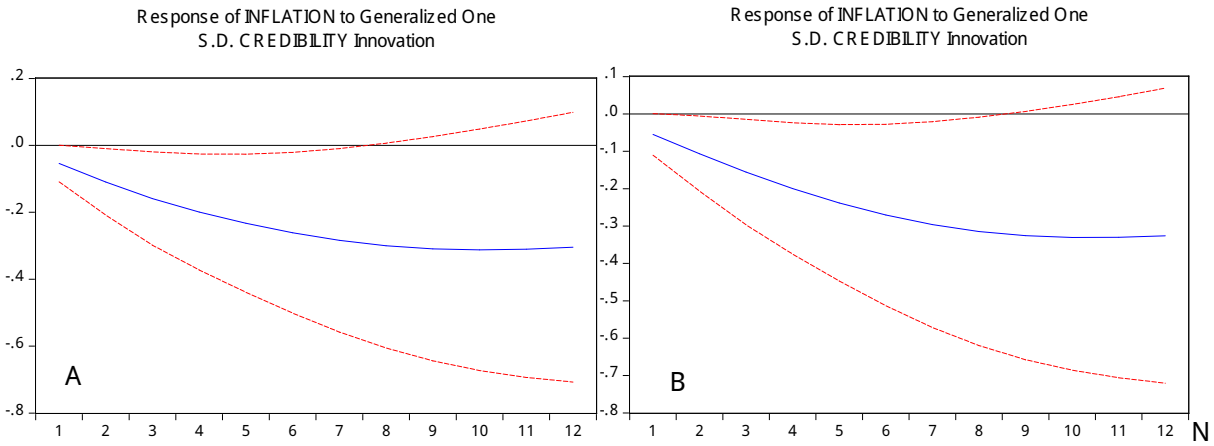
Period	Inflation	Credibility	Exchange	Output
1	96%	2.7%	1.2%	0.04%
7	85.5%	12.1%	0.18%	2.2%
13	71.9%	22.6%	0.13%	5.39%
19	65.6%	27.8%	0.12%	6.38%
25	63.7%	29.6%	0.12%	6.49%

Source: Author estimates.

[3]Using data from the Brazilian economy, de Mendon´a and Souza (2009) suggest that higher credibility causes lower variation in the interest rate to control inflation, and Montes and Bastos (2014) find evidence that gains in credibility reduce monetary authority efforts in monetary policy conduct.

In order to verify whether this result persists when we drop the output gap variable in the benchmark specification, we decided to replace this variable with two other alternative variables frequently found in the empirical macroeconomic literature: unemployment gap (Specification_2) and level of capacity utilization (Specification_3). Following the SC and HQ information criteria, these two alternative models were estimated with two lags. The generalized impulse response functions of these two models, with a 95% confidence interval, can be seen in Figure 4 below.

Figure 4. Impulse response: alternative specifications



Note: (A) Specification_2 and (B) Specification_3. Source: Compiled by the authors.

It is easy to see that the impulse response functions (and their statistical significance) are almost identical to those provided by the benchmark model, which attests to the robustness of the previous result: the response in inflation due to one standard deviation shock to the credibility index is negative and statistically significant until the eighth/ninth period. In the variance decomposition exercise of inflation (not reported), one can also verify the robustness of the results obtained in the standard specification. The difference was that in the twenty-fifth period, the credibility index increased its role in inflation explanation: 31.7% in the model with the unemployment gap and 33.8% in the model with level of capacity utilization.

5. Conclusion

In this paper, we used four monetary authority credibility indexes available in the literature and extracted one factor from these using principal components methodology. This factor represents the latent variable of interest, monetary authority credibility, as an alternative to the use of only one indicator as a proxy for credibility. The dynamic relationship between the credibility index and inflation in Brazil was analyzed using different VAR model specifications. Two important results were obtained: i) the Brazilian monetary authority has lost credibility in recent years, specifically since 2010 and ii) a positive shock to monetary authority credibility leads to a reduction in the inflation rate over at least eight periods.

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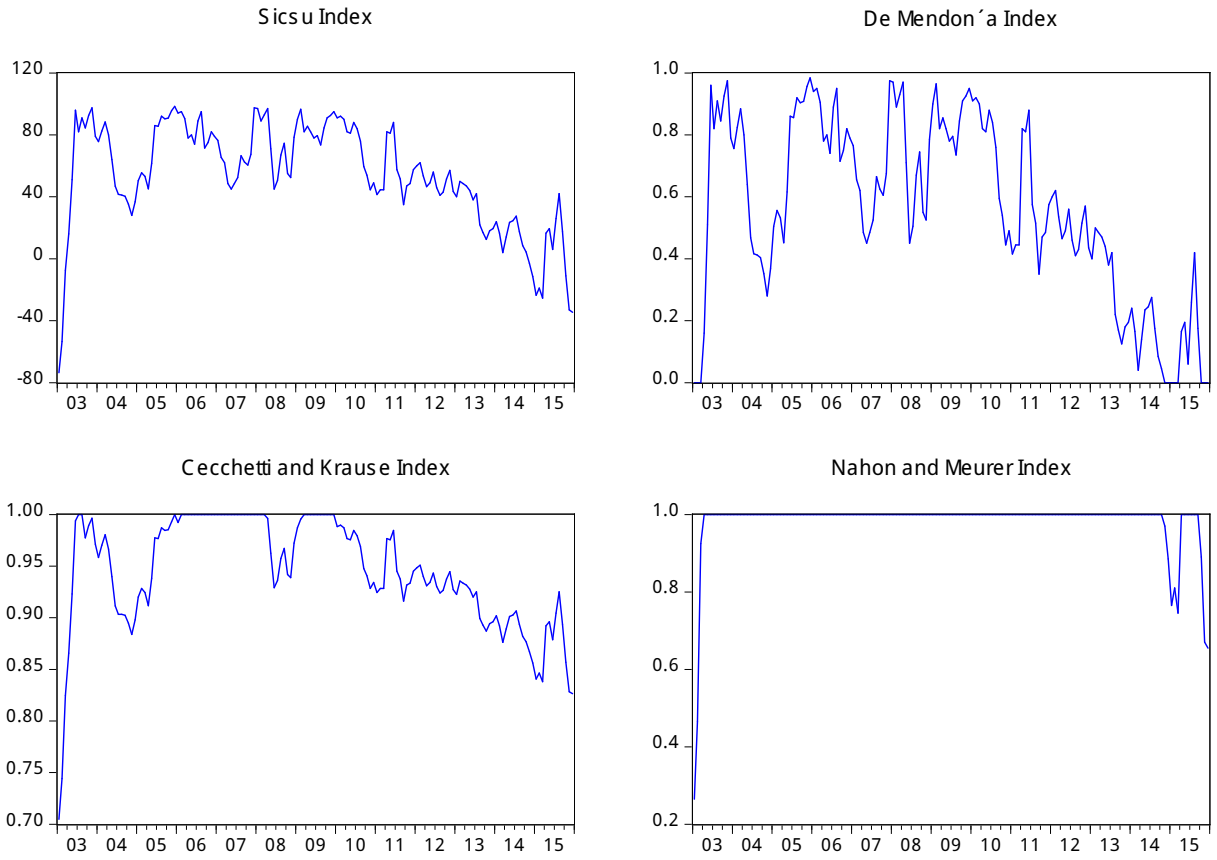
Appendix

Figure AI. Credibility Indexes



Source: Author˘s elaboration.

Table AI. AIC, SC and HC criteria of VAR model

Lag	AIC	SC	HQ
0	-0.835160	-0.754517	-0.802396
1	-7.365524	-6.962309	-7.201704
2	-7.894815	-7.169029*	-7.599940*
3	-7.970128	-6.921771	-7.544198
4	-7.935977	-6.565049	-7.378992
5	-8.039571	-6.346071	-7.351530
6	-8.118859*	-6.102787	-7.299762

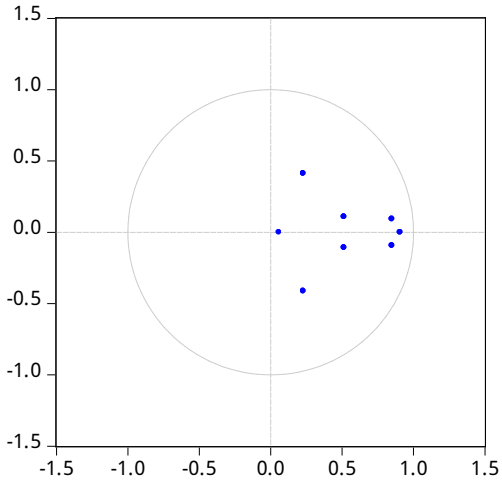
* Denotes lag order selected by the criterion. Author˘sestimates.

Table AII. LM autocorrelation test

Lag	LM-stat	Prob
1	47.33460	0.0001
2	41.91061	0.0004
3	35.13544	0.0038
4	27.51359	0.0361

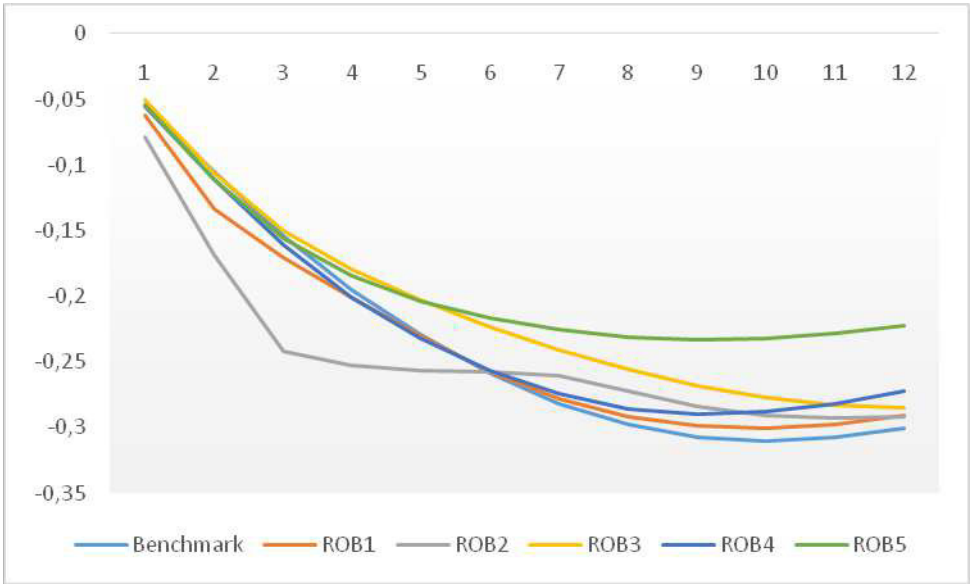
Null hypothesis: no residual autocorrelations. Author˘s estimates.

Figure AII. VAR stability: Inverse roots of AR characteristic polynomial



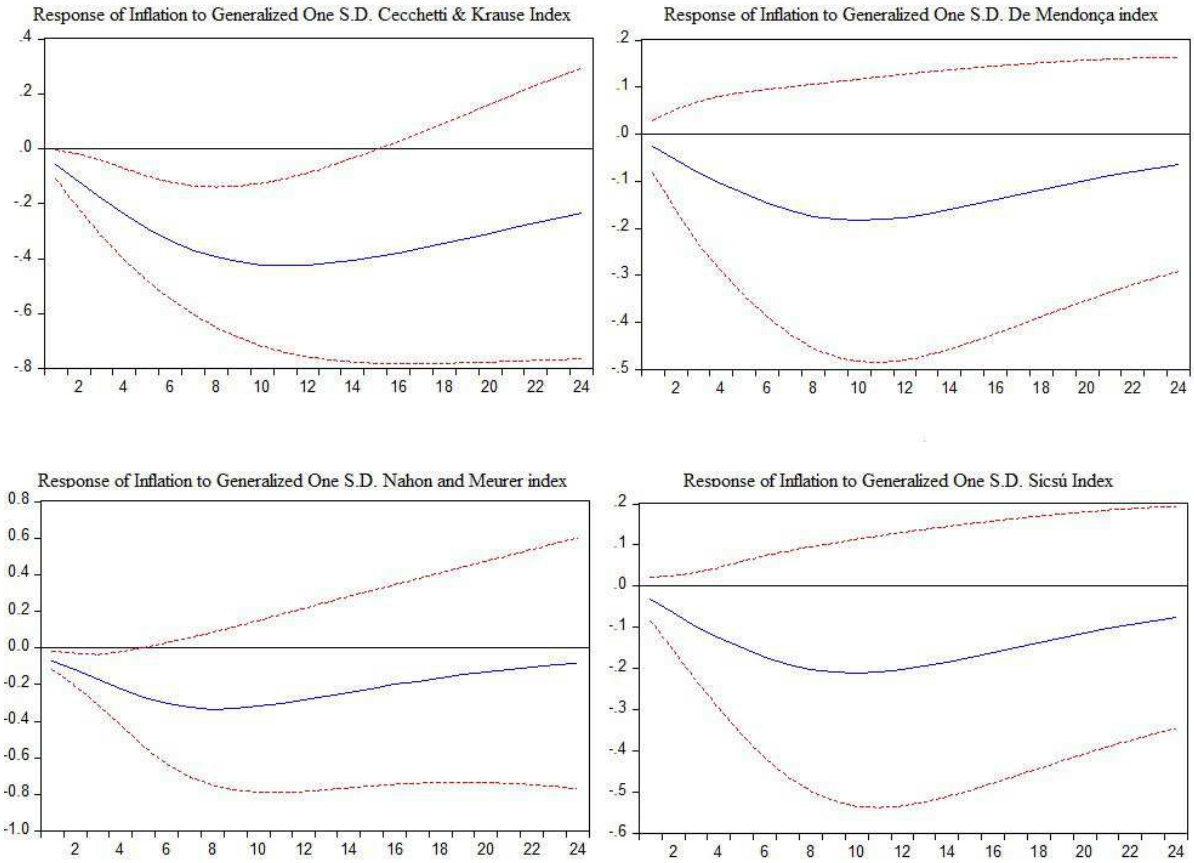
Author˘s elaboration.

Figure AIII. Robustness 1: Response of inflation to generalize one S. D. credibility innovation



Note: ROB1, standard model with 3 lags; ROB2, standard model with 4 lags; ROB3, standard model with inflation expectation; ROB4, standard model with interest rate; ROB5, standard model with inflation expectation and interest rate.
Source: Author˘s elaboration.

Figure AIV. Robustness 2: Response of inflation to generalize one S. D. credibility innovation



Source: Author˜s elaboration.