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Economia & Região

CREDIBILITY OF THE CENTRAL BANK AND GDP EXPECTATIONS: An alternative analysis on the Brazilian's sacrifice rates from 2002 to 2018

CREDIBILIDADE DO BANCO CENTRAL E EXPECTATIVAS PARA O PIB: Uma análise alternativa para as taxas de sacrifício brasileiras entre 2002 e 2018

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ABSTRACT

The recent literature on Central Bank credibility points out that an improvement in the latter generates better (a decrease in) sacrifice rates. This paper aimed to analyze whether this effect can be directly observed through GDP expectations. The analysis was based on a VAR model and impulse response functions for Brazil from 2002 to 2018. The results indicated that increases in the Central Bank credibility did not imply short-term (first 12 months) gains in GDP expectations. Nevertheless, after the first year from the credibility shock, GDP expectations show an effective increase, thereby indicating a lower long-term sacrifice rate perception.

Keywords: Credibility; GDP; Monetary Policy.

RESUMO

A literatura recente acerca de taxas de sacrifício e credibilidade dos Bancos Centrais aponta que uma melhora em relação à credibilidade gera uma melhora (diminuição) das taxas de sacrifício. Neste artigo busca-se analisar se este efeito pode ser observado diretamente nas expectativas de PIB dos agentes. A análise foi feita a partir de um modelo VAR e funções impulso-resposta para o Brasil no período de 2002 a 2018. Os resultados indicaram que um aumento na credibilidade do Banco Central não implicou em melhora nas expectativas dos agentes acerca do PIB nos primeiros doze meses. Todavia, passado um ano do choque na credibilidade, observa-se uma melhora significativa nas expectativas de PIB, demonstrando que o ganho de credibilidade da autoridade monetária reduz a taxa de sacrifício no longo prazo.

Palavras-chave: Credibilidade; PIB; Política Monetária.

JEL: E00, E40, E52.

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INTRODUCTION

Given the consensus among economists that an effort to reduce inflation generates a reduction in economic activity, some recent studies have sought to measure how the level of credibility of central banks affects this relationship. In general, authors investigate whether Central Bank Independence (CBI), the level of debt relative to Gross Domestic Product $(LdGDP)$ and the adoption of the inflation targeting regime (ITR) are capable of affecting the sacrifice rate (SR) for a given disinflation period.

The global trend of adoption of Inflation Targets *(IT)* was followed by the Brazilian monetary authority in 1999. This international trend was a response to several inflationary episodes in both developed and developing countries, as well as a replacement of the previous exchange rate and monetary targets regimes. According to De Mendonça e De Guimarães e Souza (2009), the CBB's first strategy following the adoption of IT was a rigid monetary policy, that is, an aggressive short-term reduction of inflationary rates was pursuit. This feature was later modified, with the 2003, 2004 and 2005 target adjustments.

Notwithstanding a series of exogenous shocks in the first three years of the Brazilian IT regime (energetic crisis, presidential elections, attacks of September 11, 2001 and the Argentine crisis) (MINELLA et al., 2002) followed by almost two decades of economic and political risks (corruption scandals, 2008's sub-prime crisis, 2016's presidential impeachment), the CBB was successful in maintaining satisfactory inflation rates. Based on recent studies, an increase in CBB credibility was expected as a result of this systematic achievement.

Consequently, this credibility improvement is expected to affected positively the GDP growth expectations of economic agents, although this variable was under the direct influence of the same shocks aforementioned. Thus, for a more precise assessment of the influence of the monetary policy credibility on the GDP expectations, a deeper analysis was required.

Therefore, this paper aimed to capture whether the monetary policy's credibility affected GDP growth expectations in Brazil from 2002 to 2018. In other words, this paper tested if higher credibility leads to an improvement of GDP growth expectations. To do so, it was assumed that an improvement in GDP expectation is equivalent to a lower sacrifice rate expectation. Thus, the credibility index proposed by De Mendonça (2004) was used and our hypothesis was tested through a *vector autoregressive* (VAR) model.

The purpose of this paper was to contribute to the debate about the influence of monetary policy credibility on the expectation of GDP growth by proposing the analysis for the Brazilian economy, since the selected literature indicates tests only for the *Organization for Economic Co-operation and Development* $(OECD)$ countries (DURHAM, 2001; BERNANKE et al, 1999).

To fulfill the proposed objective, this article is divided into 4 sections beyond this introduction. Section 2 presents a brief literature review on the relationship between monetary policy credibility and the sacrifice rate. Section 3 presents the methodology, variables and the data used in this study. Section 4 presents the regression results. Final comments conclude the article.

THEORETICAL SCOPE AND EMPIRICAL BIBLIOGRAPHIC REVIEW

According to Durham (2001), much of the recent research in the monetary policy area has been devoted to clarifying the determinants of the trade-off between output gap and inflation. This (positive) correlation is usually systematized from an expectational Phillips curve, where, if the central bank has credibility, the disinflation policy will have a lower cost (lower sacrifice in terms of GDP reduction). The author points out that in this approach the slope of the Phillips curve does not shift over time. In other words, the trade-off is assumed to be constant for several episodes of disinflation over time.

From this dilemma, researchers have been dedicated to establishing how the level of credibility of central banks influences the magnitude of this trade-off, especially in periods of disinflation. This discussion is usually approached from measurements of the influence of central bank credibility on sacrifice rates for periods of disinflation. According to Durham (2001) these studies generally deal with panel data for $OECD$ countries where initial inflation levels do not exceed 20 percent.

According to Ball (1993) the sacrifice rate (SR) is defined as the change in GDP (ΔY) over the change in inflation ($\Delta\pi$). Importantly, the SR, and hence ΔY and $\Delta\pi$, are calculated for specific disinflation episodes. These episodes are defined by identifying periods (in quarterly data) where an inflationary "peak" occurs followed by a reduction of at least 2 pp. in annual inflation. Also, Inflationary "peaks" are identified as higher values than those observed in the previous 4 quarters and the subsequent 4 quarters.

The most used credibility proxies in the studies mentioned are: Central Bank Independence (CBI), debt / GDP level ($LdGDP$) and adoption of the inflation targeting regime (ITR). The argument to consider $CBI's$ as a credibility proxy stems from the thesis that under this conjuncture there is less pressure for the problem of temporal inconsistency. In other words, the monetary policy would become less erratic over time. Consequently, there would be less economic instability and lower risk premium on interest rates. However, Durham (2001), Gonçalves and Carvalho (2008) and Rossi (2004) point out that in some cases the empirical evidence does not corroborate this thesis.

The use of central government deficits as a measure of central bank credibility come from the thesis that the larger the $LdGDP$, the greater the impetus to "monetize" these obligations through loosening money supply. Thus, there is a positive correlation between $LdGDP$ and SR, since a high liability stock generates agents' distrust of the credibility of disinflationary policies.

Another indicator used to verify credibility is a dummy variable that indicate the adoption of an ITR. There is relative consensus in the literature about the superiority of ITR policy over monetary and exchange rate targeting regimes (Mishkin 1997; Bernanke and Mishkin 1997). This is due to the restriction of a single objective to the Central Bank (monetary stability), besides, this regime is usually accompanied by mechanisms of transparency and flexibility (to deal with short-term fluctuations). According to Corbo et al. (2001), for a sample of 25 countries, evidence points to a higher sacrifice rate for $non-ITR$ countries. Conversely, Bernanke et al. (1999) found no evidence of this correlation when examining 25 episodes of disinflation in 9 $OECD$

countries. Lastly, Gonçalves and Carvalho (2008) conclude that the ITR is important to reduce inflation costs, however, this situation occurs more mildly in developed countries than in developing countries.

In parallel with the literature on credibility versus sacrifice rate (SR), other important measures have been developed to quantify the ability of central banks to maintain monetary stability. These are: the credibility (forward looking) and reputation (backward looking) indexes (de MENDONÇA, 2004; MENDONÇA and GUIMARÃES E SOUZA 2009). These consider inflation fluctuation bands around the pre-set target and inflation expectations in order to statistically capture agents' expectations regarding the ability of the Central Bank to maintain stable inflation rates.

With the regard of recent studies of credibility and reputation rates in Brazil, some references are equally important to this paper. Mendonça e Guimarães e Souza (2009) claim that, in a IT regime, a disinflation policy accompanied of higher degrees of credibility demands less interest rates levels and variation. Likewise, Montes e Bastos (2011) investigate the credibility of the IT regime in the level and spread of long-term interest rates $(TNJLP)$. Hence, estimations for the causes of spread variation where made for the period of January 2000 to September 2009. Empirical evidence suggests that gains in credibility have reduced the spread rates and, in addition, have smoothened the interest's rate curve. Therefore, higher credibility rates contributed to a lower degree of uncertainty, which improved long-term investment decisions.

Holland (2005) carried out an analysis of the first years of floating exchange rates in Brazil. The CBB reaction functions adopted between July 1999 and January 2005 were observed with the objective to identify if the primary concern was focused in inflation rates or exchange rates volatility. To this end, the author noted that the CBB's inflationary shocks reaction functions were not high enough in the context of low exchange rate volatility, suggesting that the exchange rate could not fluctuate as expected. The results signaled a lower attention to real exchange rate by CBB. Despite the importance of the nominal exchange rate, the inclusion of the country risk variable in the information set did not result in depreciation of the real exchange rate. In addition, the inclusion of the nominal rate indicated a slight reduction in the inflation coefficient. Thus, real depreciations weren't as important in the interest rate reaction functions as the nominal ones and two mechanisms were identified: i) The CBB disregarded a transmission channel that passes through country risk and affects nominal movements in the exchange rate; ii) there were direct and indirect effects of relative (short-term) prices, resulting in a myopic assessment of the equilibrium real exchange rate by the CBB.

Moreira (2013) evaluates the empirical evidence about the relation of observed inflation, expected inflation and CBB credibility, from January 2005 and June 2011. The author extracted the dynamic interaction between observed and expected inflation rates with a Kalman Filter and a VAR model. The dynamic relation was than considered a proxy to the CBB credibility. The paper shows that a positive shock in the observed values of inflation generates both an increase in the expected future values of inflation and a decrease in credibility. Moreira (2013) assess that the challenge of the CBB rests in maintaining inflation rates at low rates (2-3 pp. annually), thereby turning the credibility less elastic to the occasional prices fluctuations

Montes (2013) analyzes the *CBB* credibility effects in the monetary policy administration and in the transmission channels, emphasizing the effects in the agent's expectations and investment decisions. The analysis consisted in various econometrics methodologies (VAR, MQO e GMM) to data from the fourth quarter of

2001 to the second quarter of 2011 (notably, after the IT regime adoption). As a result, the author found evidence that gains in credibility about the capacity of the CBB to maintain the IT regime incurs in a more stable business environment and, thus, a stimulus to better expectations.

In another key contribution to this debate, Montes e Bastos (2014) paper demonstrate the CBB reputation and credibility effects in the amount of necessary effort to change the inflationary bias. With MQO, GMM, $GMM-system$ and VAR methods, to data from December 2001 and October 2011, the authors conclude that higher credibility and reputation engender a softer necessity of effort and, forthwith, less variation on the monetary bases. This phenomena can be read as a lesser sacrifice rate.

Curado and Curado (2014) estimated the CBB parameters of preference for the open economy optimization problem. The GMM was used to solve the optimization problem between 2002 and 2013. The author's objective was to explicitly separate the structural parameters from the preference parameters. This differentiation is important for the Brazilian case since the recent macroeconomic stability was achieved through fast monetary policy channels, in constant adaptation. The main evidence found indicates a high degree of flexibility in the Brazilian inflation targeting regime, revealing that the regime's flexibility was intensified in the period.

Lastly, Moreira (2016) paper propose a structural method of credibility measurement based on parameter calibration. This approach is pointed as a tentative to overcome the restrictions of Cecchetti e Krause (2002) credibility indexes. With a VAR model and data from January 2005 to July 2012, the author detects dynamic correlation of expected and observed inflation and credibility. Based on this discussion, the first part of the following section describes the operation and construction of the Monetary Credibility Index ($MCI1$) used in this article.

METHODOLOGY

Data

This paper investigates whether the thesis of the effects of credibility fluctuations on the sacrifice rate (SR) can be observed in a correlated manner, namely, whether the change in the Monetary Credibility Index ($MCI1$) affects the agents' expectations regarding GDP. The analysis will be made for Brazil from 2002 to 2018. Thus, we try to show that an improvement in growth expectations, given the greater credibility of the Central Bank of Brazil (CBB), would confirm that agent's perspective there is a lower sacrifice rate (SR) for maintaining the disinflation policy. The $LdGDP$ relationship, used as a credibility proxy in the literature described in the previous section, will be used as a control variable, as shown below. Because the analysis is based on a period in which monetary policy was based solely on the Inflation Targeting Regime (ITR), this study will not be able to assess its influence on GDP expectations.

In Brazil, the central goals and bands have fluctuated since the implementation of the ITR in the second half of 1999. Table 5 (in the annex) summarizes their history. The last column represents the Consumer Price Index (CPI), which although not used in the construction of the $MCI1$, serves as a measure of monetary policy success. In 2003 and 2004, changes were made to goals and bands during the year, so the table shows two values for each. In the construction of $MCI1$ only the most recent values were used for each of these years.

The $MCI1$ was built from the methodology presented by De Mendonça (2004), represented in Equation (1). Where $E\ (\pi)$ equals the expected inflation, π_t represents the center of the target in period t and π_{tMAX} and π_{tMIN} indicate, respectively, the upper and lower bounds of the fluctuation bands. The index assumes unit value when inflation expectations coincide with the central target set by the Central Bank. This index decreases linearly as the distance of expectations from the target increases to the limit where they exceed the top (or the floor) of the defined bands. From this point the index assumes the zero value. Since $MCI1$ assumes zero value several times during the study period, a value constant of one has been added for every month. The advantage of this operation is that it does not change the trajectory of the variable in the period and, thus, it is possible to work with the logarithm, since there is no zero value anymore. Thus, the $MCI1$ varies between 2 and 1, with 2 being the point that represents the maximum credibility by the monetary authority, and when the index assumes 1, it means the total loss of credibility.

$$MCI1_t = \begin{cases} 1 & se\ E_t(\pi_{t+12}) = \pi_t \\ 1 - \left[\dfrac{[E_t(\pi_{t+12}) - \pi_t]}{\pi_t^* - \pi_t}\right] & se\ \pi_{tMín}^* < E_t(\pi_{t+12}) < \pi_{tMáx}^* \\ 0 & se\ E_t(\pi_{t+12}) \geq \pi_{tMáx}^*\ ou\ E_t(\pi_{t+12}) \leq \pi_{tMín}^* \end{cases} \quad (1)$$

Data on Gross Domestic Product Expectations ($GDPE1$) were obtained directly from $CBB's$ Market Expectations System. We used the latest daily observations for each month to construct monthly series. Expectations correspond to total GDP for the current year. Also, a value constant of one was added in each month of $GDPE1$, with the same objective as in $MCI1$. Thus, negative and null values were eliminated, not changing the evolution of the variable in the studied period, being possible to use the variable in logarithm.

Given that $MCI1$ is not the sole determinant of $GDPE1$, other variables were used to measure the effects of these fluctuations, namely: Public Sector Net Debt to GDP ($PSND$); Brazilian basic interest rate ($SELIC$) and Nominal Exchange Rate (NER). The data used for these variables were collected from the Central Bank of Brazil statistics, in the Time Series Manager System - Public Module. The construction of monthly series from daily data followed the same methodology. A fourth variable is equivalent to Country Risk ($EMBI$). This was obtained from Institute of Applied Economic Research ($IPEADATA$) and acts as an attractiveness index for Brazilian public securities. The series was measured from simple averages of daily values for each month.

Econometric reference

According to Bueno (2011), VAR is used to analyze the dynamic impact of random perturbations on the variable system. The VAR approach is defined by systems of equations that models all variables as endogenous, and as a function of their lagged values. The main advantages of VAR are the possibility of estimate several variables simultaneously and the possibility to use impulse response functions. In general, one can express the VAR (of order p) as:

$$AX_t = B_0 + \sum_{i=1}^{p} B_i X_{t-1} + B\varepsilon_t \qquad (2)$$

where X_t is a vector with n endogenous variables; A is a matrix $n\,x\,n$ that defines the contemporary constraints between the variables that make up the vector $n\,x\,1$, X_t; β_0 is a vector of constants $n\,x\,1$; β_1 are matrices $n\,x\,n$; β is a diagonal matrix $n\,x\,n$ of standard deviations; ε_0, an $n\,x\,1$ vector of contemporary and temporally uncorrelated random perturbations, that is:

$$\varepsilon_t \sim i.i.d(0; I_n), \qquad (3)$$

where 0 is the null vector; and I_n the identity matrix.

According to Bueno (2011), equation (2) is called structural because it expresses the relationships between endogenous variables, according to a theoretically structured economic model. Because of the endogeneity of variables, VAR is usually estimated in its reduced form rather than the structural form. The reduced form can be expressed as follows:

$$X_t = A^{-1}B_0 + \sum_{i=1}^{p} A^{-1}B_i\, X_{t-i} + A^{-1}B\varepsilon_t = \phi_0 + \sum_{i=1}^{p} \phi_i\, X_{t-1} + e_t \qquad (4)$$

where: $\phi_i = A^{-1}B_i, i = 0,1,2,\dots,p$; and, $B\varepsilon_t = A\varepsilon_t$.

Before estimating the model, it is very important to determine the appropriate number of lags. For this, the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Criterion (AIC), Schwarz Criterion (SC) and Hannan-Quinn Criterion (HQ) were used.

In a VAR context, it is important to know how one variable responds to an impulse in another variable, ceteris paribus, in a comparative static exercise. For this, the generalized impulse was used, where the order of the variables does not generate any problem.

RESULTS AND DISCUSSIONS

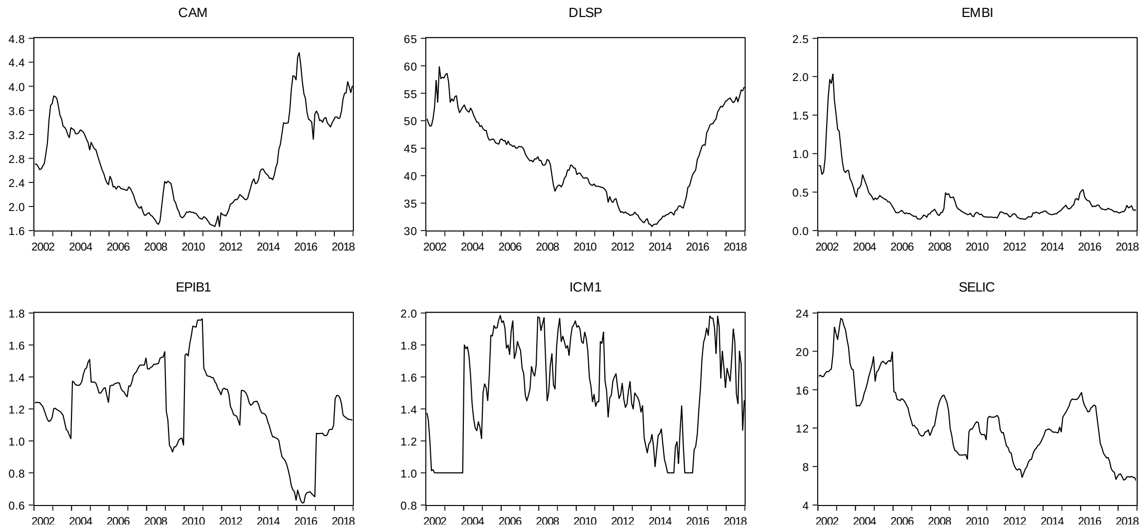
Graph 1 shows the evolution of each variable from January 2002 to December 2018. It is noted that the control series ($NER, PSND, EMBI$ and $SELIC$) presented a decreasing behavior from 2002 onwards. From 2001 and 2002 a series of exogenous influences (national and international) affected the variables under analysis, namely: energy crisis, presidential elections, attacks of September 11, 2001 and the Argentine crisis.

Foreign Exchange Rate and $SELIC$ reverse this downward trend from 2012. Unlike basic interest rates, NER reaches a peak in the 2014-2015 period. After a sharp fall between 2015-2016, this variable grows again, ending the analysis period at levels higher than 2002. $PSND's$ behavior differs from NER and $SELIC$ since it only shows inflection in 2013 assuming explosive growth until the end of the year. On the other hand, Country Risk $(EMBI)$ assumes a downward perspective until 2007. After a slight reversal given the 2008 crisis, it assumes apparently stable feature.

In full compliance, GDP expectations increases until the subprime crisis. After 2009, the upward trend is resumed with another reversal point in 2011. The decreasing behavior is circumvented in 2015, after the impeachment process of Dilma Rousseff President. The graphical analysis of the behavior of the Monetary Credibility Index $(MCI1)$ shows a falling behavior after the subprime crisis, reversed dramatically after the impeachment episode.

Table 1 presents the descriptive statistics of the data. Looking at these, although $SELIC$ reached its lowest historical level at the end of the period, an average interest rate above 13% was observed. It is noted that Country Risk $(EMBI)$ reached its highest point (2.034) at the beginning of the period and then dropped to its lowest point (0.146) in 2007, remaining with low oscillation until the end of the period. Another observation to be made refers to the $MCI1$, which presented the average and the median very close to an intermediate level of credibility, very close to the center between the maximum credibility value (2) and the value where there is no credibility (1). However, it is noticed that at various times the variable reaches or comes close to reaching these maximum and minimum points, highlighting the great fluctuation of credibility of the monetary authority.

Graph 1 - Evolution of variables from January 2002 to December 2018



Source: Own elaboration from the researched data.

Table 1 - Descriptive Statistics

	NER	PSND	EMBI	GDPE1	MCI1	SELIC
Mean	2.693242	43.11833	0.379242	1.216059	1.505248	13.04221
Median	2.509827	42.77000	0.262409	1.240500	1.525000	12.52637
Maximum	4.556667	59.80000	2.034217	1.763000	1.984000	23.41556
Minimum	1.663810	30.70000	0.146273	0.612000	1.000000	6.500000
Std. Dev.	0.736759	7.797782	0.326095	0.248225	0.321451	3.978525
Skewness	0.427090	0.142537	3.082063	-0.471923	-0.240840	0.437375
Kurtosis	2.033616	1.892421	13.34913	3.220666	1.792560	2.668477
Jarque-Bera	14.13992	11.11798	1233.357	7.986081	14.36437	7.438316
Probability	0.000850	0.003853	0.000000	0.018444	0.000760	0.024254
Observations	204	204	204	204	204	204

Source: Own elaboration from the researched data.

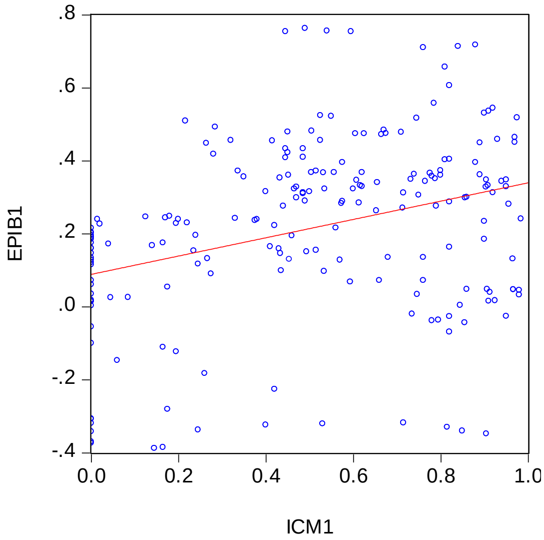
Table 2 presents the unconditional correlations between the variables. Values greater than 0.5 are noted for the relationships between: $SELIC\ x\ EMBI$ (0.617); $NER\ x\ GDPE1$ (-0.63); and $NER\ x\ PSND$ (0.737). The proportionalities of the relationships are as expected except for the correlation between $SELIC$ and $PSND$, which has a negative sign. Regarding the variables of interest, it is noted that the correlation between $MCI1\ x\ GDPE1$ is of the order of (0.328). For a better visualization of the latter, a dispersion diagram was constructed (Graph 2).

Table 2 - Unconditional correlation between variables

Correlation	SELIC	MCI1	GDPE1	EMBI	PSND	NER
SELIC	1.00000					
ICM1	-0.35992	1.00000				
EPIB1	0.04163	0.32819	1.00000			
EMBI	0.61732	-0.46403	-0.13191	1.00000		
DLSP	-0.19304	0.11313	-0.37080	0.09909	1.00000	
CAM	0.19788	-0.38057	-0.63072	0.37734	0.73756	1.00000

Source: Own elaboration.

Graph 2 – MCI1 x GDPE1 Scatter Chart



Source: Own elaboration.

Generally, the first step in time series analysis is to verify the existence of unit root. However, Sims (1980) and Sims, Stock and Watson (1990) point out that the use of non-stationary variables does not cause problems in $\boldsymbol{VAR}$ model estimation. Therefore, the estimation of the $\boldsymbol{VAR}$ will be done with the level variables. To select the number of lags to be employed, the likelihood ratio ($\boldsymbol{LR}$) criterion, the Final Forecast Error ($\boldsymbol{FPE}$), the Akaike Criterion ($\boldsymbol{AIC}$), the Schwarz Criterion ($\boldsymbol{SC}$) and the Criterion Hannan-Quinn ($\boldsymbol{HQ}$). Given the criteria $\boldsymbol{LR}$, $\boldsymbol{FPE}$ and $\boldsymbol{AIC}$, we opted for the model with two lags. (Table 3)

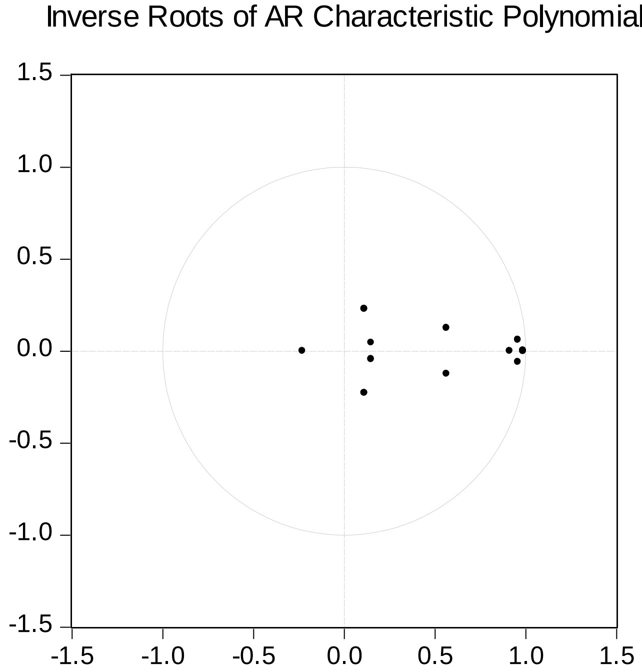
Table 3 - Determining the number of model lags

Lags	LR	FPE	AIC	SC	HQ
0	NA	7.16e-09	-1.727201	-1.626851	-1.686575
1	3375.370	1.81e-16	-19.21895	-18.51650*	-18.93465*
2	93.53045*	1.57e-16*	-19.36270*	-18.05815	-18.83455
3	41.25216	1.80e-16	-19.22842	-17.32176	-18.45651
4	43.02943	2.03e-16	-19.11270	-16.60394	-18.09704
5	36.56307	2.37e-16	-18.96695	-15.85609	-17.70753
6	17.32843	3.10e-16	-18.70859	-14.99562	-17.20540
7	32.30065	3.69e-16	-18.55236	-14.23729	-16.80541
8	25.07082	4.59e-16	-18.35556	-13.43839	-16.36485

Source: Own elaboration. Note: * Informs the criteria chosen by each test.

Through the LM Test, considering the model with two lags, it was found that the null hypothesis of absence of autocorrelation of the residues cannot be rejected. Moreover, in terms of stability of the VAR model, Figure 1 and Table 4 show that there is no root outside the unit circle, which means that it is a VAR model that satisfies the stability condition.

Figure 1 - Inverse Roots of the Characteristic Polynomial



Source: Own elaboration

Table 4 - Roots of the characteristic polynomial

Endogenous variables: $LOG\ (EPIB1)\ LOG(ICM1)\ LOG(DLSP)\ LOG(EMBI)\ LOG(CAM)\ LOG(SELIC)$

Exogenous variables: C

Lag specification: 1 2

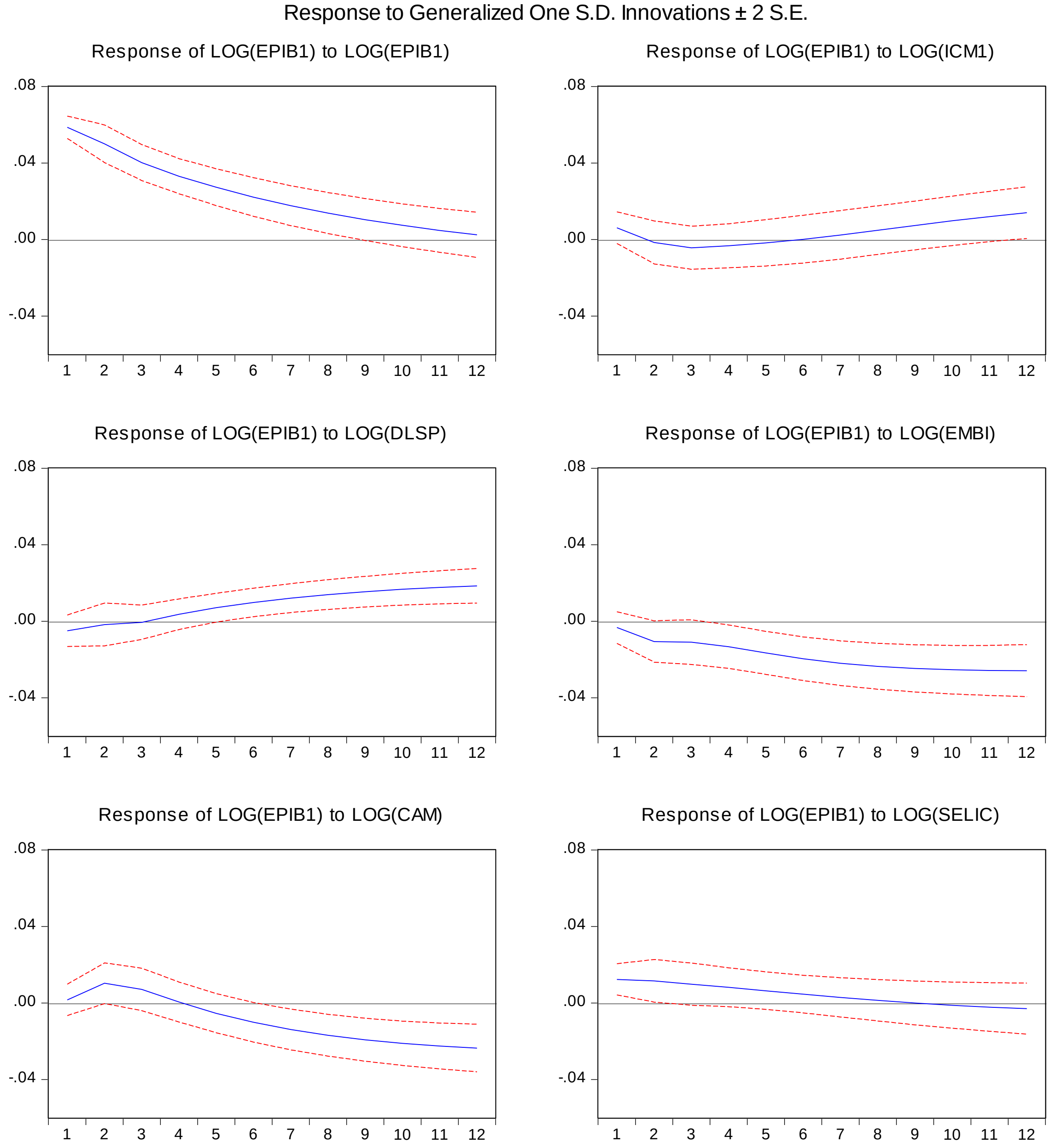
Root	Modulus
0.986451 - 0.002514i	0.986454
0.986451 + 0.002514i	0.986454
0.958478 - 0.060076i	0.960358
0.958478 + 0.060076i	0.960358
0.913253	0.913253
0.565534 - 0.124829i	0.579146
0.565534 + 0.124829i	0.579146
0.111985 - 0.228176i	0.254175
0.111985 + 0.228176i	0.254175
-0.228182	0.228182
0.150460 - 0.044211i	0.156821
0.150460 + 0.044211i	0.156821

Source: Own elaboration

After the definition and estimation of the model, the impulse response functions were analyzed (Graph 3). Note that $\boldsymbol{MCI1}$ generates a drop reaction and subsequent increase in $\boldsymbol{GDPE1}$, however, given the confidence interval, the response up to the eleventh month can be considered statistically insignificant. Thus, it can be stated that for this experiment $\boldsymbol{MCI1}$ does not interfere with $\boldsymbol{GDPE1}$ fluctuation in the short term. From the 11th month onwards, the upward trend is continued and, given the lower band of the confidence interval, a long-term positive reaction can be considered. Graph 4 shows the impulse response function of the variable $\boldsymbol{MCI1}$ over $\boldsymbol{GDPE1}$ for 30 months (long term).

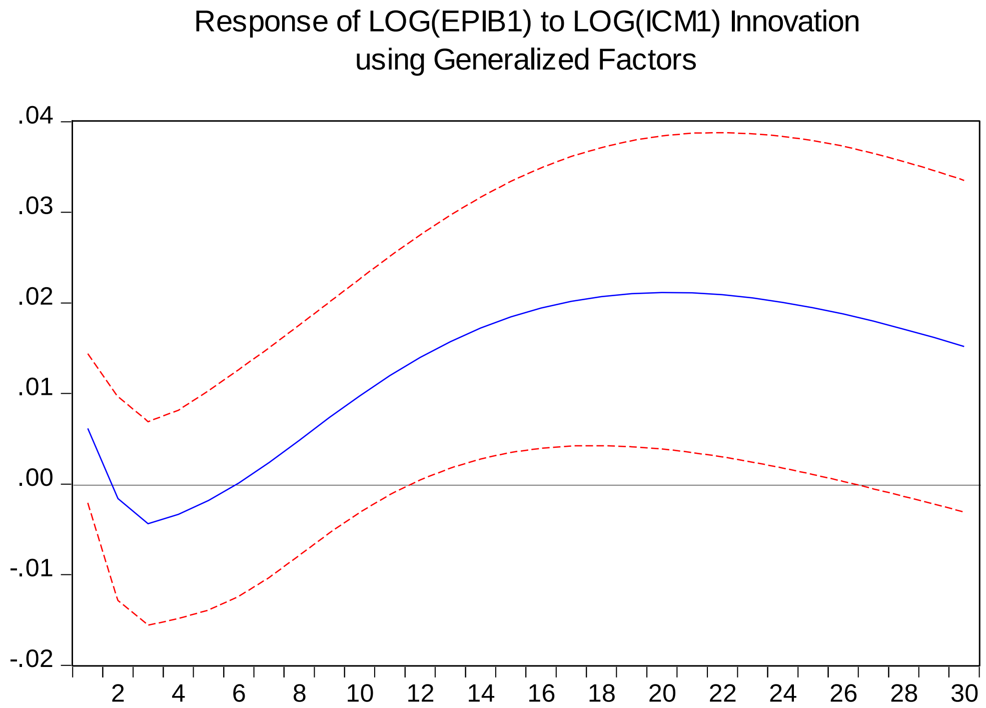
In contrast, shocks in the control variables $\boldsymbol{PSND}$, $\boldsymbol{EMBI}$ and $\boldsymbol{NER}$ generate faster responses in $\boldsymbol{GDPE1}$. Notably, the exchange rate generates strong response on this until the second month, from which it begins to decline. From the fourth month there is a neutralization of the exchange rate effect on $\boldsymbol{GDPE1}$. Among the observed reactions, the greater magnitude comes from the inertial component of the $\boldsymbol{GDP}$ expectations themselves. This generates a strong response, neutralized only after approximately 12 months. The response to a shock in $\boldsymbol{PSND}$ increases and becomes significant after the fourth month. Regarding variations in Country Risk ($\boldsymbol{EMBI}$), it is noted that negative reactions continue over the observed period (12 months), without presenting a reversal point. $\boldsymbol{SELIC}$ generates a reaction in $\boldsymbol{GDPE1}$ only for the first period.

Graph 3 - Impulse response functions for GDP expectation (level variables)



Source: Own elaboration.

Graph 4 - Impulse response function for $GDP\ expectation\ x\ MCI1$ - 30 months



Source: Own elaboration.

From the results presented, it is stated that the reaction of $MCI1$ on GDP expectations $(GDPE1)$ is shy in the short-term, only becoming significant in the long-term. Thus, it can be accepted that in the long run GDP expectations and, by hypothesis, sacrifice rates (SR), would respond accordingly given the variations in credibility indexes. As the literature (shown in section 2) described, central bank credibility would generate lower sacrifice rates. Therefore, this study shown that, for the observed period, greater central bank credibility leads to improved long-term GDP expectations.

Despite the theoretical particularities of the construction of $SR's$, especially regarding the definition of "disinflation periods", it can be considered that an improvement (decrease) in these equals an improvement in GDP expectations. In turn, the latter should be analyzed over longer periods, as the reaction to credibility shocks has a longer maturation period.

CONCLUDING REMARKS

In this paper, by assuming that an improvement in GDP expectation is equivalent to a lower sacrifice rate (SR), we sought to evaluate how the credibility of monetary policy generates an improvement in GDP growth expectations. To do so, a technique widely applied in macroeconomics was used, namely Autoregressive Vectors (VAR) and impulse response functions, which was translated into an econometric exercise for the Brazilian economy between 2002 and 2018. In order to fulfill this objective, the credibility index proposed by De Mendonça (2004) was used, as well as some control series: NER, $PSND$, $EMBI$ and $SELIC$.

By observing the behavior between the selected macroeconomic variables and its stylized facts, as well as the monetary policy, it can be emphasized that the main evidences were: a) the NER variable shows great devaluation after 2010; b) the $PSND$, after a period of decrease, shows strong growth at the end of the series; c) After an intense rise in the Country Risk $(EMBI)$ at the beginning of the period under analysis, it's behavior become stable after 2004; d) $GDPE1$ and $MCI1$ have strong volatility for the entire period; e) $SELIC$, despite its relative volatility, is an effective monetary policy instrument.

The unconditional correlations between the variables and the econometric methods used in this study indicate that: a) the negative correlation between $SELIC$ and $PSND$ disagrees with the literature; b) the 0.328 correlation between $MCI1$ and $GDPE1$ does not represent a relevant robust response; c) the impulse response between these variables indicates that $MCI1$ affects $GDPE1$ only in the long run; d) the impulse in the control variables ($PSND$, NER, $EMBI$) generate faster responses in the GDP expectation, highlighting the importance of Central Bank independence in the monetary policy management.

By analyzing the stylized facts highlighted above, this paper sought to broaden and collaborate to the debate about monetary policy in Brazil in recent years, such as in De Mendonça and Faria (2011) and Moreira (2013, 2016). For future work, it is suggested that other methods, such as GMM, be used to find other relationships between the selected variables.

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ANNEX

Table 5: Inflation Targets and CPI, 2000-2019.

Year	Goal	Side	Bottom Side	Top Side	CPI
2000	6	2	4	8	5.97
2001	4	2	2	6	7.97
2002	3.5	2	1.5	5.5	12.53
2003 - 1	3.25	2	1.25	5.25	9.3
2003 - 2	4	2.5	1.5	6.5	9.3
2004 - 1	3.75	2.5	1.25	6.25	7.6
2004 - 2	5.5	2.5	3	8	7.6
2005	4.5	2.5	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

Source: Own elaboration. Data obtained in BCB.