

# **Fiscal credibility and central bank credibility: how do we build them?**

## **Empirical evidence from Brazil**

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### **Abstract**

Since the early 1990s several countries have adopted inflation targeting (IT). However, IT may not be sufficient to ensure fiscal discipline, and governments can still pursue irresponsible fiscal policies under IT. As a consequence, the adoption of irresponsible policies which lead to a weak fiscal credibility could undermine the credibility of the central bank. In this study, we argue that fiscal discipline is a key aspect for IT and for central bank credibility. This study contributes with the literature since it provides empirical evidence for the determinants of both fiscal credibility and central bank credibility. Moreover, the study presents evidence for the influence of fiscal credibility on central bank credibility. The empirical analysis is based on different econometric techniques (OLS, GMM and TOBIT). The findings suggest fiscal credibility is important to build central bank credibility. In other words, when agents form expectations that public debt is under control, these expectations end up influencing inflation expectations.

**Key Words:** fiscal policy; monetary policy; credibility

**JEL Classification:** E52, E62, H63

### **Resumo**

A partir da década de 1990, vários países adotaram o regime de metas de inflação (RMI). Entretanto RMI pode não ser suficiente para garantir a disciplina fiscal, e governos podem continuar implementando políticas fiscais irresponsáveis sob RMI. Como consequência, a adoção de políticas irresponsáveis, que leva a uma fraca credibilidade fiscal, pode enfraquecer a credibilidade do banco central. Neste estudo argumentamos que a disciplina fiscal é um aspecto chave para o RMI e para a credibilidade do banco central. Este trabalho contribui com a literatura pois fornece evidências empíricas sobre os determinantes de ambas a credibilidade fiscal e a credibilidade do banco central. Ademais, o estudo apresenta evidências da influência da credibilidade fiscal sobre a credibilidade do banco central. A análise empírica é realizada com diferentes métodos econométricos (OLS, GMM e TOBIT). Os resultados sugerem que a credibilidade fiscal é importante para construir a credibilidade do banco central. Ou seja, quando os agentes forma expectativas que a dívida pública está sob controle, essas expectativas influenciam as expectativas de inflação.

**Palavras chave:** política fiscal; política monetária; credibilidade.

**Área 4 -** Macroeconomia, Economia Monetária e Finanças

## 1. Introduction

According to Blinder (2000, p. 1421), credibility matters in theory, and it is certainly believed to matter in practice. In his study, he asks: Why is credibility so important to central bankers? And how can a central bank create or enhance credibility?

Regarding central bank credibility, Blinder (2000) presents the following definition, which is in accordance with Kydland and Prescott's (1977) argument: a central bank is credible if people believe it will do what it says. Based on this definition, an inflation targeting central bank has credibility when people believe on the announced inflation target; and, credibility is earned when the convergence of inflation expectations for the inflation target occurs (Agénor and Taylor, 1992; Svensson, 2000). Based on the idea that series of expected inflation could be applied to derive a credibility index, existing measures of central bank credibility refer to a gap between inflation expectations of economic agents and the central bank inflation target (e.g., Svensson, 2000; de Mendonça, 2007).

Earning credibility, however, is not a trivial task in emerging economies, particularly, in those countries that lived for several years with high inflation rates, and thus, have been presenting a history of low credibility. Since the early 1990s an increasing number of emerging and developed economies have started implementing inflation targeting as the framework to guide monetary policy. However, according to Mishkin (2007), inflation targeting may not be sufficient to ensure fiscal discipline, and governments can still pursue irresponsible fiscal policies with an inflation targeting regime in place. As a consequence, the adoption of irresponsible fiscal policies which lead to a weak fiscal credibility could undermine the credibility of the central bank.

In this study, based on the arguments presented in the seminal work of Sargent and Wallace (1981), we go further and argue that fiscal discipline and absence of fiscal dominance are key aspects for inflation targeting and for central bank credibility. Thus, if both fiscal policies and public debt management are important for inflation targeters, how do we build fiscal credibility? Does fiscal credibility affect central bank credibility?

This study contributes with the literature since it provides empirical evidence for the determinants of both fiscal credibility and central bank credibility. Moreover, the study presents evidence for the influence of fiscal credibility on central bank credibility. As far as we know, there are no studies for the determinants of fiscal credibility as well as for the relationship between fiscal credibility and central bank credibility. The empirical analysis is based on different econometric techniques (OLS, GMM and TOBIT), and considers the period from December 2001 to February 2016 for the Brazilian economy.

## 2. The importance of credibility

In the 2006 speech to the Annual Washington Policy Conference, the President and CEO of the Federal Reserve Bank of San Francisco, Janet Yellen, argued that, "*credibility is not only virtuous; it is also useful. I will argue that one of its most important benefits is shaping public expectations about inflation, and in particular, 'anchoring' those expectations to price stability. As a consequence, credibility enhances the effectiveness of monetary policy*" (Yellen, 2006).

A credible monetary policy implies less effort by the central bank for the achievement of the inflation target (de Mendonça and de Guimarães and Souza, 2012; Montes and Bastos, 2014). Empirical evidence suggests that a high credibility is associated with a lower volatility of the interest rate for the achievement of the inflation

target (de Mendonça and de Guimarães and Souza, 2012). This alignment of the central bank's actions and the public's expectations strengthens monetary policy effectiveness.

Inflation targeting works as a guide for inflation expectations and it is associated with an increase in central bank transparency, which, in turn, increases accountability in the implementation of monetary policy and thus improves credibility (de Mendonça and de Guimarães and Souza, 2012). However, the fulfillment of the inflation target is the main factor to influence inflation expectations.

The inflation targeting regime has played a key role in macroeconomic stabilization in several developed and developing countries since the beginning of the 1990s (Walsh, 2009). Inflation targeting in emerging market economies has been a more challenging task than in developed economies due to several vulnerabilities and to low levels of credibility (Minella et al., 2003). In fact, one basic task of emerging market central banks has been to build credibility. This requires actions consistent with the inflation targeting framework (such as commitment with price stability, coordination between fiscal and monetary policies as well as fiscal and financial stability) combined with high levels of transparency and communication with the public (Montes, 2010).

The success of the inflation targeting regime relates, to a large extent, with the earning of credibility. Credibility in this context means that private agents believe that the central bank will act consistently within the inflation targeting framework (Minella et al., 2003), but also the government will act committed with sound fiscal policies. In this sense, the gain of credibility takes time and it depends on both fiscal and monetary policies. Thus, what is the importance of fiscal sustainability and fiscal credibility for inflation targeting emerging countries? Why fiscal sustainability so important, and how does it influence fiscal credibility?

## **2.1 Importance of debt management and fiscal sustainability to fiscal credibility**

According to Sargent and Wallace (1981), fiscal sustainability has an unequivocal impact on price stability and, thus, it represents an important condition to help monetary policy keeping inflation low and stable. As Shirakawa (2012) stresses, when the government loses its credibility with respect to the sustainability of government debt and does not make enough effort to regain it, this ultimately leads to a higher inflation or a default on the debt (or both). Hence, fiscal sustainability itself is an essential precondition for the proper functioning of a central bank (Shirakawa, 2012), and thus, fiscal credibility represents an essential precondition to build central bank credibility.

Regarding the relation between fiscal sustainability and price stability, high levels of government debt can lead to difficulties in controlling inflation. Sargent and Wallace (1981) consider the situation of a government running deficits, which are financed by issuing government bonds. If these deficits are unsustainable, in that government will not be able to finance deficits indefinitely through issuing bonds, then eventually the outstanding debt will need to be financed by an increased level of currency, and hence could lead to higher inflation in the future. Sargent and Wallace (1981) also stress that a large public debt implies a difficulty for reducing the interest rate. Moreover, if demand for money depends on expected inflation, then unsustainable deficits could lead to higher inflation in the present period. These arguments present an important relation between fiscal and monetary policy and it justifies fiscal sustainability from the perspective of inflation targeting.

Fiscal stability is a basic necessary condition for inflation control and for inflation targeting. An important lesson from Sargent and Wallace (1981) is that irresponsible fiscal policy puts pressure on the monetary authorities to monetize the debt, thereby

producing rapid money growth and high inflation. If fiscal imbalances are large enough, monetary policy eventually becomes subservient to fiscal considerations (“fiscal dominance”) and an inflation target would have to be abandoned or modified. Thus, fiscal reforms, which help keep budget deficits from spinning out of control are needed to prevent the fiscal imbalances that can lead to a collapse of an inflation targeting regime (Mishkin, 2008).

One typical problem of emerging economies that have adopted inflation targeting is that a disinflationary monetary policy can cause a fiscal imbalance. The reason is that the basic interest rate is the main monetary policy instrument. But, in countries such as Brazil, public debt is strongly indexed to the interest rate. Therefore, increases in interest rate to reach the inflation target imply increases in the primary surplus required for stabilizing the public debt/GDP ratio.

The fiscal stability can be achieved by a policy based on a tight fiscal policy (increase in taxes or decrease in government spending) as a way of generating primary surpluses. Another possibility for achieving fiscal stability, such as pointed out by Giavazzi and Missale (2004), is the low cost government funding. Therefore, public debt management can be an important tool for reducing fiscal vulnerability.

### 3. Empirical analysis

In 1999, Brazil adopted inflation targeting. Since then, central bank credibility is fundamentally explained by central bank’s commitment with inflation control. However, since fiscal policy and public debt management also exert influence on inflation, and aiming coordination between monetary and fiscal policies, the government launched in 1999, the “Fiscal Stability Program” (FSP). This program had the intention to strengthen fiscal discipline, reduce the public deficit and stabilize the debt/GDP ratio. The program introduced targets for the primary surplus, set limits on indebtedness and increased fiscal transparency.

In terms of public debt management, at the end of 1999, in an attempt to improve the composition of government liabilities, efforts were made to increase the share of fixed-rate and price-indexed securities and to reduce the share of floating rate and exchange rate-indexed debt. Besides, the Brazilian Treasury announced a strategy for extending the maturity of federal securities (de Mendonça and Vivian 2008).<sup>1</sup> The Brazilian Government adopted this strategy in order to improve credibility, based on models of public debt management (Calvo and Guidotti, 1990; Giavazzi and Pagano, 1990; Barro, 2003; Missale, Giavazzi, and Benigno, 2002; Giavazzi and Missale, 2004).

Thus, it is important to verify if the measures in terms of the public debt management adopted in Brazil have helped to build fiscal credibility. Furthermore, it is important to analyze the determinants of central bank credibility under inflation targeting.

#### 3.1 Data

The period under analysis runs from December 2001 to February 2016, containing 171 monthly observations. The database begins in this period due to availability of the data regarding expectations. The series used in this study are presented as follow.

The central bank index (**CBCI**) is based on the idea of Agénor and Taylor (1992) that series of expected inflation could be applied to derive a credibility index. As Svensson (2000) proposed, the credibility can be measured by the difference between

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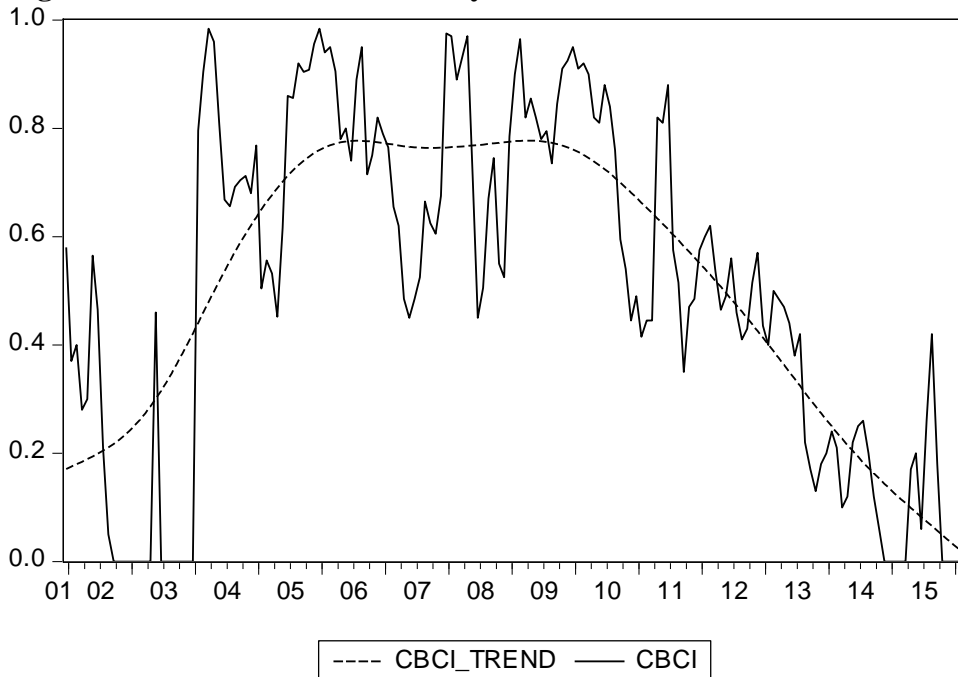
<sup>1</sup> See de Mendonça and Machado (2013), Gomes, Pires and Terra (2014) and de Mendonça and Pessanha (2014) for more details regarding public debt management in Brazil.

expected inflation and the target. In this sense, the credibility index is the index proposed by de Mendonça (2007). The central bank credibility index has a value equal to 1 when the annual expected inflation ( $E[\pi]$ ) is equal to the target ( $\pi^T$ ) and decreases in a linear way while inflationary expectation deviates from the announced target. Therefore, the credibility index shows a value between 0 and 1 strictly if the expected inflation is situated between the maximum and minimum limits ( $\pi^*$ ) established for each year and assumes a value equal to zero when the expected inflation exceeds one of these limits. The index uses the series of inflation expectations of professional forecasters obtained from the Central Bank of Brazil (CBB), the inflation target defined by the monetary authority and the tolerance bands. Hence,

$$(1) \quad CBCI = \begin{cases} 1 & \text{if } E[\pi] = \pi_t^T \\ 1 - \frac{1}{\pi_t^* - \pi_t^T} [E[\pi] - \pi_t^T] & \text{if } \pi_{tMIN}^* < E[\pi] < \pi_{tMAX}^* \\ 0 & \text{if } E[\pi] \geq \pi_{tMAX}^* \text{ or } E[\pi] \leq \pi_{tMIN}^* \end{cases}$$

Moreover, central bankers take time to increase or to decrease its credibility. In this sense, we work with the smoothed series (trend) obtained from the Hodrick-Prescott filter. Figure 1 shows the graph of the index and its trend.

**Figure 1 – Central bank credibility index**



Source: author's elaboration

To define what drives central bank credibility we follow Blinder (2000). The history of honesty is an important aspect to build credibility. In this sense, the success in keeping inflation under control is an important factor. We check this effect through the inflation deviation from the target ( $INFD$ )<sup>2</sup>, expecting a rise in the  $INFD$  to reduce central bank credibility. Moreover, to fight against inflation is also important to build credibility.

<sup>2</sup> This series is constructed by the deviation of the inflation rate accumulated in a year (IPCA “Consumer Price Index” – series 13522 obtained from the CBB) from the inflation target.

When central bank rises the basic interest rate (**IR**)<sup>3</sup>, it represents efforts to control inflation, and then is expected to increase credibility.

Due to the fact Brazil is an emerging economy, external factors are relevant to the conduct of monetary policy. The pass-through effect from exchange rate to inflation suggests exchange rate variation can affect credibility (de Mendonça and Tostes, 2015; Minella *et al.* 2003). Hence, we also check the influence of the variation in the exchange rate (**ER**)<sup>4</sup>.

The main goal of this paper is to show the relation between fiscal credibility and central bank credibility. The fiscal credibility index (**FCI**)<sup>5</sup> is calculated based on the indicator proposed by de Mendonça and Machado (2013). Since credibility represents the belief by the public in the probability of a successful execution of the policy (Drazen, 2000), and taking into account IMF's recommendation and Maastricht limits to public debt, the fiscal credibility index seeks to capture government's commitment to public debt sustainability and, thus, the public's expectations regarding fiscal solvency. The benchmarks assumed in the fiscal credibility index are in line with the IMF's (2002) calculations. Thus, the lower limit is a public debt to GDP ratio of 40% ( $debt^{Min}$ ) because it is a long-term target that should not be breached by emerging economies. The upper limit is a public debt to GDP ratio of 60% ( $debt^{Max}$ ) because this debt to GDP ratio target is part of the Maastricht treaty, and thus it is a useful reference for developed countries. Since credibility is a forward-looking variable, the credibility index takes into account the information (monthly frequency) available by the CBB on market expectations regarding public debt to GDP ratio.

Therefore, based on these benchmarks, the credibility index considers the following possibilities: (i) market's expectations on the public debt for the next 12 months are lower than the lower limit (40%) - in this case the risk of fiscal imbalance is null and thus the credibility index is 1 (full credibility); (ii) market's expectations for the next 12 months are greater than the upper limit (60%) - in this case there exists a high probability that a fiscal imbalance occurs and thus the credibility index is 0 (null credibility); and (iii) market's expectations for the next 12 months are between the above-mentioned limits - in this case the risk of fiscal imbalance is decreasing as it approaches the lower limit and it is increasing as it approaches the upper limit, thus the range of the credibility index is from 0 to 1 (strictly) (de Mendonça and Machado, 2013). It is expected a positive relation between FCI and CBB. The credibility index is a result of:

$$(2) FCI = \begin{cases} 1 & \text{if, } E_t(debt_{t+12}) \leq debt^{Min} \\ 1 - \frac{1}{debt_t^{Max} - debt_t^{Min}} [E_t(debt_{t+12}) - debt^{Min}] & \text{if, } \pi_{tMin}^* < E_t(debt_{t+12}) < debt^{Max} \\ 0 & \text{if, } E_t(debt_{t+12}) \geq debt^{Max} \end{cases}$$

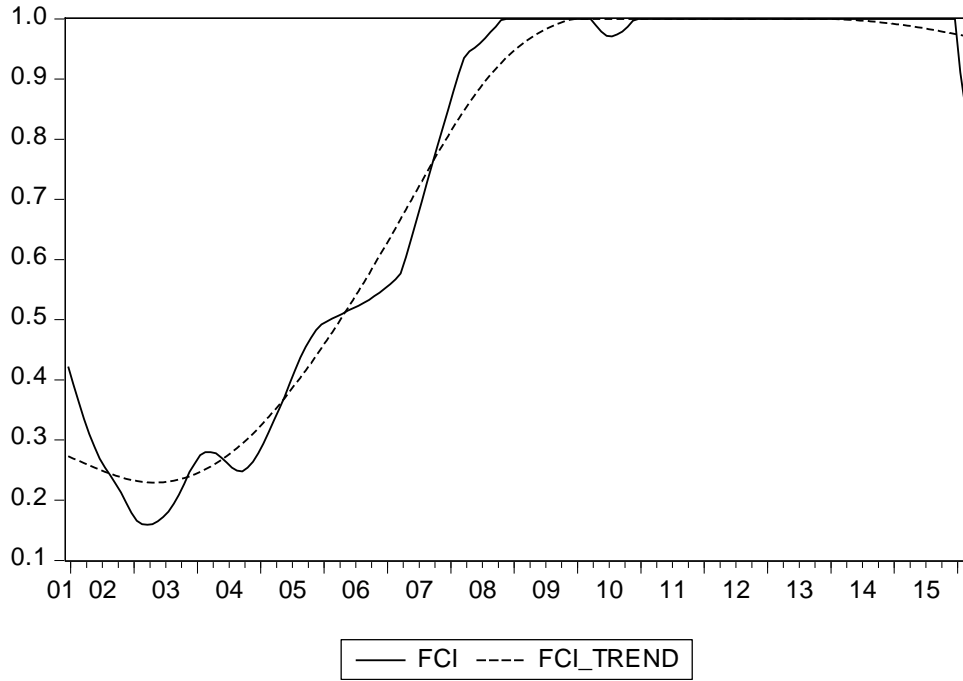
In the same way of the central bank credibility index, we apply the Hodrick- Prescott filter to obtain the trend of the series.

## Figure 2 – Fiscal credibility index

<sup>3</sup> The interest rate is the nominal basic interest rate in Brazil (SELIC - series 4189 obtained from the CBB).

<sup>4</sup> The exchange rate series is the nominal exchange rate (purchase, "end of period")

<sup>5</sup> Following de Mendonça and Machado (2013), in order to build this index we use expert's expectations for the debt/GDP ratio. The data are obtained from surveys (interviews) conducted with experts (forecasters) about their expectations for the debt/GDP ratio. The series is provided by the CBB.



Source: author's elaboration

To explain the behavior of the fiscal credibility we choose a group of variables important to the sustainability of the fiscal policy. Fiscal credibility is undermined if public debt presents an unsustainable path. Giavazzi and Missale (2004) argue that the main goal of public debt management in Brazil is the stabilization of the debt/GDP ratio (**DEBT**).<sup>6</sup> Thus, we expect a negative relationship between **DEBT** and **FCI**. The indexation composition and the maturity of the public debt are also important to fiscal credibility. The average maturity of the public debt (**AMD**)<sup>7</sup> is connected to the refinancing risk. A more extended period of maturity is one of the factors that reduces the amount of bonds that need to be rolled over in a period of crisis (Giavazzi and Pagano, 1990). The series is used following the ideas of Giavazzi and Pagano (1990), Calvo and Guidotti (1990) and Missale, Giavazzi and Benigno (2002), thus, it is expected a positive relation between **AMD** and **FCI**.

In relation to the indexation of the public debt, we create an index to simplify the interpretation. We follow the idea of Giavazzi and Missale (2004) that most of the Brazilian public debt should consist of fixed-rate bonds and price indexed bonds, and that the proportion of exchange-rate indexed bonds and interest-rate indexed bonds should be reduced in order to improve the composition of public debt and, thus, the efficiency in the management of public debt. Hence, increases in fixed rate bonds (**FIX\_B**) and inflation-linked bonds (**INF\_B**) represent improvements in public debt profile, whereas increases in bonds indexed to the interest rate (**INT\_B**) and indexed to the BRL/dollar exchange rate (**EX\_B**) indicate a deterioration of the public debt profile. The index is a result of the difference between these parts. Therefore, the index is calculated as:

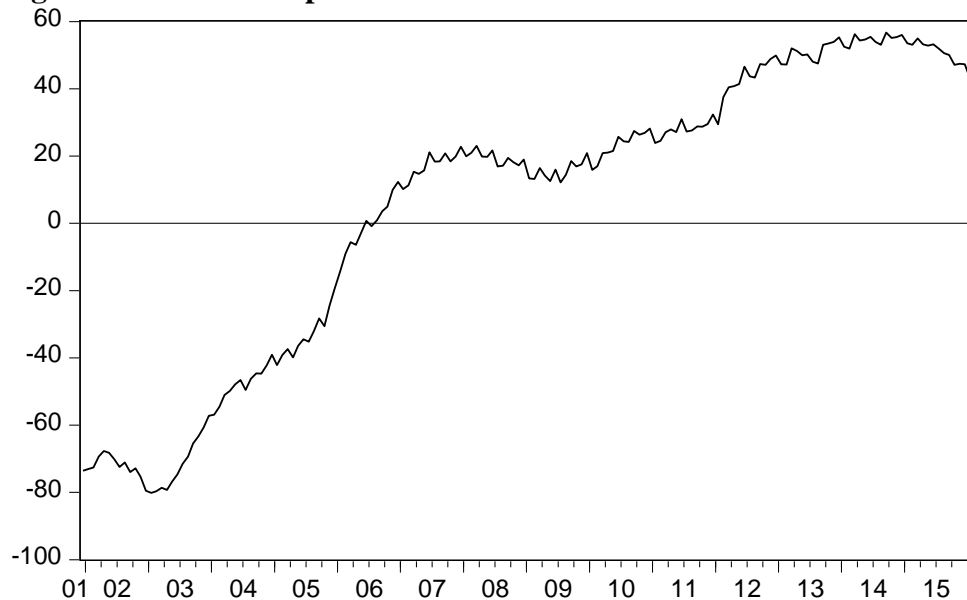
$$(3) \quad INDEX = (FIX\_B + INF\_B) - (INT\_B + EX\_B).$$

<sup>6</sup> Series provided by the CBB (code 4513). This series was also used by de Mendonça and Machado (2013, p. 13) and according to them, "This variable is an indicator of the public debt sustainability".

<sup>7</sup> Series provided by the CBB: "Dívida mobiliária federal - Títulos do Tesouro Nacional - Emitidos - Prazo médio - Total" (code 10618).

The interpretation of the **INDEX**<sup>8</sup> is straightforward. When the INDEX is positive, it denotes a good quality of the indexation profile. On the other hand, when the INDEX is negative, it represents a bad quality in the public debt profile. The expected relation between *INDEX* and FCI is positive. Figure 3 shows in the second semester of 2006 the INDEX became positive and there is a trend toward improvement

**Figure 3 – Indexation profile index**

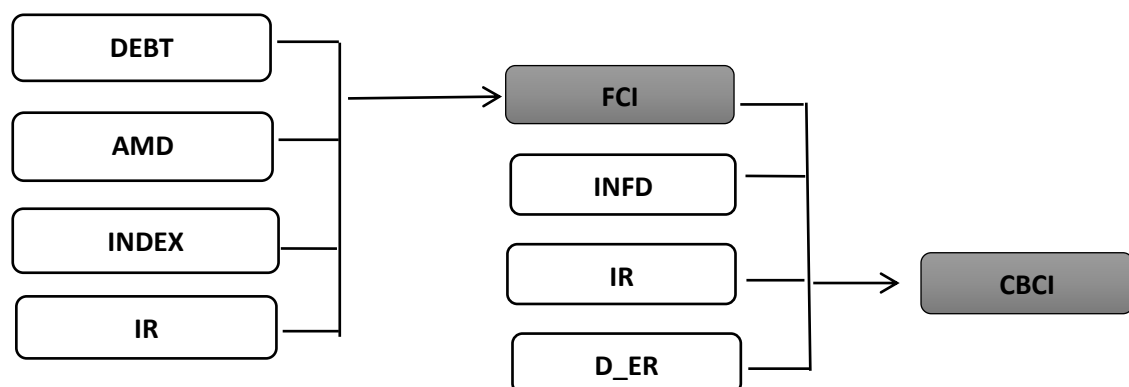


Source: author's elaboration

A first condition to be analyzed, before applying the estimations, is to check if series have unit root. Therefore, the following tests Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) were made (Table A.1, Appendix). Based on the tests, one can observe that all series are stationary.

The empirical analysis is conducted in two stages (as shown in Figure 2): first, the determinants of fiscal credibility (FCI) are estimated, and then the determinants of central bank credibility (CBCI) are estimated.

**Figure 4 – Scheme of analysis**



<sup>8 8</sup> Series provided by the CBB (series code 4178 for the proportion of fixed-rate bonds, series code 12001 for the proportion of bonds indexed to the IPCA, series code 4175 for the proportion of bonds indexed to the IGP-M and series code 4176 for the proportion of bonds indexed to the IGP-DI, series code 4173 for the proportion of exchange-rate indexed bonds and series 4177 for the proportion of interest-rate (over/SELIC) indexed bonds).



### 3.2 Methodology and preliminary analysis

We estimate the relationships expressed in Figure 4 using ordinary least squares (OLS), generalized method of moments (GMM), TOBIT and GMM system. One reason for using GMM is due to endogeneity problems. Besides, this method provides consistent estimators for the regressions (Hansen, 1982). As pointed out by Wooldridge (2001, p. 95), “to obtain a more efficient estimator than two-stage least squares (or ordinary least squares), one must have overriding restrictions.” The weighting matrix in the equation was chosen to enable the GMM estimates to be robust, considering the possible presence of heteroskedasticity and autocorrelation of unknown form.

Overidentification analysis has an important role in the selection of instrumental variables to improve the efficiency of the estimators (Cragg, 1983). We performed a standard J-test with the objective of testing this property for the validity of the overidentifying restrictions (Hansen, 1982). The chosen instruments were dated to the period  $t-1$  or earlier to help predict the contemporaneous variables, which are unavailable at time  $t$  (Johnston, 1984). We also present the Durbin–Wu–Hausman test of the endogeneity of regressors (Durbin, 1954; Wu, 1973; Hausman, 1978).

Furthermore, we use the TOBIT method (Tobin, 1958), which is an adequate method because the credibility indexes are continuous variables that assume different values between 0 and 1. It is worth noting that the values of the dependent variable (MCI and FCI) are not concentrated in censored values. In fact, as one can see through Figure 1, the values for MCI are not concentrated at all, and the Figure 2 shows FCI concentrate less than 30% of the observations. The TOBIT model uses all of the information, including information about the censoring data, and provides consistent estimates of the parameters (Long, 1997).<sup>9</sup>

The lags of the variables were determined in an empirical basis following the general-to-specific method. This methodology takes into consideration not only the statistical significance of the parameters, but also diagnostic tests, in order to ensure that the chosen model has explanatory power and thus to guarantee a parsimonious equation (Hendry, 2001).

Moreover, to assure the relation we propose in this work is in the correct direction, we present in Table 1 the Granger Causality Test to the two main variables of this analysis, CBCI and FCI. To perform this test we choose the lag of the Granger Causality Teste we follow three information criterions (Akaike, Schwarz and Hannan-Quinn), presented in the table A.2 in the appendix. The results of the Granger Causality Test indicate the CBCI does not cause FCI, but the FCI is able to influence the CBCI. This results suggests we choose the right direction in our analysis.

**Table 1 – Granger Causality Teste (CBCI and FCI)**

Null Hypothesis:	Obs	F-Statistic	Prob.
CBCI does not Granger Cause CFI	166	1.13	0.35
CFI does not Granger Cause CBCI		4.46	0.00

*Source:* author’s elaboration

<sup>9</sup> We run TOBIT model with robust Huber-White covariance approach.

### 3.3 Estimations related to fiscal credibility

In order to explain which variables drives fiscal credibility, we estimated equation 4 below:

$$(4) FCI_t = \alpha_1 + \alpha_2 DEBT_t + \alpha_3 AMD_t + \alpha_4 INDEX_t + \alpha_5 IR_t + \varepsilon_t$$

**Table 2 – OLS, GMM and TOBIT estimates (dependent variable: FCI)**

	OLS	GMM	TOBIT
<b>CONSTANT</b>	<b>1.087***</b>	<b>1.013***</b>	<b>1.671***</b>
	(0.281)	(0.220)	(0.202)
	[3.868]	[4.604]	[8.270]
<b>DEBT</b>	<b>-0.008</b>	<b>-0.008**</b>	<b>-0.017***</b>
	(0.005)	(0.004)	(0.003)
	[-1.578]	[-1.987]	[-5.152]
<b>AMD</b>	<b>0.004*</b>	<b>0.006***</b>	<b>0.004***</b>
	(0.002)	(0.001)	(0.001)
	[1.957]	[0.001]	[2.720]
<b>INDEX</b>	<b>0.003***</b>	<b>0.003***</b>	<b>0.002**</b>
	(0.001)	(0.001)	(0.001)
	[3.579]	[2.726]	[2.467]
<b>IR</b>	<b>-0.016**</b>	<b>-0.015</b>	<b>-0.025***</b>
	(0.006)	(0.006)	(0.004)
	[-2.493]	[-2.720]	[-6.725]
R <sup>2</sup>	0.924	0.915	
Adjusted R <sup>2</sup>	0.922	0.913	
F-statistic (p-value)	0.000		
Left Censored Obs			0
Right Censored Obs			49
Uncensored Obs			122
<b>Residual and Stability Diagnostics</b>			
Ramsey- RESET (1)(p-value)	0.001		
Jarque-Bera (p-value)	0.000		
ARCH (1)(p-value)	0.000		
ARCH (2)(p-value)	0.000		
LM(1)(p-value)	0.000		
LM(2)(p-value)	0.000		
Durbin-Wu-Hausman (p-value)		0.987	
J-statistic (p-value)		0.198	
Instrument Rank		23	

*Source:* author's elaboration *Notes:* Marginal Significance Levels: \*\*\* denotes 0.01, \*\* denotes 0.05 and \* denotes 0.1. Coefficients in bold, standard errors in parentheses and *t*-statistics in square brackets. Regarding OLS estimates, due to the problems of autocorrelation and heteroscedasticity, the reported *t*-statistics in the OLS estimates are based on the estimator of Newey and West (1987).

Table 2 shows the results to equation 4 estimations. The reported t-statistics in the OLS estimates are based on the estimator of Newey and West (1987), which is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form. In the GMM<sup>10</sup> estimation, the J-statistic indicates that we cannot reject the hypothesis that the instruments selection is apposite. The Durbin-Wu-Hausman test indicate the regressors are exogenous.

The results present the expected signal to all variables. The negative signal for DEBT shows that higher debt/GDP ratio reduce fiscal authority credibility. Thus, difficulties in stabilizing the debt/GDP ratio generate loss of fiscal credibility. The DEBT coefficients present statistical significance in GMM and TOBIT estimates. The AMD and INDEX variables present positive influence over FCI. Increases in the average maturity helps to reduce the risk of refinancing the public debt and then improve fiscal credibility. The result for the indexation profile implies fiscal authority can benefit of a good quality of indexation. When the INDEX increases, it also increases the fiscal credibility. Moreover, the basic interest rate (IR) presents negative signal in the results. When central bank rises the basic interest rate, it increases the cost of the public debt, reducing the fiscal credibility.

In this sense, the evidence shows that the measures adopted by the National Treasury regarding the composition of public debt and lengthening the period of maturity of public debt contributed to increase fiscal credibility. Thus, the findings corroborate the arguments and recommendations of Calvo and Guidotti (1990), Giavazzi and Pagano (1990) and Giavazzi and Missale (2004).

### 3.4 Estimations related to monetary policy credibility

Aiming to explain what drives monetary policy credibility as well as to verify whether fiscal credibility is important for central bank credibility, we estimate equation 5 below:

$$(5) \text{CBCI}_t = \beta_1 + \beta_2 \text{INFD} + \beta_3 \text{IR} + \beta_4 \text{D\_ER} + \beta_5 \text{FCI} + \nu_t$$

Table 3 presents the estimates. The reported t-statistics in the OLS estimates are based on the estimator of Newey and West (1987). The results do not present problems of specification. In terms of GMM<sup>11</sup> estimation, the J-statistic indicates that we cannot reject the hypothesis that the instrument selection is correctly specified. The Durbin-Wu-Hausman test indicate the regressors are exogenous.

The results presents expected signals according to the literature. The positive signal for IR and the negative signal for INFD corroborate the idea of Blinder (2000) that the history of honesty and the act of fighting against inflation are important to build credibility. The inflation deviation has negative influence over central bank credibility. When the inflation deviates from the target it represents lacks of commitment of the central bank with the monetary policy goals and then reduce central bank credibility. In turn, the results indicate that an increase in the basic interest rate (IR) signals the commitment of the central bank to keep inflation under control and thus increases central bank credibility. Thus, to rise the interest rates is to fight against inflation and its helps central bankers to be credible. The D\_ER variable also presents a negative relation with

<sup>10</sup> Instrumental variables: CFI(-1 to -4) DEBT(-1 to -6) AMD(-1 to -4) INDEX(-1 to -4) IR(-1 to -4)

<sup>11</sup> Instrumental variables: MCI(-1 to -3) INFD(-1 to -3) SELIC(-2 to -6) D\_ER(-1 to -6) CFI(-1 to -8)

the CBCI. This signal corroborate the idea of Minela *et al.* (2003) that the pass-through effect is relevant to the central bank credibility in an emerging economy.

**Table 3 – OLS, GMM and TOBIT estimates (dependent variable: CBCI)**

	OLS	GMM	TOBIT
<b>CONSTANT</b>	<b>0.063</b>	<b>-0.154</b>	<b>0.063</b>
	(0.270)	(0.126)	(0.149)
	[0.234]	[-1.222]	[0.424161]
<b>INFD</b>	<b>-0.068***</b>	<b>-0.086***</b>	<b>-0.068***</b>
	(0.016)	(0.005)	(0.008)
	[-4.308]	[-15.372]	[-8.013]
<b>IR(-1)</b>	<b>0.029**</b>	<b>0.044***</b>	<b>0.029</b>
	(0.014)	(0.006)	(0.007)
	[2.089671]	[7.311]	[3.810]
<b>D_ER</b>	<b>-0.814***</b>	<b>-1.726</b>	<b>-0.814***</b>
	(0.218)	(0.268)	(0.171)
	[-3.726]	[-6.441]	[-4.763]
<b>FCI</b>	<b>0.261</b>	<b>0.369***</b>	<b>0.261***</b>
	(0.176)	(0.077)	(0.094)
	[1.484]	4.758	[2.794]
R <sup>2</sup>	0.375	0.322	
Adjusted R <sup>2</sup>	0.360	0.913	
F-statistic (p-value)	0.000		
Left Censored Obs			0
Right Censored Obs			0
Uncensored Obs			170
<b>Residual and Stability Diagnostics</b>			
Ramsey- RESET (1)(p-value)	0.366		
Jarque-Bera (p-value)	0.000		
ARCH (1)(p-value)	0.000		
ARCH (2)(p-value)	0.000		
LM(1)(p-value)	0.000		
LM(2)(p-value)	0.000		
Durbin-Wu-Hasman (p-value)		0.666	
J-statistic (p-value)		0.476	
Instrument Rank		26	

*Source:* author's elaboration *Notes:* Marginal Significance Levels: \*\*\* denotes 0.01, \*\* denotes 0.05 and \* denotes 0.1. Coefficients in bold, standard errors in parentheses and *t*-statistics in square brackets. Regarding OLS estimates, due to the problems of autocorrelation and heteroscedasticity, the reported *t*-statistics in the OLS estimates are based on the estimator of Newey and West (1987).

The FCI presents positive signal to all methods. This positive signal implies fiscal credibility can help to build central bank credibility. Fiscal credibility is related with the capacity of the fiscal authority to honor its debts providing public debt sustainability. Thus, the positive signals indicate when the fiscal authority is committed to a sound fiscal policy it helps to increase the central bank credibility. This result reinforces the argument of King (1995) that fiscal discipline enhances monetary policy credibility. This result also

puts light in the fiscal dominance theory. If the fiscal authority increases its debts and deteriorates the confidence public has on the public debt sustainability, it will reduce the central bank credibility.

Thus, the results indicate that when there is a commitment of the monetary authority and government with their goals, an increase in central bank credibility is verified.

### 3.5 Systems of simultaneous equations

Based on evidence found in the estimations above, fiscal discipline and the policies adopted by the National Treasury in terms of public debt management are important to increase fiscal credibility. In turn, fiscal credibility and the commitment of the monetary authority with price stability are important to enhance central bank credibility. In this sense, the conduct of economic policies and the behavior of policymakers are important for macroeconomic stability and, thus, to build both fiscal credibility and central bank credibility.

A way of testing the validity of the equations and coefficients previously achieved is through system of equations. For treating possible problems of endogeneity, the use of system of equations which applies GMM is adequate for estimating non-biased coefficients. Thus, in order to give robustness for the results presented in the previous sections, one systems of equations are estimated<sup>12</sup> with equation (4) and (5):

$$\text{System} = \begin{cases} FCI\_T_t = \alpha_1 + \alpha_2 DEBT_t + \alpha_3 AMD_t + \alpha_4 INDEX_t + \alpha_5 IR_t + \varepsilon_t \\ MCI\_T_t = \beta_1 + \beta_2 INFD + \beta_3 IR + \beta_4 D\_ER + \beta_5 FCI + v_t \end{cases}$$

The results presented in table 4 corroborate the previous findings. All coefficients present the same signal and statistical significance. The J-test indicates the instruments respect the orthogonality restriction. Hence, the evidences provided by the GMM system provide robustness to previous results.

Regarding the estimates presented in Table 4, all coefficients presented the expected signs and statistical significance. The estimates show the importance of public debt management and government commitment with fiscal targets for building fiscal credibility. In other words, the improvement in the composition of public debt, a more extended period of maturity of public debt and the commitment with the fiscal targets contributed to the increase of fiscal credibility. Regarding the determinants of central bank credibility, the findings corroborate those already found and, in particular, the estimates of the systems reveal, as well as in the individual estimates, the influence of fiscal credibility on central bank credibility.

## 4. Conclusion

Since the adoption of inflation targeting by several developed and developing countries, and the recognition that credibility matters not only in theory but also, in especially, in practice, academics and policymakers share a common concern: how to build credibility.

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<sup>12</sup> The system of simultaneous equations estimated through GMM applied the same instrumental variables of the individual equations estimated through GMM

**Table 4 – GMM system estimates**

	<b>Equation 1</b>		<b>Equation 2</b>
	<b>Dependent Variable : FCI</b>		<b>Dependent Variable: CBI</b>
<b>CONSTANT</b>	<b>-0.010</b> (-0.097) [-1.024]	<b>CONSTANT</b>	<b>1.166***</b> (-0.166) [7.039]
<b>DEBT</b>	<b>-0.085***</b> -0.004 [-19.544]	<b>INFD</b>	<b>-0.010***</b> (-0.003) [-3.482]
<b>AMD</b>	<b>0.041***</b> -0.005 [8.829]	<b>IR(-1)</b>	<b>0.006***</b> (-0.001) [4.871]
<b>INDEX</b>	<b>-1.797***</b> -0.211 [-8.532]	<b>D_ER</b>	<b>0.002***</b> (-0.001) [3.674]
<b>IR</b>	<b>0.331***</b> -0.062 [5.354]	<b>FCI</b>	<b>-0.018***</b> -0.003 [-5.154]
R <sup>2</sup>	0.297		0.919
Adjusted R <sup>2</sup>	0.279		0.917
J-Statistic		0.173	
Prob (J-Statistic)		0.991	

Source: author's elaboration Notes: Marginal Significance Levels: \*\*\* denotes 0.01, \*\* denotes 0.05 and \* denotes 0.1. Coefficients in bold, standard errors in parentheses and *t*-statistics in square brackets.

This study investigates the determinants of both fiscal credibility and central bank credibility in Brazil. The findings suggest that since 2002, the National Treasury has promoted improvements in public debt management that were important to build fiscal credibility: the improvement in the indexation profile and the lengthening of the country's average debt maturity. The analysis showed the commitment with an appropriate debt management and responsible fiscal policies are important to build fiscal credibility.

Regarding central bank credibility, the analysis showed that inflation deviations from the target and currency devaluations have a negative effect on central bank credibility. In turn, increases in the basic interest rate show the public the commitment of the central bank with a specified inflation.

Moreover, a relevant finding obtained through the empirical analysis is the influence of fiscal credibility on central bank credibility, i.e., fiscal credibility is important to build central bank credibility. In other words, when agents form expectations that public debt is under control, these expectations end up influencing inflation expectations.

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## Appendix

**Table A.1 – Unit Root Tests**

Series	ADF				PP				KPSS			
	Leg Lenght	Exogenous	Test	10%	Bandwidth	Exogenous	Test	10%	Exogenous	Bandwidth	Test	1%
AMD	22	I/T	-3.43	-3.14	3.08	I/T	-3.36	-3.14	I/T	44.7	0.14	0.22
D_EXCH	10	I/T	-5.49	-3.14	0.661	N	-9.18	-1.62	I/T	4.88	0.14	0.22
DEBT	9	I	-3.59	-2.58	2.61	N	-1.36	-1.62	I/T	47.1	0.15	0.22
INDEX	12	I	-3.38	-2.58	0.429	N	-1.62	-1.62	I	141	0.42	0.74
INF_DEV	13	I/T	-1.60	-3.14	7.33	N	-2.25	-1.62	I	60.7	0.15	0.74
SELIC	13	I	-3.55	-2.58	20	N	-0.90	-1.62	I	129	0.38	0.74

Source: author's elaboration Notes: "I" denotes intercept; "I/T" denotes intercept and trend; and "N" denotes none. The final lag selection in the ADF tests was made based on the Akaike information criteria. PP and KPSS spectral estimation method is Bartlett kernel and the Andrews Bandwidth is used.



**Table A.2 – Granger Causality Test Lag Selection**

Lag	AIC	SC	HQ
0	0.468	0.506	0.483
1	-16.691	-16.577	-16.644
2	-27.377	-27.188	-27.300
3	-33.000	-32.734	-32.892
4	-35.149	-34.808	-35.011
5	-35.803*	-35.385*	-35.633*
6	-35.7780	-35.284	-35.578
7	-35.7584	-35.189	-35.527
8	-35.7281	-35.083	-35.466

\* indicates lag order selected by the criterion

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion