Economics Bulletin

Volume 36, Issue 4

# Observing the influence of fiscal credibility on inflation: Evidence from an emerging economy

Helder Ferreira de Mendonça
*Fluminense Federal University and National Council for Scientific and Technological Development*

Roseli da Silva
*University of São Paulo - RP*

## Abstract

This study investigates empirically how the fiscal credibility affects the inflation rate in an emerging economy under inflation target. Based on the Brazilian experience, a fiscal credibility index is built taking into account how the market expectations are anchored to the primary surplus target. The main idea is that a government that is able to anchor expectations around the target (case of high credibility) may reduce inflation. The findings provide empirical evidence that the success of government in achieving the fiscal primary surplus target (gain of credibility) is an important ally to reduce inflation rate and its expectations.

**Citation:** Helder Ferreira de Mendonça and Roseli da Silva, (2016) "Observing the influence of fiscal credibility on inflation: Evidence from an emerging economy", *Economics Bulletin*, Volume 36, Issue 4, pages 2333-2349
**Contact:** Helder Ferreira de Mendonça - helderfm@hotmail.com, Roseli da Silva - roselisilva@usp.br.
**Submitted:** October 18, 2016. **Published:** December 02, 2016.

## 1. Introduction

A sound fiscal position is essential to any economy. Since the 1990s the growing concern with inflation has brought several countries to adopt inflation targeting. There exist several studies which indicate that the use of this monetary framework represents a success in the control of inflation (e.g. Lin and Ye, 2009; and de Mendonça and de Guimarães e Souza, 2012). However, one of the preconditions to the success of inflation targeting is the fiscal balance. It is well-known that in the case where the government is not committed to fiscal balance, the result is a pressure on inflation due to the risk of using an expansionary monetary policy to finance the public debt. In brief, there exists a relationship between government fiscal commitment and inflation.

An important issue in the analysis regarding inflation targeting is credibility because it plays an essential role in the commitment of reaching low and stable inflation. Although a great part of the literature pays attention only to the credibility of the monetary authority, this is only one side of the coin. Following the literature that builds on Sargent e Wallace (1981), unsustainable fiscal police may lead the monetary authority to monetize fiscal deficits and thus wreck credibility. Furthermore, as pointed out by scholars from fiscal theory of price level (e.g. Woodford, 2001; and Sims, 1994) the control of money supply is not a sufficient condition to stabilize inflation. In brief, the government solvency is essential to monetary policy being able to control inflation.

This study investigates how the fiscal credibility affects the inflation rate in an emerging economy under inflation targeting. The analysis on the Brazilian case after adoption of inflation targeting is useful, as with Chile and Poland, this country announces the inflation target jointly by the government and central bank in order to make the government commit to the fiscal discipline needed to achieve the target. Moreover, Brazil has had explicit fiscal primary surplus targets since 2000, and expectations of macroeconomic variables (e.g. inflation rate and primary surplus) are available from the Time Series Management System - Central Bank of Brazil (TSMS/CBB). The main idea is that a government that is able to anchor expectations around the target (case of high credibility) may reduce inflation. The results in this study provide empirical evidence that the success of government in achieving the fiscal primary surplus target (gain of credibility) contributes to the reduction of inflation.

Few studies analyze the impact of fiscal credibility on inflation rate in emerging economies. For an analysis of the pass-through on inflation for the Brazilian economy, de Mendonça and Tostes (2015), taking into account the fiscal credibility index built by de Mendonça and Machado (2013), found that fiscal credibility is an important tool for reducing inflation. Kuncoro (2015) in an analysis regarding Indonesia concluded that fiscal credibility is important for price stabilization in an inflation targeting framework.

This study differs from these above-mentioned in several dimensions. It is important to highlight that the indicator of fiscal credibility in de Mendonça and Machado (2013) is based on the deviations of the market expectations on public debt-to-GDP in relation to the prudential benchmark suggested by International Monetary Fund. Moreover, the index used by Kuncoro (2015) quantifies the fiscal rules credibility measure using the deviation of actual budget from the projected one. In a different manner, the fiscal credibility index in this study takes into account how the market expectations are anchored to the primary surplus target. Therefore, we consider a true fiscal commitment announced previously by the government. This procedure is in agreement with the well-known definition of credibility made by Cukierman and Meltzer (1986), which can be understood as the difference between the policymaker's plans and the public's beliefs about those plans. Furthermore, we provide empirical evidence regarding the effect of fiscal credibility on inflation rate, inflation of market prices, inflation of administered prices, and inflation expectations, based on the structural model adopted by Central Bank of

Brazil (CBB) through Ordinary Least Squares (OLS) and Generalized Method of Moments (GMM) regressions. Furthermore, a vector autoregression model (VAR) is also performed for the period January 2003 to December 2015.

The remainder of this study is organized as follows: Section 2 makes a presentation of the measurement of the fiscal credibility in Brazil for the period from 2003 to 2015. Section 3 presents the data and methodology used in this study. Section 4 provides empirical evidence, through an econometric analysis, of the effect of the fiscal credibility on inflation. Section 5 concludes the paper.

## 2. Measuring fiscal credibility in Brazil

It is a challenge to summarize the government's ability in guiding the expectation process of the economic agents through only one measurement (fiscal credibility index). Some of the first authors to introduce a fiscal credibility index applied to the Brazilian case were de Mendonça and Machado (2013). The index developed by these authors has as its main characteristics the deviations of the public debt-to-GDP ratio expectations from the levels considered as benchmarks by international institutions (e.g. IMF and European Commission). The credibility varies from 1 (full credibility) - case where expectations are lower than 40% (target that should not be breached by emerging economies) to 0 (null credibility) – when expectations of the public debt-to-GDP exceed the limit of 60% as defined in the Maastricht Treaty. The framework developed by the authors is compelling, but there exist some caveats. In particular, this index tends to overestimate the performance of fiscal credibility because it does not consider one essential policy instrument for the success of inflation targeting, that is, the performance of primary surplus.[1]

Taking as reference the framework developed by de Mendonça and Machado (2013), we develop a new fiscal credibility index for the Brazilian economy. The main difference is that instead of considering the public debt-to-GDP ratio, the essential variable in our index is the primary surplus. One reason for this is that since 2000, each year the Brazilian government is committed with a fiscal surplus target. Although, in a first view the indices seem similar, they are quite different. In specific, we develop our index taking into account two criteria which are not observed in de Mendonça and Machado (2013): (i) because the index under construction is a limited variable, instead of using variables like debt-to-GDP ratio, which usually follow a non-stationary stochastic process, stationary fiscal flow measurement is used (primary surplus); and (ii) the use of a reference for exogenous expectation guidance based on a very well defined lower bound for the fiscal flow variable which is publicly preannounced for the next year.

The one-step-ahead expectations of fiscal primary surplus are the natural candidate for being the main information for a fiscal credibility index because the fiscal primary surplus is the adjustment component in the nominal deficit that could ensure the fulfillment of the intertemporal budget restriction. In addition, the expectations of fiscal primary surplus are measured as a ratio-to-GDP (usually a stationary process) and represent the median of financial market institutions expectations for the next year for the fiscal primary surplus. This information is extracted from a daily survey of market expectations conducted by Central Bank of Brazil (CBB) for the evolution of the main Brazilian macroeconomic variables (Focus Market Readout).

It is important to highlight that since the promulgation of the Fiscal Responsibility Law in 2000 the government needs to define annual goals for fiscal variables for execution in current year and the next two years, publicly announced as an Annex of Budget Guidelines Law (Lei

[1] Regarding the relevance of fiscal surplus for inflation targeting applied to the Brazilan case, see de Mendonça and Silva (2009).

de Diretrizes Orçamentárias – LDO) by September of the previous year. In other words, this information represents a benchmark for macroeconomic forecasts, and thus, the primary surplus target (*FPS**) is the essence of the fiscal credibility index in order to evaluate the performance and ability of the government to anchor expectations. Table 1 shows the targets and their respective laws.[2]

It is a fact that expectations deteriorate faster as the fiscal primary surplus is lower than the target. Hence, the use of different intervals creates an asymmetrical framework which is useful in the measurement of credibility. In this context, two intervals are considered in the index: (i) an ideal interval which corresponds to a very good performance of the government regarding the primary surplus in reaching the target, that is, $\left[FPS_{\min}^{ideal}, FPS_{\max}^{ideal}\right] = \left[FPS^{*} - 0.05, FPS^{*} + 0.1\right]$; and (ii) a tolerance interval which represents an acceptable performance given by $\left[FPS_{\min}^{tolerance}, FPS_{\max}^{tolerance}\right] = \left[FPS^{*} - 0.15, FPS^{*} + 0.3\right]$. Taking into consideration the idea above, a fiscal credibility index is elaborated (*FCRED*), which assumes a loss in credibility when the average of the market expectations on fiscal primary surplus (*E(FPS)*), indicates the expectation that the government is not capable of bringing the fiscal primary surplus to the ideal interval or to the tolerance interval around the target.

**Table 1**

*Legal framework for fiscal primary surplus (2000-2015)*

| Year | Legal framework | Target |
|---|---|---|
| 2000 | LDO 2000 – Law N. 9,811 | 3.40 |
| 2001 | LDO 2001 – Law N. 9,995 | 3.35 |
| 2002 | LDO 2002 – Law N. 10,226 | 3.88 |
| 2003 | LDO 2003 – Law N. 10,524 | 3.75 |
| 2004 | LDO 2004 – Law N. 10,707 | 4.50 |
| 2005 | LDO 2005 – Law N. 10,934 | 4.25 |
| 2006 | LDO 2006 – Law N. 11,178 | 4.25 |
| 2007 | LDO 2007 – Law N. 11,439 | 4.25 |
| 2008 | LDO 2008 – Law N. 11,514 | 3.80 |
| 2009 | LDO 2009 – Law N. 11,768 | 3.80 |
| 2010 | LDO 2010 – Law N. 12,017 | 3.30 |
| 2011 | LDO 2011 – Law N. 12,309 | 3.10 |
| 2012 | LDO 2012 – Law N. 12,465 | 3.10 |
| 2013 | LDO 2013 – Law N. 12,708 | 3.10 |
| 2014 | LDO 2014 – Law N. 12,919 | 3.10 |
| 2015 | LDO 2015 – Law N. 13,080 | 1.20 |

Source: Brazilian Parliament
(http://www2.camara.leg.br/atividade-legislativa/orcamentobrasil)

Therefore, when the expectation on fiscal primary surplus is found between the lower bound $\left(FPS_{\min}^{ideal}\right)$ and the upper bound $\left(FPS_{\max}^{ideal}\right)$ of the ideal interval, the credibility is full (assumes value 1). In contrast, fiscal credibility is null (assumes value 0) when expectation on fiscal primary surplus is out of the tolerance interval $\left[FPS_{\min}^{tolerance}, FPS_{\max}^{tolerance}\right]$. Furthermore, the index assumes a value between 0 and 1 when market expectations are inside the intervals $\left]FPS_{\max}^{ideal}, FPS_{\max}^{tolerance}\right]$ and $\left]FPS_{\min}^{ideal}, FPS_{\min}^{tolerance}\right]$, and decreases as expectations deviate from the ideal

[2] Some fiscal surplus goals were revised within the current year. Those revisions were not considered because they do not affect the expectations formed during the previous year.

interval. Hence,

$$FCRED = \begin{cases} 1 & if \quad FPS_{\min}^{ideal} \le E_t(FPS_{t+12}) \le FPS_{\max}^{ideal} \\ 1 - \dfrac{1}{FPS_{\max}^{tolerance} - FPS_{\max}^{ideal}} \left[ E_t(FPS_{t+12}) - FPS_{\max}^{ideal} \right] & if \quad FPS_{\max}^{ideal} < E_t(FPS_{t+12}) \le FPS_{\max}^{tolerance} \\ 1 - \dfrac{1}{FPS_{\min}^{tolerance} - FPS_{\min}^{ideal}} \left[ E_t(FPS_{t+12}) - FPS_{\min}^{ideal} \right] & if \quad FPS_{\min}^{ideal} > E_t(FPS_{t+12}) \ge FPS_{\min}^{tolerance} \\ 0 & if \quad E_t(FPS_{t+12}) < FPS_{\min}^{tolerance} \quad or \quad E_t(FPS_{t+12}) > FPS_{\max}^{tolerance} \end{cases} \tag{1}$$

Taking into account monthly data, the behavior over time regarding targets for fiscal primary surplus and expectations for the next year for the fiscal primary surplus which are essential for building the credibility index, is presented in figure 1.[3] In general, it is possible to identify two phases. The first, before the subprime crisis (2007), inflation expectations are inside the tolerance interval and near the primary surplus target practically all the time. The second represents a deterioration of the expectations and they exceed the lower bound of the tolerance interval most of the time.

**Figure 1**

*Primary surplus targets and expectations*

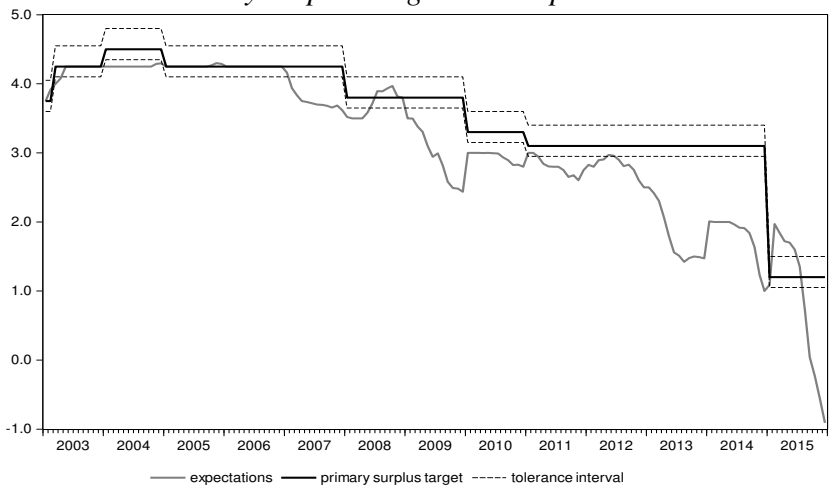



Figure 2 shows the performance of fiscal credibility from 2003 to 2015 in Brazil.[4] A clear trend of worsening over time is observed. In particular, in large measure, the subprime crisis implied a change of the fiscal stance in the Brazilian economy. As pointed out by CBB, the intensification of the effects of the international financial crisis on the internal expectations prompted the government to adopt expansionist fiscal measures. As a consequence, "in December 2008 tax cuts were introduced which favored the credit market conditions and propitiated expansion of consumers' available income. In this sense, noteworthy is the adjustment of the progressive income tax table to the growth of nominal wages of the economy; the reductions of IPI rates levied on the purchase of new vehicles and trucks, and of the

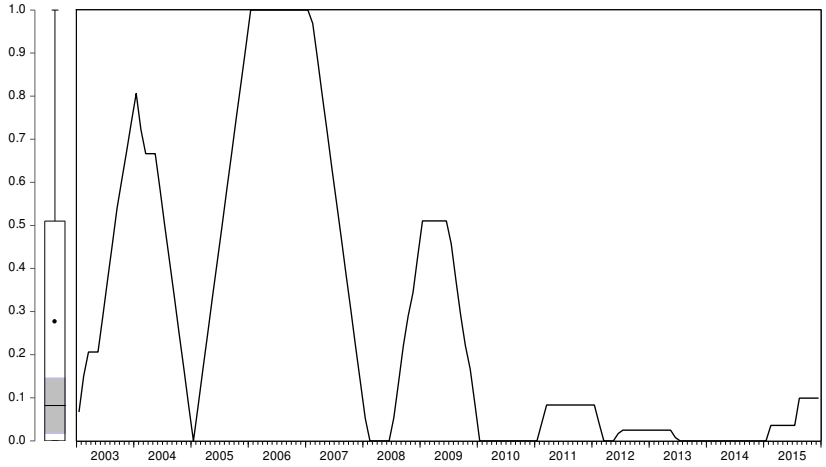
[3] The start date corresponds to when all series used in this study are available from CBB.

[4] Once again, it is important to note to register the difference of this index in comparison with that developed by de Mendonça and Machado (2013). While the index developed by the mentioned authors performs a credibility close to 1 (full credibility) since 2008, this credibility index reveals a clear deterioration since 2007.

Financial Operations Tax (IOF) levied on loans granted to individuals; the creation of two intermediate rates, of 7.5% and 22.5%, of the table of the Individual Income Tax (IRPF), reducing in up to 50% the tax levied on lower income bracket" (CBB, Inflation Report, March 2009, p. 51). After this period, because of the bad management of the Brazilian fiscal policy, there is a clear downturn in fiscal credibility (since 2009, fiscal credibility is lower than 0.1).

**Figure 2**

*Fiscal credibility – Brazil (2003-2015)*




## 3. Data and methodology

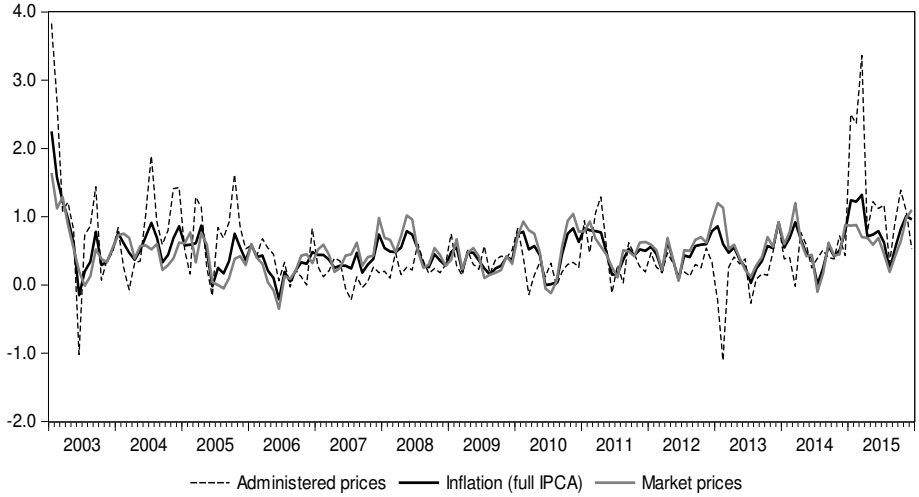
In order to observe the possible impact of the fiscal credibility on inflation rate, the period under analysis is from January 2003 to December 2015 (156 observations – monthly frequency). This analysis starts in January 2003 because this is when the Brazilian economy starts to eliminate the negative effects caused by the confidence crises due to the election of President Luiz Inácio Lula da Silva and when, for example, new information started being released by CBB such as Brazilian Economic Activity Index (IBC-Br). It is important to highlight that although fiscal credibility has been high between 2003 and 2004, it was not enough to bring inflation to the target in both years. However, fiscal credibility was crucial to reversing the trend of increase in inflation which reached two digits in 2002 (12.53%) as a consequence of the political crisis. In brief, in some measure fiscal credibility contributed to reduce inflation.

The official price index that is used to measure inflation rate in Brazil is the National Consumer Price Index (extended) – IPCA. In general, prices are a result of market prices (prices resultant of market force) and administered prices (prices defined by contracts and prices that are monitored, depending on government authorization).[5] Administered prices are divided into tax, public utility services, and petroleum derivatives, which in turn, are slightly sensitive to the market forces. Moreover, inflation expectations are an essential component to be analyzed under inflation targeting system.

[5] Figure 3 presents the performance of these variables for the period 2003 to 2015.

**Figure 3**

*Inflation (full IPCA), Market Prices, and Administered Prices (%)*




With the intention of observing the relation between the fiscal credibility and inflation rate in the Brazilian economy, the first empirical procedure is straightforward. We present four scatterplots and correlations for fiscal credibility (*FCRED*) and its relation with: full inflation rate (*INF*), inflation of market prices ($INF_M$), inflation of administered prices ($INF_A$), and inflation expectations (*E(INF)*) respectively (see figure 4). With exception for the case of administered prices, there exists a negative correlation to other cases (around -0.3), which in turn, suggests that fiscal credibility may reduce inflation rate and reinforces the causal hypothesis to be tested econometrically.

A simple manner of observing how fiscal credibility can affect inflation under inflation targeting is through a Phillips curve. Therefore, we take as reference the version of the Phillips curve used in the structural model adopted by CBB when inflation targeting was adopted in June of 1999 (see Bogdanski, Tombini, and Werlang, 2000). Furthermore, because credibility is a forward-looking concept (see de Mendonça and de Guimarães e Souza, 2009), this means that economic agents anticipate the future through this variable and thus the effect of inflation is not lagged. In particular, it is well-known for the case of inflation targeting countries that one of the main pillars of this framework is the lack of fiscal dominance (Allsopp and Vines, 2005). The presence of high fiscal deficits (low fiscal credibility) can lead to the monetization of the public debt, and thus, start an inflationary process (Mishkin and Savastano, 2001). In brief, there is no doubt that fiscal discipline is essential to a low and stable inflation rate (Fatás and Mihov, 2003; Wyplosz, 2005). Hence, the following equation is considered in this analysis:[6]

$$INF_t = \alpha_0 + \alpha_1 INF_{t-1} + \alpha_2 E_t(INF_{t+12}) + \alpha_3 GAP_t + \alpha_4 \Delta(WPI + EX)_t + \alpha_5 FCRED_t + \varepsilon_t^0, \qquad (2)$$

where: $\varepsilon_t^0 \sim N(0, \sigma^2)$;

$INF_t$ - is the inflation measured by National consumer price index – extended (IPCA);

$E_t(INF_{t+12})$ – is the market expectations (average) on inflation accumulated over the next 12 months (measured by IPCA);

*GAP* – is the output gap and corresponds to the difference between Brazilian Economic Activity Index (IBC-Br) and the potential output (Hodrick-Prescott filter);

*WPI* – is the log of wholesale price index (USA);

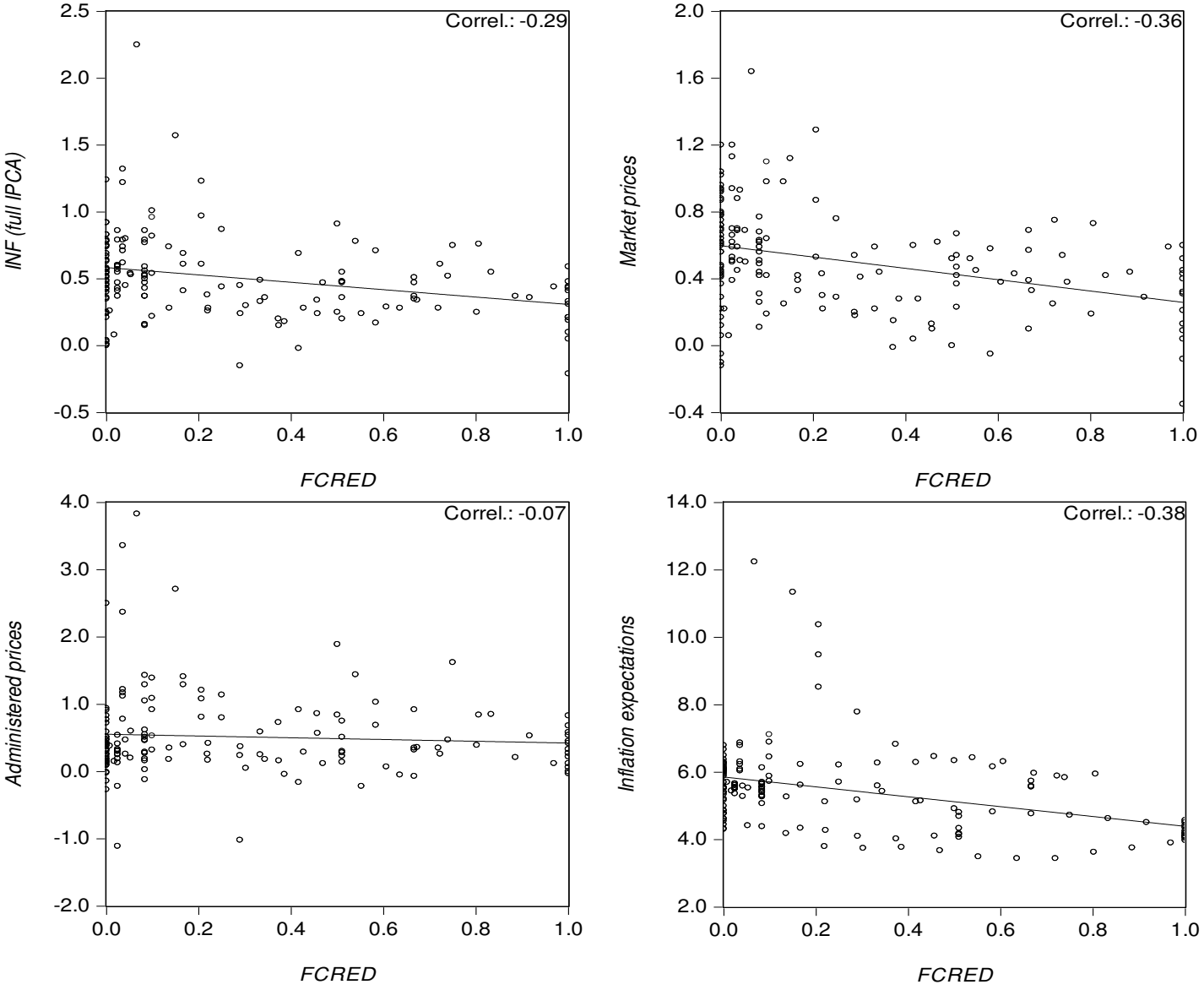
*EX* – is the log of exchange rate - US dollar/Brazil nominal exchange rate; and

[6] See table A.1 (appendix) for sources of data and description of the variables. Descriptive statistics are presented in table A.2 (appendix).

*FCRED* – is the fiscal credibility – it is computed following the procedure presented in the previous section (see equation 1).

**Figure 4**

*Correlations between fiscal credibility and: INF, $INF_M$, $INF_A$,* and *E(INF)*




In order to see the effect of fiscal credibility on inflation of market prices, inflation of administered prices, and inflation expectations, equation (2) is rewritten in the following way:

$$INF_{M_t} = \alpha_6 + \alpha_7 INF_{M_{t-1}} + \alpha_8 E_t(INF_{t+12}) + \alpha_9 GAP_t + \alpha_{10}\Delta(WPI + EX)_t + \alpha_{11} FCRED_t + \varepsilon_t^1, \quad (3)$$

$$INF_{A_t} = \alpha_{12} + \alpha_{13} INF_{A_{t-1}} + \alpha_{14} E_t(INF_{t+12}) + \alpha_{15} GAP_t + \alpha_{16}\Delta(WPI + EX)_t + \alpha_{17} FCRED_t + \varepsilon_t^2, \quad (4)$$

$$E_t(INF_{t+12}) = \alpha_{18} + \alpha_{19} INF_{t-1} + \alpha_{20} GAP_t + \alpha_{21}\Delta(WPI + EX)_t + \alpha_{22} FCRED_t + \varepsilon_t^3, \quad (5)$$

where:

$INF_{M_t}$ - is the inflation measured by IPCA - non monitored prices; and $INF_{A_t}$ - is the inflation measured by IPCA - supervised prices – total.

In this framework, the impact of the variable *FCRED* on inflation rate is straightforward. From the theoretical view it is expected that the results indicate a negative and significant

coefficient on *FCRED* ($\alpha_5, \alpha_{11}, \alpha_{17}, \alpha_{22}<0$). The negative impact of the credibility on inflation is in consonance with the view that a greater commitment with the fiscal goals increases the power of the central bank to achieve the target and thus to anchor inflation expectations.

In general, the use of time series data in equations estimations demands to analyze whether the series in the model have a unit root (non-stationary data series) to avoid the possibility of spurious regression. Hence, the Augmented Dickey–Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are performed. The results indicate that all series are I(0) (see table A.3 – appendix).[7]

In order to estimate the equations (2), (3), (4), and (5), this study uses two methods: Ordinary Least Squares with heteroskedasticity and autocorrelation covariance matrix estimators (HAC), and one-step Generalized Method of Moments (GMM) with HAC (see Davidson and MacKinnon, 2004). These methods are useful to observe the impact caused by the fiscal credibility on inflation rate (and its variations) through a direct observation of the estimated parameters.

In general, the use of OLS method in macroeconomic time series models is subject to the problem of heteroscedasticity.[8] Moreover, the use of inflation expectations as regressor can create a possible risk of endogeneity in the regressions.[9] Hence, OLS method cannot perform well under these issues. As pointed out by Wooldridge (2001), the use of the GMM estimator with its overriding restrictions is a more efficient estimator than OLS. Furthermore, according to Baum, Schaffer, and Stillman (2007) the use of GMM-HAC (heteroscedasticity and autocorrelation consistent) is more appropriate than, for example, IV method. Therefore, in order to estimate the GMM-HAC models based on equations from 2 to 5 and assuming that $\varepsilon_t^i \sim iid$ (where $i=0,1,2,3$), the orthogonal conditions (moment equations) correspond respectively to:

$$E_t\left[\left(INF_t - \alpha_0 - \alpha_1 INF_{t-1} - \alpha_2 E_t(INF_{t+12}) - \alpha_3 GAP_t - \alpha_4 \Delta\left(WPI + EX\right)_t - \alpha_5 FCRED_t\right) z_t\right] \quad (6)$$

$$E_t\left[\left(INF_{M_t} - \alpha_6 - \alpha_7 INF_{M_{t-1}} - \alpha_8 E_t(INF_{t+12}) - \alpha_9 GAP_t - \alpha_{10} \Delta\left(WPI + EX\right)_t - \alpha_{11} FCRED_t\right) z_t\right] \quad (7)$$

$$E_t\left[\left(INF_{A_t} - \alpha_{12} - \alpha_{13} INF_{A_{t-1}} - \alpha_{14} E_t(INF_{t+12}) - \alpha_{15} GAP_t - \alpha_{16} \Delta\left(WPI + EX\right)_t - \alpha_{17} FCRED_t\right) z_t\right] \quad (8)$$

$$E_t\left[\left(E_t(INF_{t+12}) - \alpha_{18} - \alpha_{19} INF_{t-1} - \alpha_{20} GAP_t - \alpha_{21} \Delta\left(WPI + EX\right)_t - \alpha_{22} FCRED_t\right) z_t\right] \quad (9)$$

where $z_t$ is a vector of instrumental variables.

It is important to note that the use of GMM to estimate the Phillips curve is common in the literature (see Galí and Gertler, 1999; Jondeau and Le Bihan, 2005, and de Mendonça, 2009). A condition for efficient estimation based on GMM is that overriding restrictions need to be respected (Woodridge, 2001). In this framework, when there are more instruments than parameters to be estimated, a chi-square test can be used to test the over-identifying restrictions. Hence, all regressions present the J-statistic as a test of over-identifying moment conditions. In the case where the null hypothesis is accepted (Prob(J-statistic)>0.10) the over-identifying restrictions are valid. As usual, the instrument variables in the GMM regressions are the lagged regressors. In order to eliminate skewing the results, the maximum of lags applied for each instrument was 9. In addition, the number of instruments in all models is less than 14% in relation to the total of observations) – the instruments are listed in the appendix (see table A.4).

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[7] The main criticisms of those tests are their lack of power (low probability of rejection when the null is false), as our general results were rejection over non-stationarity we considered unnecessary to perform other tests. Moreover, our fiscal credibility index is not tested for nonstationarity because it is a limited variable by construction.

[8] The presence of heteroscedasticity is observed in the estimates of equations 2 and 4 (see table 2).

[9] Breusch-Godfrey serial correlation LM test indicates the presence of autocorrelation in the residuals (equations 2, 4, and 5 - see table 2).

Besides the methods above, in order to observe the relative importance of the fiscal credibility on inflation under a dynamic perspective, unrestricted vector autoregressive (VAR) framework is used in this analysis. One of the main advantages of VAR models is that this approach is not subject to identification restrictions in structural models by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. In brief, a "VAR is an n-equation, n-variable linear model in which each variable is in turn explained by its own lagged values, plus current and past values of the remaining n-1 variables" (Stock and Watson, 2001, 101). Therefore, based on equations (2) to (5), the reduced form for VAR models regarding full inflation rate, inflation of market prices, inflation of administered prices, and inflation expectations correspond respectively to:

$$INF_t = \beta_0^0 + \sum_{i=1}^{p} \beta_i^1 INF_{t-i} + \sum_{i=1}^{p} \beta_i^2 E_t(INF_{t+12})_{t-i} + \sum_{i=1}^{p} \beta_i^3 GAP_{t-i} + \sum_{i=1}^{p} \beta_i^4 \Delta\left(WPI + EX\right)_{t-i} + \sum_{i=1}^{p} \beta_i^5 FCRED_{t-i} + \mu_t^0, \quad (10)$$

$$INF_{M_t} = \beta_0^6 + \sum_{i=1}^{p} \beta_i^7 INF_{M_{t-i}} + \sum_{i=1}^{p} \beta_i^8 E_t(INF_{t+12})_{t-i} + \sum_{i=1}^{p} \beta_i^9 GAP_{t-i} + \sum_{i=1}^{p} \beta_i^{10} \Delta\left(WPI + EX\right)_{t-i} + \sum_{i=1}^{p} \beta_i^{11} FCRED_{t-i} + \mu_t^1, \quad (11)$$

$$INF_{A_t} = \beta_0^{12} + \sum_{i=1}^{p} \beta_i^{13} INF_{A_{t-i}} + \sum_{i=1}^{p} \beta_i^{14} E_t(INF_{t+12})_{t-i} + \sum_{i=1}^{p} \beta_i^{15} GAP_{t-i} + \sum_{i=1}^{p} \beta_i^{16} \Delta\left(WPI + EX\right)_{t-i} + \sum_{i=1}^{p} \beta_i^{17} FCRED_{t-i} + \mu_t^2, \quad (12)$$

$$E_t(INF_{t+12})_t = \beta_0^{18} + \sum_{i=1}^{p} \beta_i^{19} INF_{t-i} + \sum_{i=1}^{p} \beta_i^{20} E_t(INF_{t+12})_{t-i} + \sum_{i=1}^{p} \beta_i^{21} GAP_{t-i} + \sum_{i=1}^{p} \beta_i^{22} \Delta\left(WPI + EX\right)_{t-i} + \sum_{i=1}^{p} \beta_i^{23} FCRED_{t-i} + \mu_t^3, \quad (13)$$

where: $i=1,2,\ldots, p$ (order); $\beta_0^0, \beta_0^6, \beta_0^{12}$, and $\beta_0^{18}$ are constant terms; and $\mu_0^0, \mu_0^1, \mu_0^2$, and $\mu_0^3$ are innovation terms (impulse or shocks).

In general, the analysis of VAR is made through impulse-response functions. Although, a VAR model allows one to see how each variable in the model responds to itself and others, we are specifically interested in observing how an impulse (shock) transmitted by fiscal credibility affects inflation and inflation expectations over time. Hence, we present the graphs which show the response of *INF*, $INF_M$, $INF_A$, and *E(INF)* to *FCRED*. The errors are orthogonalized by Cholesky decomposition. This implies that the ordination of the variables is important in the analysis of the impulse-response. Following the presentation of the variables in the equations above, the ordination for analysis is given by: *INF*, $INF_M$, $INF_A$, *E(INF)*, *GAP*, Δ(*WPI+EX*), *FCRED*. The next step is to define the VAR order. With this intention Akaike (AIC), Schwarz (SIC), and Hannan-Quinn (HQ) criteria are used and the results indicate that the VAR order is 2 (see table A.5 – appendix). Furthermore, it is observed that the stability condition is satisfied (see figure A.1 – appendix).

## 4. Empirical evidence

This section presents some empirical evidence on the impact of the fiscal credibility on inflation (full IPCA), inflation of market prices, inflation of administered prices, and inflation expectations in the Brazilian economy. The analysis is divided into three steps. In the first step we present OLS estimations. The second step presents GMM estimations. Finally, in the third step, we observe the response of the inflation rate and its variations to a shock transmitted by the fiscal credibility through impulse-response analysis.

The coefficients for the OLS estimations are in consonance with the theoretical perspective (see table 2). The negative and significant coefficients on fiscal credibility observed for the regressions on inflation (full IPCA), inflation of market prices, and inflation expectations are in line with the first impression from the correlation observed in figure 5. This observation is a clear indication that the government commitment with the fiscal primary surplus target (high credibility) is an important mechanism to reduce inflation rate. This result is not a surprise because one of the main pillars for the success of inflation targeting is the sustained fiscal balance. In this context, a breach of the Brazilian government with the fiscal surplus (low credibility) target denotes a lack of the commitment to ensure an environment that supports the reaching of the inflation target. The non-significance for fiscal credibility in the explanation of inflation of administered prices can be a consequence that prices are defined by contracts and thus are less subject to the success of the government in the achievement of the targets.

Besides the coefficients on fiscal credibility, the coefficients on the other variables for the explanation of the dependent variables shown in table 2 are in line with the theoretical view. The positive and significant coefficient on inflation expectations in most models is coherent with the argument that the forward-looking behavior of economic agents is crucial for the success of inflation targeting. It sounds logical that a positive output gap should lead to upward pressure on prices. However, besides the amount of goods, the amount of money has a key role in the system. For a given amount of goods and services, an increase in prices is a result of an increase in the money supply. This observation explains the negative sign observed for the variable *GAP* in most of the models. In response to the recession caused by subprime crisis (a negative output gap), CBB adopted a loose monetary policy combined to a strong expansion of credit to households. In fact, according to data gathered from CBB/TSMS the money supply (currency outside banks), increased more than 140% between January 2008 and December 2015. This process damage the process of wealth generation and thereby, over time, weakens the potential output and also current output. Therefore, it is possible that due to the time lag between changes in the money supply and its effect on prices and output, prices will increase while the economy is in a recession. Finally, although the coefficient on the variable that captures the effect on the external shocks transmitted to inflation is positive in most models, the non-significance is a result that the exchange rate was overvalued most of the time.[10]

[10] In order to check whether the effect of fiscal credibility on inflation and inflation expectations is also significant when change in fiscal credibility ($\Delta FCRED$) is considered in the models, new estimates were made. The results are presented in table A.6 (appendix) and, in general, are in line with those observed in tables 2 and 3.

**Table 2**

*OLS estimates of the effect of fiscal credibility on INF, $INF_M$, $INF_A$, and E(INF)*

| Regressors | OLS (HAC) | | | |
|---|---|---|---|---|
| | Equation (2) | Equation (3) | Equation (4) | Equation (5) |
| Const. | 0.051 | 0.166* | -0.397** | 0.728*** |
| | (0.108) | (0.100) | (0.202) | (0.068) |
| $INF_{t-1}$ | 0.496*** | | | 0.332***[(a)] |
| | (0.053) | | | (0.058) |
| $INF_{Mt-1}$ | | 0.531*** | | |
| | | (0.049) | | |
| $INF_{At-1}$ | | | 0.387*** | |
| | | | (0.066) | |
| $E_t(INF_{t+12})$ | 0.040* | 0.020 | 0.120*** | 0.840***[(b)] |
| | (0.022) | (0.019) | (0.039) | (0.013) |
| $GAP_t$ | -0.009*** | -0.012*** | -0.001 | 0.007 |
| | (0.003) | (0.003) | (0.010) | (0.003) |
| $\Delta(WPI+EX)_t$ | 0.337 | -0.233 | 2.159 | 0.871** |
| | (0.476) | (0.492) | (1.481) | (0.403) |
| $FCRED_t$ | -0.084* | -0.150** | 0.142 | -0.212*** |
| | (0.049) | (0.060) | (0.099) | (0.046) |
| Adj. $R^2$ | 0.509 | 0.470 | 0.344 | 0.979 |
| F-statistic | 32.896 | 28.348 | 17.185 | 1409.011 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 |
| BPG test | 1.254 | 3.062 | 0.921 | 2.198 |
| Prob(BPG test) | 0.287 | 0.012 | 0.469 | 0.058 |
| BG test | 3.130 | 0.235 | 3.966 | 28.106 |
| Prob(BG test) | 0.047 | 0.791 | 0.021 | 0.000 |

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. BPG means - Breusch-Pagan-Godfrey test, where the null hypothesis indicates the presence of heteroscedasticity. Robust standard errors (Newey-West) are in parentheses. [(a)] regressor *INF* is no lagged. [(b)] regressor $E_t(INF_{t+12})$ is lagged.

The coefficients for the GMM estimations (see table 3) do not present significant changes in terms of sign and statistical significance when they are compared with those in the OLS estimations (see table 1). Therefore, the results are in line with the assumption that the fiscal credibility is an important element to decrease inflation rate and its expectations.

Extending the analysis regarding the impact of the fiscal credibility on inflation rate, inflation of market prices, inflation of administered prices, and inflation expectations, the previous results from OLS and GMM models are confirmed through impulse-response functions plotted out to the 36th month. It is important to note that the results in the graphs need to be analyzed with care. Although, we are observing the impact of fiscal credibility on inflation and inflation expectations over time, the comparison among them is not direct. As can be seen in figure 3, while inflation (full IPCA) and inflation of market prices follow a similar path, the same cannot be said regarding inflation of administered prices. As a consequence, it is natural that the impulse-response graphs present different scales. Indeed, the relevant point is to detect if the fiscal credibility has significant impact on inflation and on inflation expectations and how long are the duration of these effects.

**Table 3**

*GMM estimates of the effect of fiscal credibility on INF, $INF_M$, $INF_A$, and E(INF)*

| Regressors | GMM (HAC) | | | |
|---|---|---|---|---|
| | Equation (2) | Equation (3) | Equation (4) | Equation (5) |
| Const. | 0.022 | 0.092 | -0.482** | 0.475** |
| | (0.100) | (0.132) | (0.219) | (0.196) |
| $INF_{t-1}$ | 0.520*** | | | 0.387***[(a)] |
| | (0.069) | | | (0.127) |
| $INF_{Mt-1}$ | | 0.515*** | | |
| | | (0.064) | | |
| $INF_{At-1}$ | | | 0.461*** | |
| | | | (0.092) | |
| $E_t(INF_{t+12})$ | 0.045** | 0.038* | 0.132*** | 0.880***[(b)] |
| | (0.018) | (0.020) | (0.044) | (0.035) |
| $GAP_t$ | -0.014** | -0.015** | -0.012 | 0.016** |
| | (0.006) | (0.006) | (0.013) | (0.007) |
| $\Delta(WPI+EX)_t$ | 0.213 | -1.839 | 2.015 | 0.792 |
| | (1.004) | (0.974) | (2.458) | (0.951) |
| $FCRED_t$ | -0.088* | -0.131** | 0.138 | -0.150** |
| | (0.049) | (0.066) | (0.090) | (0.063) |
| Adj. $R^2$ | 0.464 | 0.424 | 0.349 | 0.964 |
| J-statistic | 17.607 | 19.348 | 9.406 | 16.238 |
| Prob(J-statistic) | 0.284 | 0.251 | 0.896 | 0.133 |
| Instrum. rank | 21 | 22 | 22 | 17 |

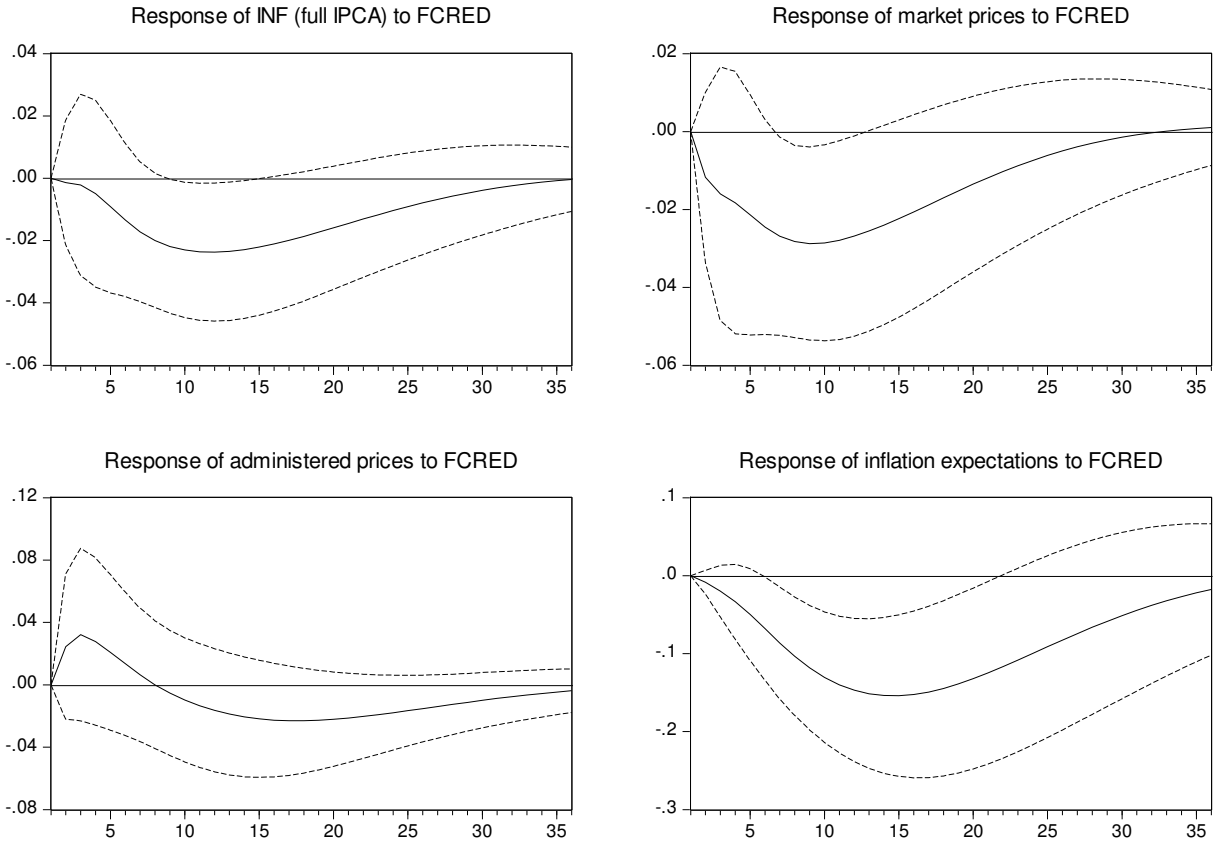
Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust standard errors (Newey-West) are in parentheses. [(a)] regressor *INF* is no lagged. [(b)] regressor $E_t(INF_{t+12})$ is lagged.

Figure 5 suggests that an impulse transmitted by fiscal credibility provokes a significant decrease in inflation rate, inflation of market prices, and inflation expectations. We can see that a decrease of inflation due to an innovation on fiscal credibility takes around 9 months to become significant and remains significant for about 6 months. A similar effect is valid for the case of inflation of market prices. An impulse on fiscal credibility provokes a significant decrease in inflation of market prices after 6 months and abides significantly for 6 more months. In the same vein, an innovation transmitted by fiscal credibility also provokes a negative impact on inflation expectations. Finally, such as presented in the OLS and GMM estimations, the effect of fiscal credibility on inflation of administered prices does not have statistical significance and thus the path of this relation does not bring useful interpretations.

**Figure 5**

*Response of INF, $INF_M$, $INF_A$, and E(INF) to generalized one s.d. FCRED innovation*

Response to Cholesky One S.D. Innovations ± 2 S.E.




## 5. Conclusion

This study presented empirical evidence regarding the effect of fiscal credibility on inflation rate, inflation of market prices, inflation of administered prices, and inflation expectations, in the Brazilian economy after the adoption of inflation targeting. One important contribution in this study was the elaboration of a fiscal credibility index based on how the market expectations are anchored to the primary surplus target. The findings suggest that the success of government in achieving the fiscal primary surplus target (gain of credibility) is an important ally to reduce inflation rate and its expectations.

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## Appendix

**Table A.1**
*Sources of data and description of the variables*

| Variable name | Variable description | Data source |
|---|---|---|
| ***FPS**** | Primary surplus target - annual goals for fiscal primary surplus | LDO |
| ***E(FPS)*** | Primary surplus expectations - Market expectations on fiscal primary surplus | CBB – MES |
| $FPS^{tolerance}$ | Tolerance interval - acceptable range for fiscal primary surplus. | Devised by authors |
| $FPS^{ideal}$ | Ideal interval - ideal range for fiscal primary surplus. | Devised by authors |
| ***INF*** | Inflation - National consumer price index (IPCA) - in 12 months | CBB – TSMS (code 13,522) |
| ***E(INF)*** | Inflation expectations - Market expectations inflation accumulated over the next 12 months (IPCA – official price index) | CBB – MES |
| $INF_M$ | Broad national consumer price index (IPCA) - non monitored prices | CBB – TSMS (code 11,428) |
| $INF_A$ | Broad national consumer price index (IPCA) - Supervised prices – Total | CBB – TSMS (code 4,449) |
| ***GAP*** | Output gap - difference between Economic Activity Index (IBC-Br) and the potential output (Hodrick-Prescott filter) | CBB – TSMS (code 17,439) |
| ***WPI*** | Wholesale price index (2005=100) - United States | CBB – TSMS (code 3808) |
| ***EX*** | Exchange rate - Free - United States dollar (purchase) - period average | CBB – TSMS (code 3697) |
| ***FCRED*** | Fiscal credibility index | Devised by authors, based on equation 1 |

Note: CBB - Central Bank of Brazil; TSMS - Time Series Management System; MES – Market Expectation System; and LDO - Budget Guidelines Law (Lei de Diretrizes Orçamentárias).

**Table A.2**

*Descriptive statistics*

| Variables | Mean | Median | Maximum | Minimum | Std. Dev. |
|---|---|---|---|---|---|
| *INF* | 0.508 | 0.480 | 2.250 | -0.210 | 0.315 |
| *E(INF)* | 5.452 | 5.508 | 12.237 | 3.437 | 1.282 |
| $INF_M$ | 0.504 | 0.500 | 1.640 | -0.350 | 0.310 |
| $INF_A$ | 0.519 | 0.375 | 3.830 | -1.110 | 0.624 |
| *GAP* | -9.75E-13 | 0.418 | 10.024 | -13.502 | 4.246 |
| *Δ(WPI+EX)* | 0.003 | 0.000 | 0.134 | 0.035 | 0.584 |
| *FCRED* | 0.276 | 0.083 | 1.000 | 0.000 | 0.332 |

**Table A.3**

*Unit root tests (ADF, PP, and KPSS)*

| Series | ADF | | | | PP | | | | KPSS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lags | I/T | Test | C.V. (5%) | Band | I/T | Test | C.V. (5%) | Band | I/T | Test | C.V. (10%) |
| *INF* | 0 | I | -7.14 | -2.88 | 2 | I | -7.20 | -2.88 | 6 | I | 0.25 | 0.35 |
| *E(INF)* | 2 | I+T | -4.87 | -3.44 | 6 | I+T | -6.56 | -3.43 | 9 | I | 0.32 | 0.35 |
| $INF_M$ | 0 | I | -6.18 | -2.88 | 6 | I | -6.08 | -2.88 | 5 | I | 0.27 | 0.35 |
| $INF_A$ | 0 | I | -8.15 | -2.88 | 5 | I | -8.16 | -2.88 | 7 | I | 0.28 | 0.35 |
| *GAP* | 13 | I | -4.25 | -1.94 | 2 | | -7.92 | -1.94 | 5 | I | 0.03 | 0.35 |
| *Δ(WPI+EX)* | 0 | | -9.69 | -1.94 | 6 | | -9.65 | -1.94 | 7 | I+T | 0.04 | 0.12 |

Note: C.V. = critical value. Trend (T) and intercept (I) are included based on Schwarz criterion. ADF – the final choice of lag was made based on Schwarz criterion. PP and KPSS – spectral estimation method is Bartlett kernel and the Newey West Bandwidth is used.

**Table A.4**

*List of GMM instruments*

| | |
|---|---|
| Equation (2) | *INF*(-2 to -6) *E(INF)*(-1 to -6) *GAP*(-1 to -2) *Δ(WPI+EX)*(-1) *FCRED*(-1 to -6) |
| Equation (3) | $INF_M$(-2 to -6) *E(INF)*(-1 to -7) *GAP*(-1 to -2) *Δ(WPI+EX)*(-1) *FCRED*(-1 to -6) |
| Equation (4) | $INF_A$(-2 to -3) *E(INF)*(-1 to -9) *GAP*(-1 to -3) *Δ(WPI+EX)*(-1) *FCRED*(-1 to -6) |
| Equation (5) | *INF*(-1 to -3) *GAP*(-1) *Δ(WPI+EX)*(-1 to -6) *FCRED*(-1 to -6) |

**Table A.5**

*AIC, SIC, and HQ criteria for VAR*

| Order | AIC | SIC | HQ |
|---|---|---|---|
| 0 | 0.696 | 0.838 | 0.754 |
| 1 | -7.085 | -5.951 | -6.625 |
| 2 | -8.147* | -6.020* | -7.283* |
| 3 | -7.922 | -4.803 | -6.655 |
| 4 | -7.810 | -3.699 | -6.140 |
| 5 | -7.670 | -2.566 | -5.596 |
| 6 | -7.694 | -1.598 | -5.217 |
| 7 | -7.650 | -0.562 | -4.770 |
| 8 | -7.562 | 0.518 | -4.279 |

Note: (*) denotes lag order selected by the criterion.

**Table A.6**

*OLS estimates of the effect of change in fiscal credibility on INF, $INF_M$, $INF_A$, and E(INF)*

| Regressors | OLS (HAC) | | | |
|---|---|---|---|---|
| | Equation (2) | Equation (3) | Equation (4) | Equation (5) |
| Const. | -0.062 | -0.004 | -0.277 | 0.541*** |
| | (0.103) | (0.096) | (0.204) | (0.068) |
| $INF_{t-1}$ | 0.489*** | | | 0.371***[(a)] |
| | (0.055) | | | (0.061) |
| $INF_{Mt-1}$ | | 0.556*** | | |
| | | (0.058) | | |
| $INF_{At-1}$ | | | 0.402*** | |
| | | | (0.069) | |
| $E_t(INF_{t+12})$ | 0.057** | 0.041** | 0.104** | 0.860***[(b)] |
| | (0.023) | (0.020) | (0.042) | (0.014) |
| $GAP_t$ | -0.009*** | -0.012*** | -0.003 | 0.010*** |
| | (0.003) | (0.003) | (0.010) | (0.004) |
| $\Delta(WPI+EX)_t$ | 0.524 | 0.056 | 2.057 | 1.213*** |
| | (0.489) | (0.510) | (1.480) | (0.430) |
| $\Delta FCRED_t$ | -0.534* | -0.615* | -0.290 | -0.492 |
| | (0.283) | (0.315) | (0.878) | (0.323) |
| Adj. $R^2$ | 0.508 | 0.457 | 0.339 | 0.976 |
| F-statistic | 32.852 | 26.957 | 16.824 | 1246.153 |
| Prob(F-statistic) | 0.000 | 0.000 | 0.000 | 0.000 |

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust standard errors (Newey-West) are in parentheses. [(a)] regressor *INF* is no lagged. [(b)] regressor $E_t(INF_{t+12})$ is lagged.

**Figure A.1**