

Credibility on Pass-through in Brazil

Felipe Santos Tostes

Fluminense Federal University
Department of Economics

Address: Av. Pero de Góes, 98 – Jd. Maria Queiroz
Campos dos Goytacazes – Rio de Janeiro – Brazil
CEP: 28035-040
email: *felipesantostes@hotmail.com*
phone: +55(22)3025-1921

Helder Ferreira de Mendonça

Fluminense Federal University
Department of Economics and
National Council for Scientific and Technological
Development (CNPq)

Address: Rua Dr. Sodré, 59 – Vila Suíça
Miguel Pereira – Rio de Janeiro – Brazil
CEP: 26900-000
email: *helderfm@hotmail.com*
phone: +55(24)2484-4143

Abstract

This study is connected with the literature about exchange rate pass-through effect on inflation for developing economies under inflation targeting. The novelty is the introduction of the effect of both monetary and fiscal credibility on pass-through. The article addresses empirical evidence, based on the Brazilian experience, regarding the idea that high credibility might reduce the exchange rate pass-through on inflation. The findings denote that although monetary credibility is relevant only for pass-through on inflation of market prices, fiscal credibility is an important tool to reduce the pass-through on both inflation and inflation expectations.

Key words: pass-through, fiscal credibility, monetary credibility, inflation targeting.

Resumo

Este estudo está relacionado com a literatura sobre o efeito pass-through da taxa de câmbio na inflação para as economias em desenvolvimento no âmbito de metas de inflação. A novidade é a introdução do efeito da credibilidade monetária e fiscal no pass-through. O artigo aborda a evidência empírica, com base na experiência brasileira, em relação à ideia de que a alta credibilidade pode reduzir a taxa de repasse cambial sobre a inflação. Os resultados indicam que, apesar da credibilidade monetária ser relevante apenas para o pass-through sobre a inflação dos preços livres, a credibilidade fiscal é uma ferramenta importante para reduzir o pass-through para a inflação e para as expectativas de inflação.

Palavras-chaves: pass-through, credibilidade fiscal, credibilidade monetária, metas de inflação.

Área 4 (ANPEC): Macroeconomia, Economia Monetária e Finanças.

JEL classification: E31, E52, E58, E62, E63.

1. Introduction

With the growing adoption of inflation targeting framework and due to the fact that the use of inflation targeting demands a flexible exchange rate regime, more attention has been paid to the exchange rate pass-through on inflation. As pointed out by Minella et al. (2003), exchange rate volatility and construction of credibility has been one of the main challenges to the inflation targeting regime in developing countries. The reason is that a depreciation of the exchange rate erodes inflation expectations and may result in non-fulfillment of inflation targets.

The idea above is close to the definition of credibility presented by Svensson (1993). That is, there is credibility in the case that market agents believe that the future inflation will fall within the target range. However, this is only one side of the coin for analyzing the effects of credibility on inflation under inflation targeting. The other side of the coin is the fiscal credibility. As pointed out by Mishkin (2000), a disadvantage of the inflation targeting for the case of developing economies is that it cannot prevent fiscal dominance, and that the exchange rate flexibility required by inflation targeting might cause financial instability. In particular, the risk of monetization of the public debt is relevant under an inflation targeting environment because it can start an inflationary process (Mishkin and Savastano, 2001).

It is important to highlight that fiscal credibility is directly connected with the sustainability of public debt. An important condition is that public debt/GDP ratio does not jeopardise the intertemporal fiscal solvency. Hence public debt management plays a crucial role in this system.¹ A high public debt increases the temptation of government to repudiate its debt and thus wrecks credibility. In short, low fiscal credibility, as well as low monetary credibility, put in doubt the public's belief that inflation will converge to the target.

This study is a contribution to the literature on exchange rate pass-through effect on inflation for developing economies under inflation targeting. The novelty is the introduction of the effect of both monetary and fiscal credibility on pass-through. The main idea is that a high credibility might reduce the exchange rate pass-through on inflation. With this objective, this article addresses empirical evidence based on the Brazilian experience.

The analysis on Brazil (the largest Latin American economy) fits well for analyzing the effect of fiscal and monetary credibility due to the fact that there exists recent empirical evidence on the significance of the exchange rate pass-through for inflation (see Choudhri and Hakura, 2006; and Giannellis and Koukouritakis, 2013). Furthermore, the Brazilian economy is still building monetary and fiscal credibility (see Minella et al., 2003, de Mendonça, 2007, and de Mendonça and Machado, 2013).

Empirical evidence is a result of several estimations, based on the structural model adopted by Central Bank of Brazil (CBB), using Ordinary Least Squares (OLS) and Generalized Method of Moments (GMM) for the period from November of 2001 to September of 2013. Due to the fact that there are credibility indices that are compatible with the above-mentioned idea and that they were applied to the Brazilian economy, we take as reference the monetary credibility index developed by de Mendonça (2007) and de Mendonça and de Guimarães e Souza (2009), and the fiscal credibility index proposed by de Mendonça and Machado (2013). It is noteworthy that besides the analysis for the pass-through on inflation, we also consider the effect on inflation of market prices and administered prices. Furthermore, we extended the analysis for observing the effect of credibility on exchange rate pass-through and then on inflation expectations.

The results provided from this study denote that contrary to Reyes's (2007) suggestion that the adoption of inflation targeting reduces the exchange rate pass-through on inflation; the pass-through is significant in the Brazilian economy after more than ten years of adoption of inflation targeting. Regarding the effect due to credibility, the main result is that although monetary credibility is relevant only for pass-through into market prices, fiscal credibility is an important tool

¹ For an analysis on the relevance of public debt/GDP as a fiscal indicator, see: Calvo (1988); Giavazzi and Pagano (1990); Drudi and Giordano (2000); Lloyd-Ellis and Zhu (2001); Angeletos (2002); Giavazzi and Missale (2004); Faraglia, Marcet, and Scott (2008); Mehl and Reynauld (2010).

to reduce the pass-through on both inflation and inflation expectations. In short, the results could be of help for academics and policy-makers in developing economies.

The remainder of this study is organized as follows: Section 2 explores the relationship between exchange rate pass-through and credibility. Section 3 presents the methodology and data used in the study. Section 4 provides empirical evidence, through an econometric analysis, from the effect of monetary and fiscal credibility on exchange rate pass-through effect taking into account inflation (also market prices and administered prices) and inflation expectations. Section 5 concludes the article.

2. Exchange rate pass-through and credibility

The transmission of the variations in the exchange rate for inflation is a problem particularly observed in the developing economies which experience high inflation rate and episodes of currency crises (Goldfajn and Werlang, 2000). Some authors such as Calvo and Reinhart (2002) and Choudhri and Hakura (2006), provide evidence that changes in import prices due to variations in the exchange rate are passed on to domestic prices in developing countries more so than developed countries.

Several studies have been shown that the exchange rate pass-through on inflation has been decreasing for developing countries with inflation targeting.² Reyes (2007), in a comprehensive analysis on exchange rate pass-through effects and inflation targeting in developing countries, highlights that one reason behind the declining of pass-through effects is the stronger credibility of the central bank's commitment towards achieving low inflation rates.³ In particular, as observed by Eichengreen (2002), in the case of lacks of credibility, sharp changes in exchange rates will make firms not reduce price increases to meet the inflation target.

Inflation targeting countries with low monetary policy credibility cannot neglect the exchange rate pass-through for inflation. Currency devaluations can put in doubt the capacity of the central bank to achieve the inflation target creating frequent revisions in the inflation expectations and thus damaging the development of monetary credibility.⁴ This difficulty to develop monetary credibility is due to the distrust of the market regarding the conduct of monetary policy (Nogueira Jr. and León-Ledesma, 2011). Hence, one assumption that deserves attention is that an increase of monetary credibility reduces the exchange rate pass-through on inflation.

In Brazil, such as other developing countries (for example, Chile and Poland), inflation target is announced by the government and central bank jointly as a manner for the government to commit to the fiscal discipline needed to achieve the target. In short, inflation targeting must be supported by reinforcement of fiscal institutions as a way of delivering better fiscal outcomes (Eichengreen, 2002).

When the percentage of public debt indexed to the exchange rate is high, the effect of currency devaluation on the public debt/GDP ratio can put in doubt the public debt sustainability (de Mendonça and Machado, 2013). Furthermore, a high public debt/GDP ratio increases the risk of public debt default that, combined with low fiscal policy credibility, increases the likelihood of fiscal deficits to be monetized. Hence, high public's inflation expectations will follow and can cause an inflation targeting regime to break down (Mishkin and Savastano, 2001).

In a general way, public debt management has the objective of efficiently meeting government borrowing requirements at the lowest possible long-term financing cost, while maintaining prudent risk levels (ABP, 2012). With this objective the Brazilian National Treasury has adopted an issuance strategy of gradually replacing bonds indexed to the Selic rate (Financial

² See, Mishkin and Savastano (2001), Minella et al. (2003), Edwards (2006), Nogueira Jr. (2007), Nogueira Jr. and León-Ledesma (2009), and Odria, Castillo, and Rodriguez (2012).

³ Before Reyes (2007), Gagnon and Ihrig (2004) suggested that decreased pass-through observed in several countries is a result of a greater credibility of central banks in maintaining low inflation.

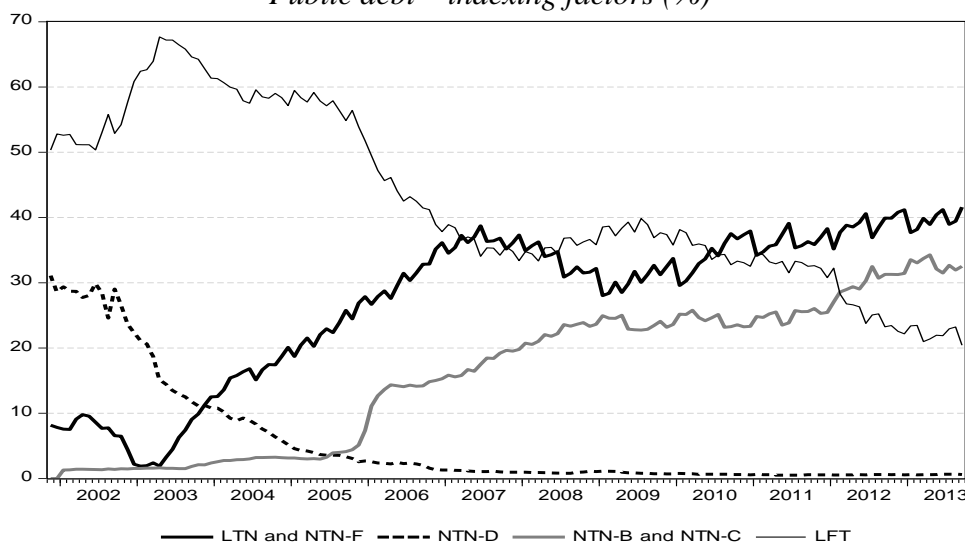
⁴ See, Mishkin and Savastano (2001), Schmidt-Hebbel and Werner (2002), Eichengreen (2002), Gagnon and Ihrig (2004), and Batini and Tereanu (2010).

Treasury Bills - LFT) and indexed to the BRL/dollar exchange rate (National Treasury Notes Series D – NTN-D) with fixed rate bonds (National Treasury Bills – LTN and National Treasury Notes Series F – NTN-F) and inflation-linked bonds (National Treasury Notes Series B – NTN-B and National Treasury Notes Series B -NTN-C) – see figure 1. For improving the market’s perception of public debt management for purposes of protection against exchange volatility, since 2002 CBB and Brazilian National Treasury have carried out exchange swap operations conjugated with primary offers of LFT. This strategy has been intensified after the subprime crisis for mitigating the external vulnerability.

There is a trade-off in the strategy adopted by the Brazilian fiscal authority. On one hand, the change in the public debt composition reduced the sensitivity of the public debt/GDP ratio to currency devaluations. However, there is a cost for the management of the public debt that cannot be ignored. An increase in the inflation increases the public debt due to inflation-linked bonds (NTN-B and NTN-C). Furthermore, there is an additional cost when the monetary authority increases the interest rate for controlling inflationary pressure due to bonds indexed to the interest rate (LFT).

The strategy of eliminating issue of bonds indexed to exchange rate (NTN-D) implies that currency devaluation does not affect directly the public debt. However, under low monetary and fiscal credibility, currency devaluations are transmitted to (domestic) inflation. As a consequence, public debt is affected through inflation-linked bonds (NTN-B and NTN-C). Moreover, public debt is also affected by an increase in the interest rate for controlling inflationary pressure due to LFTs. In short, although the new composition of the public debt has reduced directly the exposition to exchange rate, it is not sufficient to eliminate the indirect effect caused by an increase in inflation due to currency devaluation.

Figure 1
Public debt – indexing factors (%)



Therefore, low credibility of the economic policy (monetary and fiscal) amplifies the vulnerability of inflation target countries for external shocks on inflation. Low monetary policy credibility creates inflation expectations greater than the target. As a result, central bank increases the interest for the convergence of the inflation expectations to the inflation target (de Mendonça and de Guimarães e Souza, 2009). Another point that cannot be neglected in an inflation targeting framework is that the low fiscal policy credibility can generate the fiscal dominance problem. According to Sargent (1994), when the monetary policy is submitted to a government that is not committed to fiscal balance, persistent public budget deficits are a consequence. Therefore, as pointed out by Mishkin and Savastano (2001) the possibility of monetization of the public debt increases creating high inflation expectations and thus a possible loss of control on inflation.

3. Methodology and data

The measurement of monetary and fiscal credibility is crucial for the objective of this study. In the last years, the literature has presented advances in the measurement of the monetary policy credibility based on Cukierman and Meltzer (1986), Agénor and Taylor (1992, 1993), and Svensson (1993, 2000) argue that credibility indices can be built through deviations of inflation from the target.⁵

For the purpose of analyzing the Brazilian case, the monetary credibility index presented by de Mendonça and Galveas (2013), an update of that developed by de Mendonça (2007), is useful for this analysis due to the fact that it considers the public's forward-looking behavior on inflation. In other words, this monetary credibility index ($CRED_M$) is a useful tool for measuring the public's trust on the capacity of the monetary authority to reach the inflation target. According to this view, the credibility is maximum when the inflation expectation for the next 12 months ($E_t(INF_{t+12})$) is equal to the weighted inflation target (next 12 months - INF_{t+12}^*) and decreases in a linear way while inflationary expectation deviates from this target. When the inflation exceeds the bounds of the tolerance interval, the $CRED_M$ is equal to 0. Therefore, based on information available from CBB (Time Series Management System) the scale of the index is from 0 to 1. Hence, $CRED_M$ is a result of:

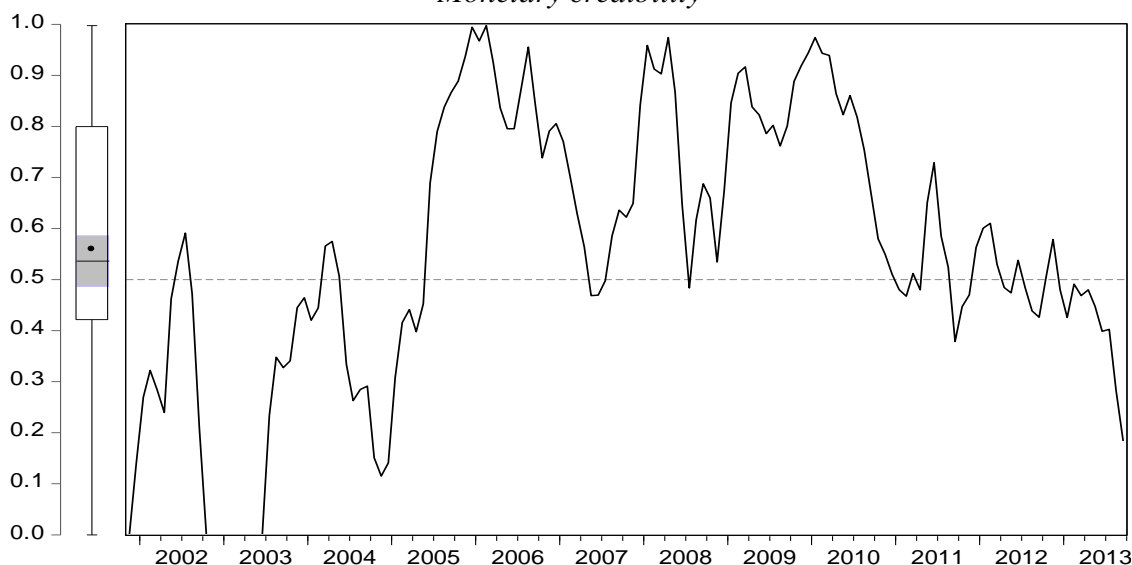
$$(1) \quad CRED_{M_t} = \left\{ \begin{array}{ll} 1 & \text{if } E_t(INF_{t+12}) = INF_{t+12}^* \\ 1 - \frac{1}{INF_{i+1}^{bound} - INF_{i+1}^*} [E_t(INF_{t+12}) - INF_{t+12}^*] & \text{if } INF_i^{lower_bound} < E_t(INF_{t+12}) < INF_i^{upper_bound} \\ 0 & \text{if } E_t(INF_{t+12}) \geq INF_i^{upper_bound} \text{ or } E_t(INF_{t+12}) \leq INF_i^{lower_bound} \end{array} \right\}$$

where: INF_{i+1}^{bound} is the limit of tolerance interval inflation defined for the next year; INF_{i+1}^* is the inflation target for the next year.

Figure 2 shows that the monetary credibility presents three phases. The first phase (2001-2004) is marked by a low performance that is a result of the presidential election in late 2002. Luis Inácio Lula da Silva (the winner of that election) promised to change the macroeconomic policy in Brazil (based on flexible exchange rate, inflation targeting, and primary surplus target) and the result was a confidence crisis in the market. The second phase (2005-2009) has the best performance. The combination of abundance of international liquidity, absence of significant external shocks transmitted to the Brazilian economy, and fiscal responsibility helped CBB in the task of using inflation targeting as a nominal anchor. The third phase (2010-2013) presents a decreasing trend. This phase is a result of the lagged effects caused by the subprime crisis. The adverse scenery (low world economic growth), low economic growth of the Brazilian economy, use of fiscal expansionist fiscal policy, decrease in international liquidity and thus consequent risk of increasing of the exchange rate pass-through on inflation, resulted in a negative environment for CBB guiding inflation expectations.

⁵ See, for example, Cecchetti and Krause (2002), de Mendonça (2007), and de Mendonça and de Guimarães e Souza (2009).

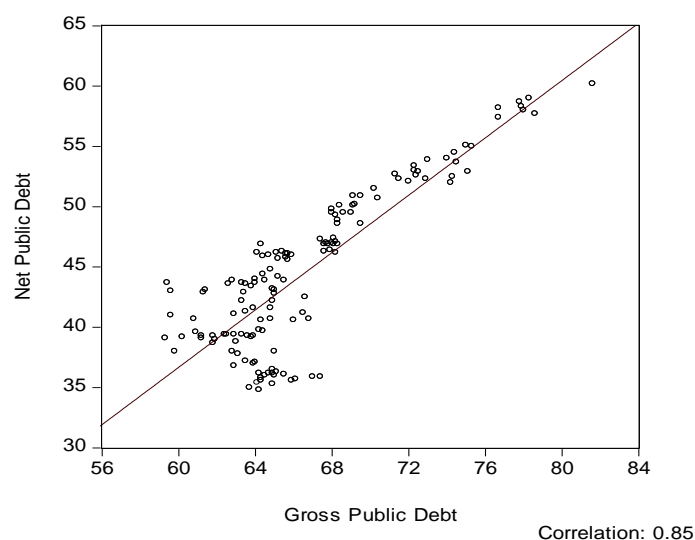
Figure 2
Monetary credibility



Based on information available from CBB (Time Series Management System), the main variable used for building the fiscal credibility index ($CRED_F$) is the net public debt (% GDP) – $DEBT$.⁶ The reason for using this indicator is due to the fact that in Brazil it is used by the government as a reference for economic policy decisions (Silva, Carvalho, and Medeiros, 2010). In addition, taking into consideration the period under analysis (2001-2013) net public debt (% GDP) is highly correlated with gross public debt (% GDP) (see figure 3).

Such as considered for the monetary credibility index, $CRED_F$ takes into account the public’s expectations. This study makes use of the fiscal credibility index developed by de Mendonça and Machado (2013) that measures the expectations regarding government commitment with public debt sustainability using as reference IMF’s recommendation and Maastricht limits to public debt. This point is important for this analysis due to the fact that macroeconomic weakness erodes inflation expectations and the possible result is an increase in the exchange rate pass-through on inflation.

Figure 3
Net Public Debt (% GDP) vs Gross Public Debt (% GDP)



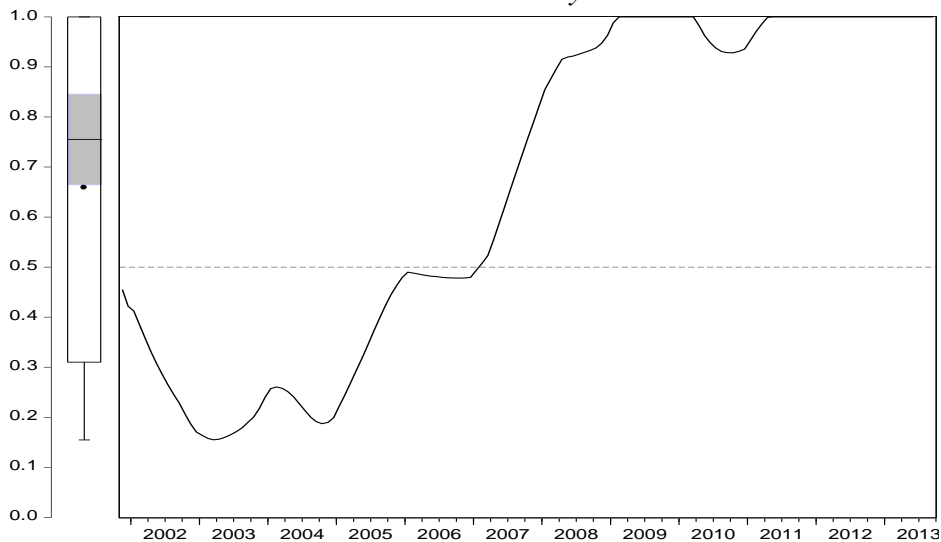
⁶ Furthermore, “unlike other countries, net debt includes Central Bank assets and liabilities including, among other items, international reserves (assets) and the monetary base (liabilities)” (Silva, Carvalho, Medeiros, 2010, p. 92).

As highlighted by de Mendonça and Machado (2013), $CRED_F$ has value from 0 (null credibility) to 1 (full credibility). $CRED_F$ is 0 when market's expectations for the next 12 months ($E_t(DEBT_{t+12})$) are greater than the upper limit (60%) and thus it represents a case of high risk of default. $CRED_F$ is 1 when market's expectations for the next 12 months are lower than the lower limit (40%) and thus there is no risk of default. $CRED_F$ has value between 0 (near the higher limit - $DEBT^{Max}$) and 1 (near the lower limit - $DEBT^{Min}$) when the market's expectations for the next 12 months are between the limits. Hence $CRED_F$ is a result of:

$$(2) \quad CRED_{F_t} = \left\{ \begin{array}{ll} 1 & \text{if } E_t(DEBT_{t+12}) \leq DEBT^{Min} \\ 1 - \frac{1}{DEBT_t^{Max} - DEBT_t^{Min}} [E_t(DEBT_{t+12}) - DEBT^{Min}] & \text{if } DEBT^{Min} < E_t(DEBT_{t+12}) < DEBT^{Max} \\ 0 & \text{if } E_t(DEBT_{t+12}) \geq DEBT^{Max} \end{array} \right\}.$$

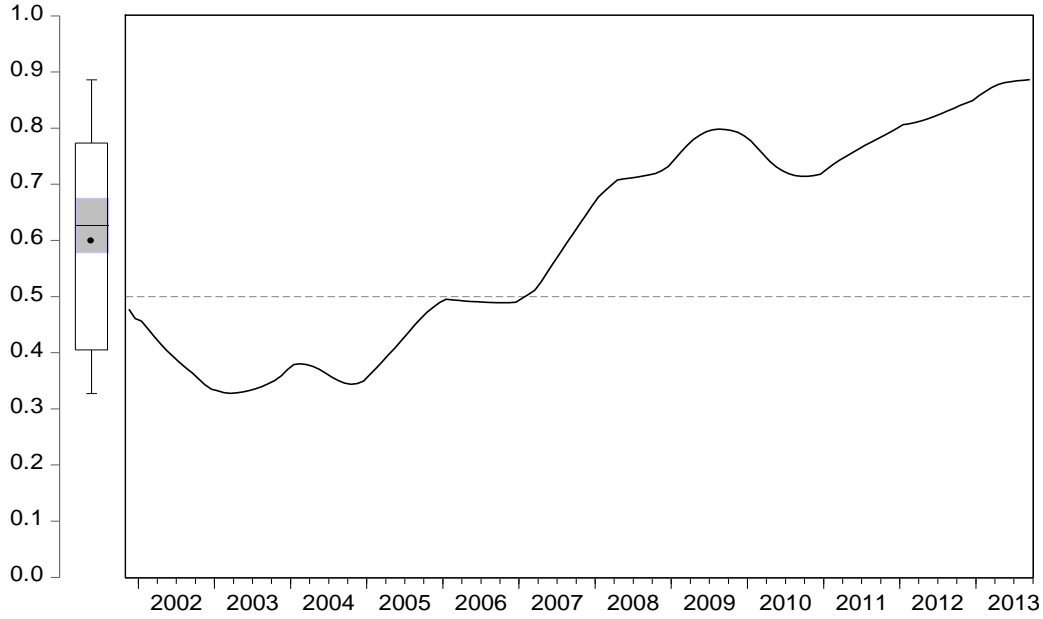
Figure 4 shows the fiscal credibility path over time. In a general way, after the problems due to the Brazilian presidential election in 2002, the index presents strong performance and after 2007 stabilizes around the maximum. As suggested by de Mendonça and Machado (2013), one reason for this good performance was a sound fiscal policy that implied a fall in the Treasury bond risk premium due to the increased investor confidence (Brazil received investment grade in May 2008).

Figure 4
Fiscal credibility



A possible doubt regarding the fiscal credibility is in regard to the limits used in the index. As a manner of giving robustness to the previous analysis, the result of fiscal credibility index is observed by changing the limits. With this purpose, the lower limit is reduced to 30% while the higher limit is increased to 70%. The performance of the adjusted fiscal credibility index ($CRED_{AF}$) is presented in figure 5. Such as observed for the $CRED_F$, the $CRED_{AF}$ path presents a positive trend confirming the previous result. However, through $CRED_{AF}$ path it is possible to see that the effect caused by subprime crisis was responsible for stopping the positive trend between 2009 and 2010.

Figure 5
Adjusted fiscal credibility



As found in most of the literature on the exchange rate pass-through for inflation, this study takes in to account external shocks based on Phillips curve.⁷ There is evidence that hybrid Phillips curve is most adequate to explain the Brazilian inflation behavior after adoption of inflation targeting. The justification for the use of this type of Phillips curve is that it is more appropriate to a transition environment where the public's expectations are not consolidated.⁸ It is important to highlight that in an environment of low credibility there exists a propensity to backward-looking behavior. On the other hand, when the credibility is high, public's inflation expectations converge to the target. In brief, both observed inflation and inflation expectations are relevant to an economy that needs to consolidate its credibility. Hence, the version of the Phillips curve in this study is based on the structural model adopted by CBB when inflation targeting was adopted in June of 1999 (see Bogdanski, Tombini, and Werlang, 2000). Therefore, the baseline model to observe the exchange rate pass-through for inflation is:

$$(3) \quad INF_t = \alpha_1 INF_{t-1} + \alpha_2 INF_{t-2} + \alpha_3 E_t(INF_{t+12}) + \alpha_4 GAP_{t-1} + \alpha_5 \Delta(WPI + EX)_t + \varepsilon_t,$$

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

INF_t - is the inflation accumulated in 12 months (measured by National Consumer Price Index (extended) – IPCA - official price index);

$E_t(INF_{t+12})$ – 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 GDP accumulated in the last 12 months (valuated by the IGP-DI in the month) and the potential output (Hodrick-Prescott filter);

WPI – is the wholesale price index (USA);

EX – is the exchange rate - United States dollar (purchase); and

$(WPI+EX)$ - considers the pass-through of exchange rate changes to domestic inflation.

⁷ See, for example: Goldfajn and Werlang (2000), Gagnon and Ihrig (2004), Choudhri and Hakura (2006), Correa and Minella (2010), Edwards (2006), Faruqee (2006), McCarthy (2007), Bouakez and Rebei (2008), Nogueira Jr. and Leon Ledesma (2009, 2011), Nogueira Jr. (2010), Takhtamanova (2010), Beirne and Bijsterbosch (2011), and An and Wang (2012).

⁸ See, for example: Tombini and Alves (2006), Areosa and Medeiros (2007), de Mendonça and Valerio (2010), and de Mendonça and Galveas (2013).

In the Brazilian case, both monetary and fiscal credibility are still in development. It is expected that high monetary credibility will protect inflation expectations from the effect caused by currency devaluations. In a similar way, high fiscal credibility implies that currency devaluations will not put in risk the public's expectations on the sustainability of the public debt and thus there is no influence on inflation expectations. Therefore, high credibility can avoid the exchange rate pass-through on inflation. With the intention of evaluating the effect caused by monetary and fiscal credibility on pass-through, the following models are considered:

$$(4) \quad \begin{aligned} INF_t = & \alpha_6 INF_{t-1} + \alpha_7 INF_{t-2} + \alpha_8 E_t(INF_{t+12}) + \alpha_9 GAP_{t-1} + \alpha_{10} \Delta(WPI + EX)_t \\ & + \alpha_{11} \Delta CRED_{Mt} [\Delta(WPI + EX)_t] + \varepsilon_t^a \end{aligned} ;$$

$$(5) \quad \begin{aligned} INF_t = & \alpha_{12} INF_{t-1} + \alpha_{13} INF_{t-2} + \alpha_{14} E_t(INF_{t+12}) + \alpha_{15} GAP_{t-1} + \alpha_{16} \Delta(WPI + EX)_t ; \quad \text{and} \\ & + \alpha_{17} \Delta CRED_{AFt} [\Delta(WPI + EX)_t] + \varepsilon_t^b \end{aligned}$$

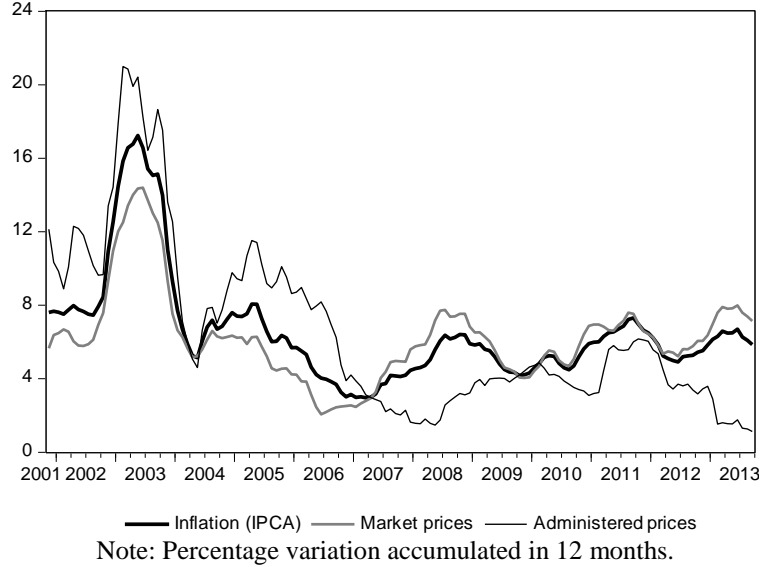
$$(6) \quad \begin{aligned} INF_t = & \alpha_{18} INF_{t-1} + \alpha_{19} INF_{t-2} + \alpha_{20} E_t(INF_{t+12}) + \alpha_{21} GAP_{t-1} + \alpha_{22} \Delta(WPI + EX)_t \\ & + \alpha_{23} \Delta CRED_{Mt} [\Delta(WPI + EX)_t] + \alpha_{24} \Delta CRED_{AFt} [\Delta(WPI + EX)_t] + \varepsilon_t^c \end{aligned}$$

Due to the fact that the Brazilian economy was hit by important shocks over the period, one other analysis is made taking into account the equations above also considering the presence of a dummy variable (*shocks*) which includes the two main shocks in the period. In specific: (i) the market instability due to the presidential election in late 2002 caused by the announcement that Luís Inácio Lula da Silva that would introduce important changes to the macroeconomic policy; and (ii) the effects from the subprime crisis that hit the economy in the last quarter of 2008. Hence, a dummy variable is introduced in the model and it assumes value "1" for the periods July 2002 to June 2003 and October 2008 to September 2009, and the value "0" otherwise.

It is important to highlight that the term $\Delta CRED_{it}$ (where i is M or AF) makes the coefficient of exchange rate pass-through for inflation dependent on the monetary credibility. In the case where the credibility is improving (score approaching 1), then the total pass-through coefficients $\alpha_{10} + \alpha_{11}$ (equation 4), $\alpha_{16} + \alpha_{17}$ (equation 5), and $\alpha_{22} + \alpha_{23} + \alpha_{24}$ (equation 6) is less than α_{10} , α_{16} , and α_{22} , respectively (assuming α_{11} , α_{17} , and $\alpha_{23} + \alpha_{24} < 0$). Contrary to this, when the credibility is worsening (score approaching 0), the total pass-through coefficient is greater than α_{10} , α_{16} , and α_{22} .

It is important to highlight that there is considerable difference in the behavior of the prices in the Brazilian economy (see figure 6). In a general way, the prices can be divided into market prices (prices defined by market force) or administered prices (prices defined by contracts and prices which are monitored depending on previous government authorization). Administered prices are slightly sensitive to the market forces, as for example energy prices.⁹ Furthermore, there is an inertial effect in administered prices due to the fact that contracts consider the past variation of price indices. As a consequence, it is important to evaluate if the observed effects due to exchange rate pass-through on inflation rate (full IPCA) are also observed for the case of inflation of market prices and administered prices. In this sense, equations (4), (5), and (6), including variations with dummy (shocks), are estimated for both market prices and administered prices as dependent variables, respectively.

⁹ Administered prices considered in the composition of IPCA are divided into tax, public utility services, and petroleum derivatives.

Figure 6*Inflation (IPCA), Market Prices, and Administered Prices (%)*

Based on the fact that inflation expectations have a fundamental role in an environment of inflation targeting, credibility can be an important mechanism for reducing the impact of exchange rate pass-through effect on inflation expectations. In this sense, an exercise is made as a manner of evaluating if the observed effects due to exchange rate pass-through on inflation are also observed for the case of inflation expectations. Therefore, equations (3), (4), (5), and (6) are rewritten for this purpose in the following manner:

$$(7) \quad E_t(INF_{t+12})_t = \beta_1 INF_{t-1} + \beta_2 INF_{t-2} + \beta_4 GAP_{t-1} + \beta_5 \Delta(WPI + EX)_t + \varepsilon_t^\beta;$$

$$(8) \quad E_t(INF_{t+12})_t = \beta_6 INF_{t-1} + \beta_7 INF_{t-2} + \beta_8 GAP_{t-1} + \beta_9 \Delta(WPI + EX)_t + \beta_{10} \Delta CRED_{Mt} [\Delta(WPI + EX)_t] + \varepsilon_t^d;$$

$$(9) \quad E_t(INF_{t+12})_t = \beta_{11} INF_{t-1} + \beta_{12} INF_{t-2} + \beta_{13} GAP_{t-1} + \beta_{14} \Delta(WPI + EX)_t + \beta_{15} \Delta CRED_{AFt} [\Delta(WPI + EX)_t] + \varepsilon_t^e; \quad \text{and}$$

$$(10) \quad E_t(INF_{t+12})_t = \beta_{16} INF_{t-1} + \beta_{17} INF_{t-2} + \beta_{18} GAP_{t-1} + \beta_{19} \Delta(WPI + EX)_t + \beta_{20} \Delta CRED_{Mt} [\Delta(WPI + EX)_t] + \beta_{21} \Delta CRED_{AFt} [\Delta(WPI + EX)_t] + \varepsilon_t^f.$$

In addition, such as made in the previous cases, the analysis regarding the pass-through effect on inflation expectations is also extended with the inclusion of the main shocks observed in the period (dummy *shocks*).

Taking into account the availability of information from CBB, the data in this study has monthly frequency for the period from November of 2001 to September of 2013 (143 observations - descriptive statistics are presented in table A.1 - appendix). As usual, the use of time series data in estimations demands the need to check whether the series have unit root (non-stationary data series) as a way of avoiding the possibility of spurious regression. Therefore, Augmented Dickey-Fuller (ADF), Dickey-Fuller Test with GLS Detrending (DF-GLS), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) are performed. The results reveal that all series are I(0) (see table A.2 – appendix).¹⁰

Due to the fact that the methods OLS and GMM allow one to see the statistical significance and the sign of each coefficient on each variable in the empirical model, they are used in order to make the estimations. As a consequence, it is easy, making use of these methods, to identify the

¹⁰ Taking into account the three tests, at least two indicate that the series under analysis is I(0).

pass-through effect on inflation.

Although OLS estimator is useful for our objectives it is largely well-known that the estimated coefficients are not reliable in the presence of serial autocorrelation, heteroskedasticity, or nonlinearity (see Greene, 1993). In particular, heteroskedasticity problem is common in macroeconomic time series and there is a risk of endogeneity problem when the credibility effects on pass-through are included in the Phillips curve models. Hence, the use of GMM estimator having overriding restrictions is a more efficient estimator than OLS (see Wooldridge, 2001). In this sense, all GMM estimations take into account the results from J-test as a manner of guaranteeing the validity of the overriding restrictions. Moreover, the instrument variables considered in the regressions are the lagged independent variables.

4. Empirical evidence

In a general way the coefficients on the variables in the estimations are in consonance with theoretical perspective. Both OLS and GMM estimations for all models in table 2 show that the coefficient on INF_{t-1} is positive and significant, and on INF_{t-2} is negative and significant. As a consequence, persistence of inflation (inertial effect) is not observed after the adoption of inflation targeting. This observation is confirmed with the fact that inflation expectations are relevant for explaining inflation (statistical significance in all models). Hence, the results are in line with the argument that the forward-looking behavior of economic agents is crucial for the success of inflation targeting. Furthermore, the focus on inflation is also detected. The coefficients on output gap are not significant, and thus indicate that the CBB is not contaminated with an inflation bias.

Regarding the exchange rate pass-through effect on inflation, the results in table 1 allow one to see that the coefficients on $\Delta(WPI+EX)$ are positive and have statistical significance for all models, and thus this effect cannot be neglected in the Brazilian economy. The possible benefits caused by a greater monetary credibility on the reduction of the pressure of exchange rate pass-through effect on inflation are not observed (coefficients without statistical significance and the sign is not clear). In contrast, although the coefficients on the fiscal credibility effect are not significant, the sign is negative for all models. This result suggests that the development of fiscal credibility can be an important ally to reduce the negative consequences due to the exchange rate pass-through.

In order to check if the results observed for the case of inflation (full) are also observed for the case of inflation of market prices (non-monitored prices) new estimations are presented in table 2. The sign of the coefficients of the variables present in the Phillips curve are in accordance with the theoretical view. The main difference in comparison with the case of inflation (full) is that inflation expectations are not significant and the output gap becomes significant for the case of inflation of market prices.

In specific for the exchange rate pass-through effect, different from the previous case (full inflation), statistical significance is not observed. Furthermore, one other point that cannot be neglected is due to the fact that in the case of inflation of market prices an increase in the monetary credibility (coefficient are negative for all models and there exists significance in GMM models) is a better mechanism than fiscal credibility (coefficients are not significant in any model and the sign is not clear) for mitigating the exchange rate pass-through effect.

Table 1
Estimates of the pass-through with credibility effects on inflation (full – IPCA)

Estimator	Without credibility effect				Monetary credibility effect				Fiscal credibility effect				Monetary and Fiscal credibility effect			
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<i>Constant</i>	-0.500** (0.213)	-0.269* (0.156)	-0.448** (0.204)	-0.283* (0.159)	-0.494** (0.214)	-0.322** (0.159)	-0.500** (0.209)	-0.326** (0.167)	-0.491** (0.231)	-0.314* (0.170)	-0.441** (0.221)	-0.215 (0.193)	-0.478** (0.236)	-0.336* (0.202)	-0.427* (0.226)	-0.281 (0.230)
<i>INF_{t-1}</i>	1.398*** (0.082)	1.596*** (0.114)	1.375*** (0.082)	1.565*** (0.120)	1.399*** (0.082)	1.543*** (0.109)	1.354*** (0.089)	1.474*** (0.101)	1.396*** (0.081)	1.496*** (0.100)	1.374*** (0.081)	1.482*** (0.099)	1.397*** (0.082)	1.541*** (0.114)	1.375*** (0.083)	1.537*** (0.115)
<i>INF_{t-2}</i>	-0.504*** (0.074)	-0.656*** (0.105)	-0.484 (0.073)	-0.636*** (0.109)	-0.505*** (0.075)	-0.616*** (0.098)	-0.472*** (0.077)	-0.560*** (0.093)	-0.503*** (0.074)	-0.573*** (0.092)	-0.483*** (0.073)	-0.558*** (0.091)	-0.503*** (0.074)	-0.611*** (0.103)	-0.483*** (0.073)	-0.609*** (0.103)
<i>E(INF_t)</i>	0.220*** (0.066)	0.117*** (0.045)	0.208*** (0.062)	0.126*** (0.045)	0.219*** (0.066)	0.139*** (0.049)	0.225*** (0.066)	0.152** (0.049)	0.218*** (0.070)	0.144*** (0.051)	0.206*** (0.066)	0.118** (0.055)	0.216*** (0.071)	0.137** (0.059)	0.204* (0.067)	0.123* (0.066)
<i>GAP_{t-1}</i>	7.09E-08 (3.05E-07)	1.63E-08 (2.70E-07)	2.20E-07 (3.22E-07)	1.11E-07 (2.92E-07)	1.06E-07 (3.08E-07)	-1.04E-07 (3.74E-07)	4.02E-07 (3.45E-07)	1.06E-07 (3.50E-07)	1.13E-07 (3.67E-07)	2.53E-07 (4.22E-07)	2.50E-07 (3.77E-07)	6.00E-07 (4.99E-07)	1.83E-07 (3.85E-07)	1.08E-07 (5.87E-07)	3.26E-07 (3.89E-07)	2.99E-07 (6.97E-07)
<i>Δ(WPI+EX)_t</i>	0.034** (0.015)	0.083** (0.034)	0.043*** (0.014)	0.108*** (0.039)	0.036** (0.015)	0.082** (0.040)	0.042*** (0.014)	0.077** (0.038)	0.039** (0.022)	0.095* (0.056)	0.048** (0.021)	0.137** (0.065)	0.045* (0.024)	0.140** (0.068)	0.054** (0.022)	0.173** (0.083)
<i>ΔCRED_{Mt}[Δ(WPI+EX)]_t</i>					0.112 (0.135)	-0.365 (0.548)	0.826 (0.612)	-0.283 (0.489)					0.146 (0.133)	0.108 (0.520)	-0.155 (0.146)	0.287 (0.579)
<i>ΔCRED_{AFt}[Δ(WPI+EX)]_t</i>									-1.159 (3.415)	-3.605 (7.064)	-0.872 (3.458)	-6.599 (7.288)	-1.852 (3.488)	-2.740 (7.978)	-1.608 (3.508)	-4.115 (8.601)
<i>Shocks</i>			0.164** (0.082)	0.155 (0.129)			0.165* (0.094)	0.156 (0.147)			0.163* (0.083)	0.242 (0.163)			0.164** (0.082)	0.180 (0.213)
<i>Adj. R²</i>	0.987	0.986	0.988	0.986	0.987	0.986	0.988	0.987	0.987	0.986	0.988	0.986	0.987	0.984	0.987	0.984
<i>J-statistic</i>		7.847		6.379		13.559		9.500		12.324		10.934		11.392		10.135
<i>P(J-statistic)</i>		0.727		0.783		0.330		0.576		0.420		0.449		0.411		0.429
<i>Inst. rank</i>		17		17		19		19		19		19		19		19

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust (White) standard errors are in parentheses. P(J-statistic) report the respective p-valued of the J-test.

Table 2
Estimates of the pass-through with credibility effects on inflation of market prices

Estimator	Without credibility effect				Monetary credibility effect				Fiscal credibility effect				Monetary and Fiscal credibility effect			
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<i>Constant</i>	1.131** (0.528)	1.725*** (0.433)	1.229** (0.541)	1.859*** (0.496)	1.080** (0.525)	1.667*** (0.479)	1.176** (0.539)	1.635*** (0.529)	1.166** (0.538)	2.023*** (0.588)	1.259** (0.555)	1.822*** (0.592)	1.080** (0.537)	1.964*** (0.487)	1.172** (0.554)	1.758*** (0.623)
<i>INF_{t-1}</i>	1.086*** (0.164)	0.987 (0.211)	1.043*** (0.167)	0.922*** (0.239)	1.077*** (0.160)	1.005*** (0.234)	1.036*** (0.164)	1.009*** (0.240)	1.080*** (0.165)	0.967*** (0.230)	1.038*** (0.168)	0.966*** (0.249)	1.077*** (0.161)	0.999*** (0.227)	1.036*** (0.165)	1.131*** (0.265)
<i>INF_{t-2}</i>	-0.438*** (0.151)	-0.363* (0.195)	-0.400** (0.155)	-0.305 (0.217)	-0.430*** (0.148)	-0.378* (0.203)	-0.394** (0.153)	-0.387* (0.209)	-0.432*** (0.151)	-0.316 (0.209)	-0.395** (0.155)	-0.335 (0.220)	-0.430*** (0.149)	-0.384* (0.197)	-0.394** (0.154)	-0.487** (0.227)
<i>E(INF_t)</i>	0.1634 (0.109)	0.092 (0.090)	0.140 (0.118)	0.072 (0.097)	0.171 (0.108)	0.085 (0.111)	0.148 (0.117)	0.095 (0.108)	0.156 (0.113)	0.001 (0.150)	0.134 (0.122)	0.076 (0.123)	0.171 (0.110)	0.056 (0.122)	0.149 (0.120)	0.083 (0.133)
<i>GAP_{t-1}</i>	4.52E-06** (1.88E-06)	5.24E-06 (1.59E-06)	4.80E-06 (1.97E-06)	5.47E-06*** (1.64E-06)	4.22E-06** (1.85E-06)	4.44E-06*** (1.57E-06)	4.50E-06* (1.94E-06)	4.43E-06*** (1.63E-06)	4.69E-06** (1.97E-06)	6.57E-06*** (2.03E-06)	4.94E-06** (2.04E-06)	4.86E-06*** (1.56E-06)	4.22E-06** (1.93E-06)	4.55E-06*** (1.52E-06)	4.48E-06** (2.00E-06)	4.02E-06** (1.68E-06)
<i>Δ(WPI+EX)_t</i>	-0.010 (0.071)	-0.142 (0.094)	0.008 (0.071)	-0.104 (0.120)	-0.029 (0.066)	-0.128 (0.087)	-0.011 (0.066)	-0.139 (0.104)	0.011 (0.085)	0.004 (0.176)	0.027 (0.088)	-0.140 (0.157)	-0.030 (0.073)	-0.189 (0.132)	-0.013 (0.078)	-0.231 (0.182)
<i>ΔCRED_{Mt}[Δ(WPI+EX)]_t</i>					-0.968 (0.756)	-2.845** (1.212)	-0.943 (0.746)	-3.213** (1.375)					-0.968 (0.801)	-3.498** (1.510)	-0.951 (0.780)	-3.819** (1.672)
<i>ΔCRED_{AFt}[Δ(WPI+EX)]_t</i>									-4.574 (9.298)	-6.890 (16.551)	-4.040 (9.195)	-0.204 (15.909)	0.040 (9.939)	1.299 (23.062)	0.479 (9.675)	-0.474 (24.756)
<i>Shocks</i>			0.307 (0.308)	0.267 (0.438)			0.295 (0.310)	-0.001 (0.441)			0.303 (0.308)	0.027 (0.505)			0.295 (0.309)	-0.486 (0.616)
<i>Adj. R²</i>	0.863	0.852	0.863	0.853	0.865	0.847	0.865	0.842	0.862	0.853	0.863	0.849	0.863	0.830	0.864	0.816
<i>J-statistic</i>		14.013		13.520		14.206		14.611		13.219		14.062		14.100		13.849
<i>P(J-statistic)</i>		0.232		0.200		0.288		0.201		0.353		0.230		0.228		0.180
<i>Inst. rank</i>		17		17		19		19		19		19		19		19

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses. P(J-statistic) report the respective p-valued of the J-test.

Besides the analysis on inflation of market prices we make the estimations considering the case of inflation measured by administered prices (monitored prices). The results in table 3 reveal that the coefficients on inflation and inflation expectations do not present a considerable difference from those observed for inflation of market prices. Contrary to the previous case, the coefficients on output gap are positive and significant. A possible explanation for this observation is that monitored prices are subject to some control by the Brazilian federal government through important corporations such as Petrobras (semi-public Brazilian multinational energy) and Eletrobras (government owns more than 50%). In other words, the Brazilian federal government is using administered prices to control inflation.

Putting the focus on the exchange rate pass-through effect, the case of inflation of administered prices is near that observed for full inflation (although coefficients are not significant for all models, the sign of them are positive). A justification for the sensitivity of administered prices caused by the pass-through is a consequence that some prices are indexed to the General Price Index (IGP). This price index is more sensitive to the variation of exchange rate than to IPCA. Moreover, the results observed for full inflation are also valid when monetary and fiscal credibility are considered in the model. In brief, although monetary credibility is not significant for reducing the pass-through effect, fiscal credibility can be an important tool for controlling the pressure on inflation of administered prices.

The results regarding the estimations for inflation expectations indicate that both past inflation and output gap are significant in the explanation of the inflation expectations (see table 4). Furthermore, the exchange rate pass-through cannot be neglected (all coefficients are positive and in half the models there is statistical significance). Such as observed for the case of full inflation, the monetary credibility is not an efficient mechanism for reducing the pressure of an increase in the exchange rate pass-through on inflation expectations (coefficients without statistical significance and there is indetermination on the sign). In contrast, the fiscal credibility (coefficients are negative and significant for all models) is revealed to be a powerful instrument for reducing the increase in inflation expectations due to the exchange rate pass-through effect.

Table 3
Estimates of the pass-through with credibility effects on inflation of administered prices

Estimator	Without credibility effect				Monetary credibility effect				Fiscal credibility effect				Monetary and Fiscal credibility effect			
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<i>Constant</i>	-3.404** (1.396)	-5.000*** (1.179)	-3.402** (1.431)	-4.717*** (1.193)	-3.275** (1.390)	-4.211*** (1.137)	-3.262** (1.425)	-3.967*** (1.152)	-3.409** (1.441)	-4.349*** (1.409)	-3.406** (1.484)	-3.603** (1.615)	-3.168** (1.448)	-4.618*** (1.353)	-3.159** (1.494)	-4.313*** (1.259)
<i>INF_{t-1}</i>	1.838*** (0.433)	2.718*** (0.565)	1.837*** (0.451)	2.566*** (0.577)	1.861*** (0.430)	2.806*** (0.536)	1.855*** (0.452)	2.538*** (0.622)	1.839*** (0.428)	3.335*** (0.920)	1.837*** (0.450)	3.359*** (1.034)	1.847*** (0.425)	2.691*** (0.610)	1.843*** (0.451)	2.438*** (0.646)
<i>INF_{t-2}</i>	-0.541 (0.350)	-1.340** (0.515)	-0.540 (0.372)	-1.211** (0.521)	-0.563 (0.346)	-1.429*** (0.511)	-0.558 (0.371)	-1.196** (0.586)	-0.542 (0.347)	-1.863** (0.791)	-0.541 (0.372)	-1.848** (0.873)	-0.548 (0.343)	-1.327** (0.552)	-0.544 (0.373)	-1.092* (0.587)
<i>E(INF_t)</i>	0.256 (0.364)	0.448 (0.271)	0.255 (0.381)	0.393 (0.255)	0.237 (0.364)	0.337 (0.232)	0.234 (0.380)	0.291 (0.236)	0.257 (0.379)	0.190 (0.404)	0.256 (0.397)	-0.065 (0.454)	0.215 (0.381)	0.399 (0.328)	0.213 (0.398)	0.335 (0.294)
<i>GAP_{t-1}</i>	-9.71E-06** (4.69E-06)	-1.53E-05*** (4.49E-06)	-9.70E-06* (5.02E-06)	-1.44E-05*** (4.77E-06)	-8.94E-06* (4.61E-06)	-1.47E-05*** (4.64E-06)	-8.90E-06* (4.98E-06)	-1.40E-05*** (5.20E-06)	-9.73E-06* (5.03E-6)	-1.53E-05*** (4.59E-06)	-9.72E-06* (5.35E-06)	-1.38E-05*** (4.76E-06)	-8.43E-06* (4.94E-06)	-1.35E-05*** (4.67E-06)	-8.40E-06 (5.33E-06)	-1.33E-05*** (4.68E-06)
<i>Δ(WPI+EX)_t</i>	0.148 (0.147)	0.387 (0.239)	0.149 (0.165)	0.467* (0.274)	0.198 (0.142)	0.472** (0.237)	0.200 (0.159)	0.565* (0.299)	0.146 (0.190)	0.500 (0.410)	0.146 (0.211)	0.584 (0.483)	0.258 (0.176)	0.643 (0.391)	0.260 (0.199)	0.620** (0.038)
<i>ΔCRED_{Mt}[Δ(WPI+EX)]_t</i>					2.481 (1.524)	4.182 (2.887)	2.484 (1.532)	3.900 (3.034)					2.702 (1.645)	5.895 (3.560)	2.704 (1.660)	5.234 (3.235)
<i>ΔCRED_{AFt}[Δ(WPI+EX)]_t</i>									0.580 (27.382)	-37.019 (56.934)	0.596 (27.039)	-18.053 (66.745)	-12.296 (28.796)	-27.373 (59.152)	-12.250 (28.518)	-28.880 (52.643)
<i>Shocks</i>			0.009 (0.940)	0.506 (1.011)			0.040 (0.946)	0.958 (1.121)			0.009 (0.937)	1.375 (1.478)			0.031 (0.937)	1.042 (1.121)
<i>Adj. R²</i>	0.751	0.722	0.750	0.721	0.754	0.723	0.752	0.719	0.749	0.703	0.747	0.690	0.753	0.714	0.751	0.714
<i>J-statistic</i>		11.228		11.250		13.408		13.066		11.509		10.873		11.796		11.561
<i>P(J-statistic)</i>		0.424		0.338		0.340		0.289		0.486		0.454		0.379		0.316
<i>Inst. rank</i>		17		17		19		19		19		19		19		19

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses. P(J-statistic) report the respective p-valued of the J-test.

Table 4
Estimates of the pass-through with credibility effects on inflation expectations

Estimator	Without credibility effect				Monetary credibility effect				Fiscal credibility effect				Monetary and Fiscal credibility effect			
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
<i>Constant</i>	3.192*** (0.344)	3.080*** (0.210)	3.229*** (0.327)	3.066*** (0.210)	3.202*** (0.343)	3.263*** (0.239)	3.240*** (0.327)	3.195*** (0.303)	3.237*** (0.328)	3.180*** (0.247)	3.269*** (0.315)	3.260*** (0.260)	3.266*** (0.323)	3.098*** (0.279)	3.297*** (0.311)	3.197*** (0.271)
<i>INF_{t-1}</i>	1.198** (0.466)	1.346*** (0.380)	1.083*** (0.408)	1.358*** (0.429)	1.198** (0.466)	1.576*** (0.314)	1.083*** (0.407)	1.387*** (0.434)	1.136** (0.467)	0.921*** (0.308)	1.033** (0.415)	0.818** (0.367)	1.126** (0.462)	0.814*** (0.294)	1.023*** (0.410)	0.787** (0.303)
<i>INF_{t-2}</i>	-0.869* (0.441)	-1.013*** (0.375)	-0.774** (0.392)	-1.047** (0.424)	-0.869* (0.441)	-1.269*** (0.307)	-0.775** (0.391)	-1.093** (0.446)	-0.814* (0.441)	-0.604* (0.307)	-0.730* (0.397)	-0.521 (0.348)	-0.807* (0.438)	-0.492* (0.292)	-0.723*** (0.394)	-0.475 (0.302)
<i>GAP_{t-1}</i>	3.00E-06** (1.24E-06)	1.65E-06* (9.83E-07)	3.33E-06** (1.31E-06)	1.92E-06 (1.23E-06)	3.09E-06** (1.25E-06)	1.81E-06* (1.01E-06)	3.44E-06** (1.33E-06)	1.54E-06 (1.29E-06)	3.59E-06*** (1.31E-06)	4.69E-06*** (1.54E-06)	3.86E-06*** (1.37E-06)	4.35E-06*** (1.53E-06)	3.89E-06*** (1.34E-06)	3.98E-06*** (1.08E-06)	4.16E-06*** (1.41E-06)	3.86E-06*** (1.09E-06)
<i>Δ(WPI+EX)_t</i>	0.040 (0.041)	0.056 (0.070)	0.069 (0.053)	0.118 (0.093)	0.046 (0.044)	0.073 (0.058)	0.076 (0.056)	0.029 (0.089)	0.125** (0.057)	0.633*** (0.168)	0.145** (0.061)	0.567*** (0.175)	0.154** (0.059)	0.490*** (0.121)	0.174** (0.062)	0.476*** (0.126)
<i>ΔCRED_{Mt}[Δ(WPI+EX)]_t</i>					0.329 (0.408)	0.910 (0.753)	0.359 (0.390)	-2.435 (2.143)					0.717 (0.436)	-2.383 (1.636)	0.719 (0.444)	-1.878 (1.586)
<i>ΔCRED_{Aft}[Δ(WPI+EX)]_t</i>									-19.014** (7.965)	-95.084*** (24.484)	-17.543** (8.395)	-82.095*** (29.849)	-22.220** (8.625)	-78.486*** (19.799)	-20.757** (8.935)	-76.531*** (24.063)
<i>Shocks</i>			0.496 (0.429)	0.556 (0.449)			0.499 (0.430)	0.628 (0.606)			0.465 (0.423)	0.193 (0.676)			0.465** (0.422)	-0.012 (0.538)
<i>Adj. R²</i>	0.675	0.674	0.686	0.669	0.674	0.651	0.684	0.610	0.683	0.510	0.692	0.559	0.685	0.468	0.693	0.501
<i>J-statistic</i>		15.170		13.459		14.278		11.643		7.990		7.416		7.120		7.073
<i>P(J-statistic)</i>		0.126		0.143		0.113		0.168		0.535		0.493		0.714		0.630
<i>Inst. rank</i>		15		15		15		15		15		15		17		17

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Robust (Newey-West) standard errors are in parentheses. P(J-statistic) report the respective p-valued of the J-test.

5. Conclusion

This study presented empirical evidence regarding the exchange rate pass-through effect on inflation in the Brazilian economy after the adoption of the inflation targeting. In general, the results are in line with most part of the literature indicating that the pass-through effect is important in the explanation of the inflation rate.¹¹

The main contribution in this study was the evaluation of the impact of the fiscal and monetary credibility in the transmission mechanism of the pass-through on inflation. The findings denote that although monetary credibility is not an efficient tool for reducing the effects from pass-through effect, the possibility of benefits from fiscal credibility cannot be ruled out. Furthermore, the results from the cases of inflation of market prices and administered prices are different. While monetary credibility is relevant for the case of market prices, fiscal credibility matters for administered prices. A possible reason for this result is that the success of the CBB in achieving the inflation target is important to guide market's expectations. Regarding administered prices, the government's role is important, as a consequence, fiscal solvency is a possible ally for attenuating the transmission of exchange-rate pass-through. Finally, the results also reveal that fiscal credibility is an important tool for reducing the impact of the exchange rate pass-through effect on inflation expectations.

The empirical evidence in this study is one more contribution that indicates credibility is an important tool for increasing the efficiency of the monetary policy under inflation targeting. In other words, due to the fact that high credibility helps to mitigate the exchange rate pass-through effect, a consequence is a better control on inflation with lower social cost. As observed by Svensson (2000) and Céspedes and Soto (2005), the trade-off between inflation and output – and potentially exchange rate volatility – is larger under imperfect credibility. Although the effect of monetary credibility reducing the pass-through is relevant only for market prices, it is important to highlight that a government committed to a sustainable public debt, and thus one which has fiscal credibility, is significant to reduce the pass-through effect on inflation expectations and thereby on inflation.

6. References

- ABP - Federal Public Debt: Annual Borrowing Plan (2012). National Treasury Secretariat, N. 12, Brasília.
- Agénor, P., Taylor, M.P. (1992) "Testing for credibility effects." *IMF Staff Papers*, 39 (3), 545–71.
- Agénor, P., Taylor, M.P. (1993) "Analysing credibility in high-inflation countries: a new approach." *Economic Journal*, 103(417), 329–36.
- An, L., Wang, J. (2012) "Exchange Rate Pass-Through: Evidence Based on Vector Autoregression with Sign Restrictions." *Open Economic Review*, 23(2), 359–80.
- Angeletos, G. (2002). "Fiscal policy with non-contingent debt and the optimal maturity structure" *Quarterly Journal of Economics*, 117 (2002), 1105-1131.
- Areosa, W. D., Medeiros, M. (2007) "Inflation Dynamics in Brazil: The Case of a Small Open Economy." *Revista de Econometria*, 27(1), 131-66.
- Batini, N., Tereanu, E. (2010) "Inflation targeting during asset and commodity price booms." *Oxford Review of Economic Policy*, 26(1), 15–35.
- Beirne, J., Bijsterbosch, M. (2011) "Exchange rate pass-through in central and eastern

¹¹ See, for example, Calvo and Reinhart (2002) and Choudhri and Hakura (2006).

- European EU Member States.” *Journal of Policy Modeling*, 33(2), 241–54.
- Bogdanski, J., Tombini, A.A., Werlang, S.R.C. (2000) “Implementing Inflation Targeting in Brazil” (in) *Inflation Targeting in Brazil*, Central Bank of Brazil.
- Bouakez, H., Rebei, N. (2008) “Has exchange rate pass-through really declined? Evidence from Canada.” *Journal of International Economics*, 75(2), 249–67.
- Calvo, G. (1988) “Servicing the Public Debt: The Role of Expectations” *American Economic Review* 78(4), 647-661.
- Calvo, G., Reinhart, C.M. (2002), “Fear of Floating.” *Quarterly Journal of Economics*, 117(2), 379-408.
- Cecchetti, S.G., Krause, S. (2002) “Central bank structure, policy efficiency and macroeconomic performance: exploring empirical relationships.” *Review*, Federal Reserve Bank of St. Louis, 84 (4), 47-59.
- Céspedes, L.F., Soto, C. (2005). “Credibility and Inflation Targeting in an Emerging Market: the case of Chile.” *Central Bank of Chile working paper*, 312.
- Choudhri, E.U., Hakura, D.S. (2006) “Exchange rate pass-through to domestic prices: Does the inflationary environment matter?” *Journal of International Money and Finance*, 25(4), 614-39.
- Correa, A.S., Minella, A. (2010) “Nonlinear Mechanisms of the Exchange Rate Pass-Through: A Phillips curve model with threshold for Brazil.” *Revista Brasileira de Economia*, 64(3), 231-43.
- Cukierman, A., Meltzer, A.H. (1986) “A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information.” *Econometrica*, 54(5), 1099-128.
- de Mendonça, H. F. (2007) “Towards credibility from inflation targeting: the Brazilian experience.” *Applied Economics*, 39(19-21), 2599–615.
- de Mendonça, H. F., de Guimarães e Souza, G.J. (2009) “Inflation targeting credibility and reputation: the consequences for the interest rate.” *Economic Modelling*, 26(6), 1228-38.
- de Mendonça, H.F., Galveas, K.A. (2013) “Transparency and inflation: What is the effect on the Brazilian economy?” *Economic Systems*, 37(1), 69-80.
- de Mendonça, H.F., Machado, M. R. (2013) “Public debt management and credibility: Evidence from an emerging economy.” *Economic Modelling* 30(1), 10-21.
- de Mendonça, H.F., Valerio, D. (2010) “What Kind of Phillips Curve Works in the Brazilian Inflation Targeting?” *Empirical Economics Letters*, 9(8), 803-09.
- Drudi, F., Giordano, R. (2000), “Default Risk and Optimal Debt Management”, *Journal of Banking and Finance*, 24(6), 861-891.
- Edwards, S. (2006) “The Relationship Between Exchange Rates and Inflation Targeting Revisited.” *NBER Working Paper*, 12163.
- Eichengreen, B. (2002) “Can Emerging Markets Float? Should They Inflation Target?” *Central Bank of Brazil Working Paper Series*, 36.
- Faraglia, E., Marcet, A., Scott, A. (2008). “Fiscal Insurance and Debt Management in OECD Economies.” *Economic Journal*, 118(527), 363-386.
- Faruqee, H. (2006) “Exchange Rate Pass-Through in the Euro Area.” *IMF Staff Papers*, 53(1), 63-88.
- Gagnon, J.E., Ihrig, J. (2004) “Monetary Policy and Exchange Rate Pass-through.” *International Journal of Finance and Economics*, 9(4), 315–38.
- Giannellis, N., Koukouritakis, M. (2013) “Exchange rate misalignment and inflation rate persistence: Evidence from Latin American countries.” *International Review of Economics and Finance*, 25(1), 202–18.

- Giavazzi, F., Missale, A. (2004), "Public Debt Management in Brazil", *NBER Working Paper* 10394, March.
- Giavazzi, F., Pagano, M. (1990), "Indexation and Maturity of Government Bonds," in Dornbusch, R and Draghi, M (eds.), *Public Debt Management: Theory and History*, Cambridge University Press: Cambridge, 52–93.
- Goldfajn, I., Werlang, S.R.C. (2000) "The Pass-through from Depreciation to Inflation: A Panel Study." *Central Bank of Brazil Working Paper Series*, 5.
- Greene, W.H. (1993). *Econometric Analysis*, 5.ed. New Jersey: Prentice Hall.
- Lloyd-Ellis, H., Zhu, X. (2001). "Fiscal shocks and fiscal risk management." *Journal of Monetary Economics*, 48(2), 309-338.
- McCarthy, J. (2007) "Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies." *Eastern Economic Journal*, 33(4), 511-37.
- Mehl, A., Reynaud, J. (2010). "Risky Public Domestic Debt Composition in Emerging Economies," *Journal of International Money and Finance*, Elsevier, 29(1), 1-18.
- Minella, A., de Freitas, P.S., Goldfajn, I., Muinhos, M.K. (2003). "Inflation Targeting in Brazil: Constructing Credibility under Exchange Rate Volatility." *Journal of International Money and Finance*, 22(7), 1015-1040.
- Mishkin, F. (2000). "Inflation Targeting in Emerging-Market Countries." *American Economic Review*, 90(2), 105-109.
- Mishkin, F., Savastano, M.A. (2001) "Monetary Policy Strategies for Latin America." *Journal of Development Economics*, 66(2), 415-44.
- Nogueira Jr., R. (2010). "Inflation Environment and Lower Exchange Rate Pass-Through in Brazil: Is There a Relationship?" *Revista Brasileira de Economia*, 64(1), 49-56.
- Nogueira Jr., R. (2007). "Inflation targeting and exchange rate pass-through" *Economia Aplicada*, 11(2), 189-208.
- Nogueira Jr., R., León-Ledesma, M.A. (2009). "Fear of Floating in Brazil: Did Inflation Targeting matter?" *North American Journal of Economics and Finance*, 20(3), 255-66.
- Nogueira Jr., R., León-Ledesma, M.A. (2011) "Does Exchange Rate Pass-Through Respond to Measures of Macroeconomic Instability?" *Journal of Applied Economics* 14(1), 167-180.
- Odria, L.R.M., Castillo, P., Rodriguez, G. (2012). "Does the exchange rate pass-through into prices change when inflation targeting is adopted? The Peruvian Case Study between 1994 and 2007." *Journal of Macroeconomics*, 34(4), 1154-1166.
- Reyes, J. (2007) "Exchange Rate Passthrough Effects and Inflation Targeting in Emerging Economies: What is the Relationship?" *Review of International Economics*, 15(3), 538-559.
- Sargent, T.J. (1994) "Rational expectations and the reconstruction of macroeconomics." In: Miller, P. J. *The rational expectations revolution: readings from the front line*. MIT Press.
- Schmidt-Hebbel, K., Werner, A. (2002) "Inflation Targeting in Brazil, Chile, and Mexico: Performance, Credibility, and the Exchange Rate." *Central Bank of Chile working paper*, 171.
- Silva, A.C., Carvalho, L.O., Medeiros, O.L. (2010). *Public debt: the Brazilian experience*. Brasilia: National Treasury; World Bank.
- Svensson, L.E.O. (2000). "How should monetary policy be conducted in an era of price stability?" *NBER Working Paper*, 7516.
- Svensson, L.E.O. (1993). "The Simplest Test of Inflation Target Credibility." *NBER*

Working Paper, 4604.

Takhtamanova, Y.F. (2010) “Understanding changes in exchange rate pass-through” *Journal of Macroeconomics*, 32(4), 1118-30.

Tombini, A.A., Alves, S.A.L. (2006) “The recent Brazilian disinflation process and costs.” *Central Bank of Brazil Working Paper Series*, 109.

WOOLDRIDGE, J.M. (2001) “Applications of Generalized Method of Moments Estimation.” *Journal of Economic Perspectives*, 15(4), 87-100.

Appendix

Table A.1
Descriptive statistics

Variables	Mean	Median	Maximum	Minimum	Std. Dev.
<i>INF</i>	6.562	6.010	17.240	2.960	2.967
<i>INFL</i>	6.241	6.060	14.400	2.060	2.452
<i>INFM</i>	6.580	4.720	20.990	1.130	4.646
<i>E(INF)</i>	5.354	5.221	12.476	3.437	1.495
<i>GAP</i>	1.22E-07	-2,995.0	148,697.7	-224,734.3	77,064.79
$\Delta(WPI+EX)$	0.330	0.465	3.572	-6.327	1.451
$\Delta CRED_M \Delta(WPI+EX)$	-0.224	-0.010	0.753	-0.558	0.132
$\Delta CRED_{AF} \Delta(WPI+EX)$	0.002	3.56E-5	0.044	-0.029	0.011

Table A.2
Unit root tests (ADF, DF-GLS, and PP)

Series	ADF		DF-GLS		KPSS	
	Lags	Test	Lags	Test	Band	Test
<i>INF</i>	1	-3.29	1	-3.23	9	0.19
<i>INFL</i>	1	-3.17	1	-3.17	9	0.17
<i>INFM</i>	3	-3.17	1	-3.05	9	0.18
<i>E(INF)</i>	3	-3.45	3	-3.38	9	0.20
<i>GAP</i>	3	-5.11	3	-5.14	9	0.03
$\Delta(WPI+EX)$	4	-5.60	1	-4.84	5	0.03
$\Delta CRED_M \Delta(WPI+EX)$	3	-6.70	1	-5.65	6	0.05
$\Delta CRED_{AF} \Delta(WPI+EX)$	3	-4.16	3	-3.13	7	0.08

Note: Trend and intercept are included. ADF critical value (10%) is -3.15. DF-GLS critical value (10%) is -2.70. KPSS critical value (10%) is 0.12. ADF and DF-GLS – the final choice of lag was made based on Akaike criterion. KPSS tests – spectral estimation method is Bartlett kernel and the Newey West Bandwidth is used.