Influence of Exchange Variation and Demand Conditions in the Determination of IPCA in Brazil (1999 -2011)

Erica Oliveira Gonzales, Allan Silveira dos Santos and Eliane Cristina Araújo

Abstract: The objective of this paper is analyzing the exchange rate pass-through in Brazil and the importance of demand pressures on prices in the period after the implementation of the inflation-targeting regime. The methodology used was the Vector Error Correction Model (VECM), between the periods January 1999 to May 2011. The results show a high degree of inertia in both periods. Furthermore, show that neglecting the inertia, the exchange was the main determinant of price variation in the first period, while in the second period the main causes of inflationary pressures were demand pressures.

Keywords: Pass-through, exchange rate, VECM, demand pressures, transmission mechanism

JEL classification: E31, E37, F31

1. Introduction

With the introduction of Plano Real, in 1994, the exchange rate anchor was essential for controlling the prices, but in 1999 it was necessary to let the exchange rate fluctuate due to the reduction of international reserves, caused by a currency crisis in the period. Thereafter, with the new exchange rate policy, it was necessary to find another measure to guarantee the control of inflation, emerging thus the inflation targeting regime (ITR). Despite the change in monetary regime, the exchange has fulfilled a major role in price control, which justifies the present research.

The knowledge about the evolution of price indices and the sources of this evolution is of utmost importance for the monetary authority, since when distinguished the causes of changes in prices it is possible to shape the conduct of monetary policy in a more specific way, providing thus that inflationary sources are tackled with greater precision and ease. Accordingly, the following question comes up: why is it necessary to find out the main causes of inflation in a given period? Because such knowledge allows a better use of the tools that are needed to control prices. Finding out the real factors that influence the price dynamics reduces a possible bias of conducting the monetary policy. The reduction of this bias helps to overcome limitations in controlling inflation, generated by the incorrect use of monetary policy instruments.

Given this, this research aimed to analyze the importance of the exchange rate for pricing, as well as to verify the importance of demand pressures on inflation. This study is developed by a variance decomposition analysis of the prediction error obtained through an error correction model (VEC) in the period after implementing the inflation targeting regime in June 1999. Besides analyzing the entire period, from July 1999 to May 2011, the sample was split into two subperiods in order to capture the change in trend in the exchange rate series, the first subperiod between July 1999 and December 2002 and the second between January 2003 and May 2011.

The division of periods was made in order to check a possible symmetry in the price adjustment process due to variations in the exchange rate in two situations. In the first subperiod wherein is verified an exchange rate depreciation, and the second in which the process is reversed and there is a tendency of
appreciation of the Real against the U.S. dollar. In this way, the present study sought to respond the following questions: even with the adoption of inflation targeting regime, the exchange has been the factor responsible for the variation of prices in the Brazilian economy, i.e., what is the importance of this channel of monetary transmission to combat inflation? What is the impact of aggregate demand on the price level in Brazil?

The results indicate that from July 1999 to December 2002, the exchange was the main factor determining the price level. However between 2003 and 2011, demand conditions stood out as the main determinant. Moreover, results showed that great part of variations of prices in all periods was explained by the inflationary inertia. The study is divided into 5 sections. Beyond this introduction, contains a short theoretical framework. The section 3 presents data used and the econometric model. In section 4 is presented the analysis of results. Finally the last topic presents the final considerations.

2. Theoretical Framework

In the 1990s, countries like New Zealand, Canada, Australia, Finland and Spain adopted the ITR (Svenson 1998). Brazil was no different. The ITR established in 1999 aimed to make public the inflation target to be achieved in a given period, that is, the maximum value determined by the National Monetary Council (NMC) and objectified by the Central Bank with tolerance intervals, and this target may or not be met. In Brazil, as a parameter to represent inflation it was adopted annual variations of the Broad Consumer Price Index (IPCA), calculated by the Brazilian Institute of Geography and Statistics (IBGE).

Since the adoption of the flexible exchange rate regime in the country, several studies on the exchange have shown a great contribution, an evidence of the concern in monitoring the exchange situation and mainly in examining the impacts of the exchange rate on prices, domestic or not. As example of some of these works it is mentioned: Belaisch (2003), Minella et al (2003), Minella and Correia (2005) and Araújo and Modenesi (2010), which are not the only ones, though of great influence to the construction of this study. In some studies the pass-through was calculated for the national product, as Woo (1984), Feinberg (1986, 1989) and Parsley and Popper (1998).

2.1. Transmission Channels

Transmission channels are considered the means used to introduce monetary policy into the economy, i.e., the way to convey the instruments of monetary policy with ultimate goals, not always similar. It is important to know the functioning of these channels, and identify which one is activated when there is a policy shock. The most usually studied mechanisms of monetary transmission are channels of exchange, asset prices, interest rates and credit, however, Minella and Souza (2009) studied another one, the expectations channel. Here is analyzed only the channel of exchange, given the purpose of investigating the importance of this variable as a monetary transmission mechanism.

2.2. The Channel of Exchange

In recent years, the exchange rate has assumed an important role, especially with the emergence of flexible exchange rates and the internationalization of economies. Minella and Souza (2009) explain that the channel of exchange also includes effects of the interest rate because as the domestic interest rate is high (or low), considering a flexible exchange rate regime, this can encourage (or discourage) capital inflows into the country, appreciating (depreciating) exchange rate, which in turn, generates impact on imports, exports and inflation. The exchange can modify the prices of domestic goods and affect the price of foreign inputs and final products. It can also affect the composition and the level of aggregate demand
and wages, which is consequence of loss or gain of competitiveness of domestic products abroad. Below is presented an overview of how the exchange rate can affect the final prices to consumer.

Figure 1 – Effects of exchange rate depreciation

Source: Figueiredo and Gouveia (2009)

Nevertheless, the way in which changes in exchange rates are passed on to the consumer depends on the degree of openness of the economy and types of products analyzed. In general, prices to final consumers are not altered in the same magnitude of variations of the exchange rate. Prices of imported products have a higher exchange rate pass-through coefficient, e.g., compared with prices of final goods and services to the consumer. The pass-through coefficient is also determined by the degree of elasticity between imported goods and those domestically produced.

The validity of the Absolute and Relative Purchasing Power Parity for the relationship between exchange and prices implies that given depreciation in the exchange rate, prices should rise in the same proportion to restore the parity, so that the exchange rate pass-through tends to be completed. However as noticed by Rogoff (1996), many researchers have tested and rejected the Law of One Price for a variety of products and countries, using different data sources and methods.

Among the possible obstacles that prevent the arbitrage in the goods market to force an approximation of prices in the international market, which implies the existence of incomplete exchange rate pass-through, Rogoff (1996) emphasizes the following factors: transportation costs, the existence of goods that although highly tradable contain significant non-tradable components, the existence of tariffs and non-tariff barriers to imports, the heterogeneity of tradable goods, price discrimination in the international market.

This impact generated by the exchange was identified by Belaish (2003) who estimates a shock in the exchange rate to inflation and found a reduction of exchange rate pass-through for Brazil between June 1999 and December 2002. Correa and Minella (2005) verified non-linear mechanisms in the exchange rate pass-through to prices and identified that the short term pass-through is higher when the economy is expanding, while the exchange rate has low volatility and when its depreciation is greater. Araújo and Modenesi (2010) examined the importance of the external sector in the evolution of IPCA and observed
that the impact of the exchange rate pass-through coefficient was significantly higher than the impact of the aggregate demand on the IPCA.

3. Database and Econometric Model

As in the work of Modenesi and Araújo (2010), herein is considered that inflation is determined by three Macroeconomic conditions: i) aggregate demand; ii) aggregate supply; and iii) exchange rate. It is considered that Brazil is a country with an open economy, justifying the exchange as an explanatory variable in determining prices. To estimate the model, it was used the following variables:

- Broad Consumer Price Index (IPCA), from the Brazilian Institute of Geography and Statistics (IBGE), as well as its decompositions: Broad consumer tradable goods price indices (IPCAC), Broad consumer non-tradable goods price indices (IPCANC), Broad consumer administered goods price indices (IPCAAD);
- Index of Real Demand (DREAL), used as proxy for the behavior of aggregate demand;
- Commodity Price index (IC), formulated by the Brazilian Institute of Applied Economic Research (IPEA) and used as proxy for supply conditions;
- Average exchange rate real/dollar (TXC), provided by BCB.

The proxy for the behavior of aggregate demand is the variable that was called real demand - DREAL, this is an adaptation over the original model found in Araújo and Modenesi (2010). In their study, the proxy used to represent the aggregate demand was the industrial production index. The variable DREAL was constructed based on the hypothesis that the amount of money in the economy is the factor determining demand conditions. However, the increased amount of currency may be necessary when the product level increases, not meaning thus increased demand. It was considered increase of aggregate demand when the increase in the amount of currency was greater than the increase in the amount of product, measured by the industrial production index – IND provided by IBGE. The variable M1 is the amount of money at the end of each month, and is provided by the BCB. Thus series were transformed into index and the variable DREAL is the division of the currency index by the industrial production index, so this division represents how much the amount of money increased without a consequent increase in output, indicating an increase in aggregate demand, i.e.:

\[
DREAL = \frac{M1}{IND}
\]

In relation to the treatment of the data used in the study, all series were transformed into indices employed. Then, we chose to work with logarithm values. The data are monthly and models are estimated for three different periods. The graph 1 depicts the change in trend of the exchange rate, justifying the division of periods of the present study. Separating the full period into two subperiods it is possible to compare the effect of exchange rates on the IPCA in two specific situations. The first, when it goes through devaluation, and the second with an opposite behavior.

Besides graphic analysis, another reason to split the period as proposed above was the possibility of structural break, found through a test performed in the period corresponding to late 2002.
4. Decomposition of Variance Analysis

According to the methodology proposed, the period was split up into two periods, namely:
- Division of the period above into two specific samples:
  - Period 2: July 1999 to December 2002.

The goal of this division is to check whether in both periods the IPCA and its decompositions had different factors as causes for their variations. Specifically, the aim is to find out the importance of the exchange to determine the variance of prices in both periods.

4.1. IPCA and its Decompositions

4.1.1. Decomposition of Variance of the IPCA
The results for the model point interesting results in terms of variance of the full IPCA. The exchange rate is a determining factor for the inflation variation at the end of the period. Nevertheless, conditions of supply and demand also had a significant impact on the variance composition of the IPCA.

<table>
<thead>
<tr>
<th>Period</th>
<th>LOGIPCA</th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35.33122</td>
<td>30.29008</td>
<td>28.37105</td>
<td>6.00766</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCA
Obs.: VEC model estimated with 2 lags and one cointegration vector, results of end of 12 periods.

### 4.1.2. Decomposition of Variance of Price Indices

Table 2 lists the behavior of the price index of free goods that are made up of tradable and non-tradable goods for the period.

<table>
<thead>
<tr>
<th></th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOGIPCAC</td>
<td>20.90355</td>
<td>37.58233</td>
<td>4.510722</td>
</tr>
<tr>
<td>LOGIPCANC</td>
<td>38.39636</td>
<td>5.345356</td>
<td>1.354043</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCANC
Obs.: VEC model estimated with 2 lags and one cointegration vector, results of end of 12 periods.

As expected, the exchange had the greatest contribution to the variance of the LOGIPCAC, but conditions of supply and demand had a great importance in explaining the variance of these prices in the model. This result is consistent since it is expected that the price of tradable goods is also susceptible to changes in demand, because usually there is not a complete replacement of domestic goods for imported ones when prices rise or given variations in the exchange rate, first due to the adjustment time of companies, and second because Brazil has a relatively closed economy, preventing a higher degree of substitution in the short term. Thus according to the model, the variation in prices of goods during this period was determined by a blend of demand, supply, and exchange rate.

Another interesting factor is verified when analyzing the behavior of prices of non-tradable goods. Following the logic, the prices of these goods were more sensitive to demand conditions than any other factor. The value found is in agreement with the expected once non-tradable goods cannot be replaced by foreign products, so it is expected that variations in exchange rates have less impact on them directly. Probably, these variations alter the price of tradable goods, which in turn affects the price of non-tradable goods. These results were expected and are in line with economic theory.

The variance of prices of administered goods is determined mostly by inertia, but of the three factors considered as decisive for pricing administered goods, the exchange was the principal. This can be explained by the influence of the low dollar on administered prices, such as the electricity, telephone and health plans, for example. These prices had increases given by the variation in the Market General Price Index (IGP-M), which is strongly influenced by the dollar, shown in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>LOGIPCAAD</th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37.69599</td>
<td>15.38338</td>
<td>27.75675</td>
<td>19.16388</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCAAD

363
Obs.: VEC model estimated with 2 lags and one cointegration vector, results of end of 12 periods.

Comparing these results with other studies, Minella et al (2003) and Araújo and Modenesi (2010) also obtained similar results. A possible explanation can be found in the study of the latter authors cited.

<table>
<thead>
<tr>
<th>Items</th>
<th>Weight in the administered (%)</th>
<th>Weight in the IPCA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil derivatives</td>
<td>18.69</td>
<td>5.57</td>
</tr>
<tr>
<td>Residential Electricity</td>
<td>11.14</td>
<td>3.32</td>
</tr>
<tr>
<td>Telephone services</td>
<td>17.28</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Source: Araújo and Modenesi (2010)

Over the studied period, the price of administered goods had a relative importance regarding the dynamics of the IPCA, in addition, the price of these goods had the highest increase, as can be seen in graph below.

Graph 3 – Evolution of indices of administered, tradable and non-tradable prices (Base Period July 1999 – May 2011).

Source: Elaboration with research data.

4.2. Decomposition of Variance Analysis of IPCA and its decompositions – Period II

The IPCA and its decompositions had different factors as causes of their variations. Specifically, the objective is to verify the importance of the exchange rate for the price variation in the periods II and III.

4.2.1. Decomposition of Variance of the IPCA

Data of Table 6 indicated reduction in the importance of the exchange rate in the second period compared to the first. It is worth highlighting the importance of demand conditions in the period between January 2003 and May 2011. Demand conditions represent approximately 13% variance of the IPCA. From this information we can infer two important considerations. The first is that perhaps the exchange rate has not
been able to greatly influence the IPCA due to the strength of demand conditions on the level of prices in this period. The second is that demand conditions continued to be the main factor in determining the IPCA.

<table>
<thead>
<tr>
<th>Period</th>
<th>LOGIPCA</th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>59.34612</td>
<td>6.352987</td>
<td>23.29368</td>
<td>11.00721</td>
</tr>
<tr>
<td>3</td>
<td>72.57406</td>
<td>13.62233</td>
<td>7.164845</td>
<td>6.63877</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCA
Obs.: VEC model estimated with 2 lags and one cointegration vector, results of end of 12 periods.

These results diverged from Squeff (2009) who observed a higher exchange rate pass-through coefficient in the period from January 2007 to December 2007. However, it should be noted that the samples in the two studies are different invalidating thus more accurate comparisons. Another interesting fact is that, although the exchange exert negative pressures on the level of prices, demand pressures may have been more important for the formation of the price level. Then despite losing importance in proportion, it still seems to have a considerable influence.

4.2.2. Decomposition of Variance of the IPCAC

Among all types of goods, tradable goods are those whose prices are affected with higher intensity due to variations in the exchange rate. Results in Table 7 reflect this sensitivity.

<table>
<thead>
<tr>
<th>Period</th>
<th>LOGIPCAC</th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30.61153</td>
<td>24.45676</td>
<td>42.89656</td>
<td>2.035154</td>
</tr>
<tr>
<td>3</td>
<td>78.04632</td>
<td>8.435193</td>
<td>8.451004</td>
<td>5.067488</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCAC
Obs.: VEC model estimated with 3 lags and one cointegration vector, results of end of 12 periods.

It is clear from the previous data that the exchange rate was the main determinant of the price of tradable goods in both periods. But in the second period, the price of tradable goods was less subject to both variations in the exchange rate and variations in supply and demand conditions. Undoubtedly, this factor was much important to fulfill the inflation targets by the Central Bank. If the exchange continued to impact prices of tradable goods in the second period in the same way that impacted in the first, it would certainly be more difficult to keep prices at low levels.

4.2.3. Decomposition of Variance of the IPCANC.

Between July 1999 and December 2002, non-tradable goods prices had the smallest increase, compared with tradable and administered goods. Nevertheless, in the period from January 2003 to May 2011 these were the main responsible for variation of the full IPCA. This behavior can be observed in the graphs below.

The variance decomposition analysis helps to understand what occurred during the two periods. Data indicated that in the second period there was a considerable increase of demand pressures, which led to increase in prices of non-tradable goods. In situations in which the aggregate demand is booming, it is natural a higher rise in the prices of these goods compared to the price of tradable goods. This is due to the
impossibility of replacing such goods by similar imported, which reduces competition and favors higher prices.

Graph 4 – Behavior of IPCA, IPCAC, IPCANC and IPCAAD in both periods.

Table 10. Decomposition of variance of the IPCANC

<table>
<thead>
<tr>
<th>Period</th>
<th>LOGIPCANC</th>
<th>LDREAL</th>
<th>LOGTXC</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>23.15042</td>
<td>13.33668</td>
<td>15.97157</td>
<td>47.54132</td>
</tr>
<tr>
<td>3</td>
<td>21.78689</td>
<td>32.57754</td>
<td>11.73026</td>
<td>14.59508</td>
</tr>
</tbody>
</table>

Cholesky Ordering: LDREAL LOGTXC LOGIC LOGIPCANC

Obs.: VEC model estimated with 3 lags and one cointegration vector, results of end of 12 periods.

From these results it can be concluded that the variations in the exchange rate from January 2003 to May 2011 were less decisive for the variance of the IPCA. Although the exchange has varied significantly in this period the conditions of demand and supply were more volatile influencing strongly the rise of price indices.

5. Final Considerations

Based on the results discussed and presented in this study, it can be noticed a marked importance of the exchange rate as a determinant of changes in price indices in the Brazilian economy. Practically in all periods and models, the exchange was a major cause of variations in the IPCA and its decompositions. This result converges with results of Belaisch (2003), Squeff (2009) and Araújo and Modenesi (2010).

Despite the importance of the exchange, except for the inflation inertia, demand conditions seem to have generated more fluctuations in prices than any other factor during the entire period of analysis. With regard to the symmetry of the importance of exchange in periods II (July 1999 – December 2002) and III (January 2002 – May 2011), our study noted a decrease in the importance of the exchange for the variation in price in the period III. While in the first period the exchange rate was the main factor causing the variance of IPCA, in the second period this role was played by demand conditions. Then under conditions of exchange devaluation, the exchange has a higher power to impact the price level. And under exchange rate appreciation, it has not much influence on the IPCA and its decompositions.
Actually, exchange rate appreciation tend to produce negative pressure on prices, perhaps owing to this reason, the monetary and fiscal policies can become more flexible, since the increase of demand pressures may be partially compensated by the movement of currency appreciation. Therefore, policies to expand economic activity through monetary expansion can be performed with appropriate limits, without necessarily deviating prices far from the center of the inflation target set by the Central Bank, once with the exchange valued part of the pressures inflation is damped. But this is something to be deeper investigated, a suggestion for future studies. Our results also indicated a very strong inertial component. In most cases, much of the variance in prices was explained by the own variation of prices in previous periods. Other studies like Freitas, Minella and Riella (2002), Gomes and Aidar (2004) had already emphasized the issue of inflation inertia in Brazil.

Another topic to be noted is that there may be flaws in the transmission mechanism of monetary policy, pointing out that the policy of increasing interest rates to contain aggregate demand does not take a great expansive effect. Variations in interest rates can be interfering more in capital movements and therefore in the exchange, so as to achieve the level of domestic prices. Then, not only this, but there are various studies that evidence the importance of the participation of the exchange rate in determining price indices. In this way, it should be examined in greater detail in the conduct of monetary policy, given its expressive participation in the variance of prices. Meantime, results presented herein should be deeper studied, owing the use of relatively small samples, especially in the period from July 1999 to December 2002. Thereby, results should be compared with numerous stylized facts of the Brazilian economy.

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Erica Oliveira Gonzales is graduated in Economics from the Federal University of Sergipe (2009). Is attending master’s degree at Maringá State University’s Graduate Program in Economics. Postal Address: Rua Tietê, 375 A, kit 05. Zona Sete. Maringá – PR. CEP 87020-210, E-mail: ericagonzales22@gmail.com, Phone number: +554499707471. Curriculum Lattes: http://lattes.cnpq.br/6342699621002828

Allan Silveira dos Santos is attending doctoral degree at Brasília University’s Graduate Program in Economics. Master in Economic Theory by the Maringá State University’s Graduate Program in Economics. Postal Address: SGAS 905, lote 03, Condomínio Edificio Central Park, Bloco B, apto 08. Asa Sul, Brasília – DF. CEP 70.390-050, E-mail: allansilveiral@gmail.com, Curriculum Lattes: http://lattes.cnpq.br/6275575067506009

Eliane Cristina Araújo, graduated in Economics at State University of Maringá (2002), MA in Economics at State University of Maringa (2004) with exchange at the Technische Universität Ilmenau (Germany) and a PhD in Economics at Federal University of Rio de Janeiro (2009). Is currently adjunct professor at the State University of Maringá. Works on the following topics: economic growth, international economics and monetary and exchange policy. E-mail: elianedearaujo@gmail.com, Curriculum Lattes: http://lattes.cnpq.br/3906456237014475