*Orthogonality and Inflation Forecast Errors***:**

**The case of central bank transparency**

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## Abstract

This paper is a contribution to the literature that deals with the role of transparency in inflation targeting and expectations. With this objective we develop an econometric framework that assesses informational content across individual forecasters taking into account central bank actions and communications. In short, orthogonality property is the essence of the analysis. The findings from the application for the Brazilian case did not indicate the presence of bias among the inflation forecasters. The results from the models with inflation rate, interest rate did not represent a surprise for the institutions and this information was brought forward in a correct way. In addition, were included the opacities of the central bank and the findings suggest that the central bank’s inflation reports can be considered an important tool to influence agents' expectations of Focus survey. In this sense, the opacity of the central bank influenced errors predictions of agents participating in the survey.

## Key words:inflation expectations, central bank transparency,inflation targeting, orthogonality property, survey forecasts.

**JEL classification:**E37, E52.

**1. Introduction**

Fromthe 1990s to now, inflation targeting framework (IT) has been adopted by more than 35 central banks as a strategy for the implementation of monetary policy. One point that is essential to the success of IT is the forward-looking behavior for inflation expectations and the capacity of the central bank managing them (Woodford, 2005). In other words, if the past inflation is relevant to building inflation expectations, the inertial effect that impedes the fall of inflation rate needs to be broken. Indeed, the challenge of macroeconomic stabilization increases when private sector does not hold rational expectations and when it is subject to an adaptive learning process. Hence, assuming that the objective of the central bank corresponds to the rational expectations equilibrium, central bank communication is important tool for driving expectations to this equilibrium (Orphanides and Williams, 2007; and Eusepi and Preston, 2010).As pointed out by Salle, Yıldızoğlu, and Sénégas (2013) the heart of IT is the idea that expectations are the prime concern of central banks, and a key channel of the transmission mechanism. As a consequence, policy decisions should be transparent, in order to make them predictable and to allow for a more effective monetary policy.

One important effect due to the transparency is that it can help to reduce asymmetric information between the central bank and the private sector (Walsh, 2003). Furthermore, as highlighted by Bernanke (2004) transparency is important due to the necessity of the public’s inference on the central bank’s probable action. In short, efficient communication and, as a consequence, higher transparency can improve the power of central banks to guide public’s expectation with the implicit objective to raise the signal-to-noise ratio of policy decisions (Blinder et al., 2008;Svensson, 2006; Woodford, 2005; and Morris and Shin, 2002).

In a general way, the transparency in IT countries has increased due to the presence of an explicit inflation target and also due to the increase of communication between the monetary authority and the private sector. In particular, central bank communication plays an essential role in this system and the literature on the subject advances in order to analyze how changes in the degree of transparency affect the public’s perception on the monetary policy (Woodford, 2005; de Haan, Eijffinger, and Rybinski, 2007; and Blinder et al, 2008).

The impact of central bank transparency on inflation is an object of intense empirical analysis in the last years and the results of several studies indicate that the effects are positive. Evidence that central bank transparency is associated with lower inflation is supported, for example, by Chortareas, Stasavage, and Sterne(2002) through anindex for transparency of forecasts and cross-section analysis based on 87 countries. In the same vein, de Mendonça and SimãoFilho (2007) based on data on economic transparency and inflation rate for 45 countries available in Fry *et alii* (2000) found that a greater transparency contributes to a decrease in inflation. Demertzis and Hughes Hallett (2007), making use of Eijffinger and Geraats (2006) central bank index found a negative relationship between inflation variability and central bank transparency. In the same direction, Dincer and Eichengreen (2009) taking into account a sample of 100 centralbanks also observed that greater central bank transparency is associated with lowerinflation volatility.

As pointed out by Brand, Buncic, Turunem, (2006), the correct combination of transparency and communication makes clear the central bank’s preferences and thus avoids this type of uncertainty, thereby stabilizing public expectations. Hence, another type of empirical analysis regarding central banking transparency is the evaluation on inflation expectation. Some studies such as Mankiw, Reis, and Wolfers (2004) and Levin, Natalucci, and Piger (2004) suggest that there is less variability and dispersion in inflation expectations due to the publication of numerical targets for inflation by central banks. Based on a sample of Eurozone countries and 8 other industrialized economies, van der Cruijsen and Demertzis (2007) observed that transparency regarding inflation target is relevant for building public expectations. Moreover, the authors making use of a central bank transparency index built by Eijffinger and Geraats (2006) observed that an increase in transparency makes inflation expectations more anchored. Through an empirical analysis for the Brazilian case after the adoption of IT, de Mendonça and Galveas (2013) observed that the Central Bank of Brazil has had success in the coordination of the private inflation expectations.

Therefore, since the adoption of IT in the 1990s there has been an increasing awareness of the importance of managing expectations in order to minimize systematic mistakes of forecasters (de Mendonça and de Guimarães e Souza, 2012). As highlighted by Chortareas, Jitmaneeroj, and Wood (2012) most studies concerning rational expectations hypothesis use an aggregate prediction, and thus can present an aggregation bias that conceals the heterogeneous behavior of forecasters and can result in misleading inferences (see Bonham and Cohen, 2001). In order to deal with this problem, time series of forecasts from individual forecasters may be used (Batchelorand Dua, 1991).

This paper is a contribution to the literature that deals with the role of transparency in inflation targeting and expectations. With this objective we develop an econometric framework that differs from Davies and Lahiri (1995) due to the fact that we consider multiple targets through a rolling window and forecast horizons. The reason is that the main point in this study is to assess if the central bank actions and communications have informational content across individual forecasters. In short, orthogonality property is the essence of our analysis. One advantage of the method developed in this paper compared to that, for example, used by Chortareas, Jitmaneeroj, and Wood (2012) is that the use of the Newey-West matrix is not sufficient to consider the decline in the variances and covariances when the forecast horizon decreases towards the target date.

In order to apply this new methodology the Brazilian case is considered. Brazil is a potential laboratory for this type of analysis because it has been employing IT since 1999 and has an institutional design that allows one to see the effect of central bank transparency. In particular, the Central bank of Brazil through the release of the Focus Market readout makes available inflation market expectations from different institutions. This variable is quite relevant because it allows one to observe how the central bank is guiding expectations through the difference between the expectations from different institutions and the inflation target. It is important to highlight that before the application of the orthogonality analysis, an investigation on the possible bias on inflation expectations made by the institutional forecasters is made. Another contribution for the application on the Brazilian analysis is the use of opacity indexes for the COPOM inflation report. Our results indicate that the orthogonality hypothesis for the Brazilian case is valid when inflation rate and interest rate (represents the transparency of policy monetary decisions) are considered in the model. However, with the use of indices opacity of the report of inflation, we obtain non-orthogonality.

The article is organized as follows: Section 2 presents how the econometric framework is developed and how the tests can be made. Section 3 describes the data and the empirical evidence from the application for the Brazilian case. Section 4 concludes the article.

**2.Analytical framework and methodology**

Forecasting rationality tests are based on the rational expectations assumption that the conditional probability distribution which in subject to the information set available to the forecaster coincides with the own forecaster’s subjective probability distribution for the future values of the variable to be predicted. More formally, let represent inflation forecast made by individual *I* in the forecast month *T-h*. Let represent the actual inflation rate in the month T. The forecast error is defined as:

(1) .

If is a rational expectation of the mean value of , then where the information set represents the information available to the individual at period We follow Batchelor and Dua (1991) and assume that the information set can be represented by a set of variables known to individual at period such that and that it cannot diminish over time. The authors state that the errors from a rational forecast must obey the following conditions: (i) Unbiasedness: Errors have zero mean; (ii) Orthogonality: Errors are uncorrelated with information known to the survey participants at the time the forecasts are made; (iii) Martingale: Forecast revisions are uncorrelated with information known to the survey participants at the time forecasts are made; and (iv) Convergence: The variances of the errors are nonincreasing as the forecast horizons shorten.

Because our interest is on testing the hypothesis that the Brazilian Monetary Policy Committee’s (COPOM) actions and elements of communication policy have informational content regarding the rationality of the Focus Market readout we dedicate attention to the orthogonality property. Our hypothesis is that if the elements of communication policy have informational content the information they carry will not explain the forecast errors. We assume that, if the Central Bank is able to guide market expectations, the information it produces will be used in full by the agents and we can expect that the information contained in the information set it releases will not explain the forecast errors. In other words if the relevant information is used by the agents we expect that the orthogonality condition holds which formally states that:

(2)

Following Batchelor and Dua (1991) we test individually the hypothesis that in equation

(3)

We therefore consider in this paper the rolling window variant of the rationality forecast test but with two forecast horizons of 3 and 6 months before the target month. In such a framework it is likely we observe that the forecast errors in the survey are heteroskedastic,as pointed out byBatchelor and Dua (1991), because the variance of the forecast errors declines as the forecast horizons are reduced. Further the authors argue the forecast errors for a specific target period made at period are correlated with the errors in the forecast in the subsequent months.

Considering such a possible structure, we use the Davies and Lahiri (1995) methodology to explicitly model the covariance structure of the forecast errors in survey based forecasts. Our objective is to decompose the forecast errors into two dimensions, a common macroeconomic aggregate shock and an individual bias. Under this view forecasters are not responsible for the forecast errors due to the macroeconomic shock but have an individual bias that is related to private information that makes their forecasts different among each other.

We assume that the participants forecast error can be decomposed between two dimensional structures. The first component assumes that there is a bias in each individual forecast and the second component represents cumulative monthly aggregate shocks which will be common to the two different forecast horizons in which we are interested. Formally let represent the unobserved value that inflation would take for period if no shock had occurred from horizon until the target month. represents therefore the value that the agents attempt to forecast. Nevertheless the agents produce biased forecasts which are represented by the individual specific biases such that . At the same time the actual values for inflation are given by the unobserved values in the absence of shocks plus these shocks such that . As a consequence we obtain the forecast error as proposed in equation

(4) and

(5) .

In this setup the error component is the cumulative effect of all shocks which occurred from months before the target month of interest to the month of interest. This cumulative effect is given simply by the summation of each monthly shock.

The common aggregate macroeconomic shock accounts for the autocorrelation present in the data and, because it is common across the survey participants, it can be considered to be present in both the sixth and the third month horizons in such a way that it follows a cumulative process that starts in the sixth forecast horizon, our longest horizon, and ends in the target month itself. In this case because the periods are overlapping we can expect that they generate correlation between the two forecast horizons we are considering. Furthermore, because the rolling window test assumes adjacent target months, the common component of the error appears in the differenttargets for three and six month horizonscausing serial correlation as well.

Davies and Lahiri (1995) propose in their paper a framework to address the problem of heteroskedastic errors through explicitly modeling the covariance of forecast errors across three dimensions, namely: multiple individuals, multiple target years, and multiple forecast horizons. Nevertheless the model setup we adopt in this paper is somewhat different from that proposed by Davies and Lahiri (1995) to the extent that the authors aggregate over the survey participants whereas our model only takes account of the cumulative macroeconomic shocks without aggregation, or in other words, we consider only the multiple targets represented by the rolling window and forecast horizons (three and six months in advance). We justify this choice by arguing that the objective of our paper is not to test the rationality forecast hypothesis but only to investigate if the COPOM actions and elements of communication policy have informational content across individuals thus not justifying the aggregation over individuals.

Batchelor and Dua (1991) propose to test the restriction in equation (3) using the result that under the hypothesis of rationality, or in our case under the null that the Brazilian Monetary Policy Committee (COPOM) actions and elements of communication policy have no informational content regarding the rationality of the Focus Market readout through the following:

(6)

(7) **.**

The test proposed in equations (6) and (7) is based on Hansen and Hodrick (1980) estimator. Its objective is to correct the variance-covariance estimator for the bias caused by serial correlation expected in overlapping forecast horizons. The estimator is based on estimating using OLS and using the correction proposed in equation (7) instead of the usual variance-covariance estimator based on least squares residuals. The variance-covariance estimator based on equation (7) depends essentially onmatrix , since the other matrices are those corresponding to the dependent variables matrix. Batchelor and Dua(1991) propose a symmetric form for based on the Bartlett weights arguing that Newey and West (1987) is a sufficient condition for being positive definite using the weights. Nevertheless as argued in Davies and Lahiri(1995), imposing the positive definite form to is not sufficient to take into account the decline in the variances and covariancesthat we expect to occur as the forecast horizon decreases towards the target date implying that this estimator is not consistent.[[2]](#footnote-3)

Their estimator proposes a very specific structure that accounts for the decline in the variances and covariances as the forecast horizon approaches the target date. Such a problem is likely to impose severe autocorrelation in the forecast errors in the rolling window test in our case because when we move from the 6 to the 3 forecast horizon, and given the sequence of target dates, we have an intricate structure of correlation across the adjacent targets that is generated by the recursive process present in the rolling window. As a consequence we have to deal with two different structures for correlation. The first given by the decrease in the variance as the forecast horizon decreases and the second given by the common source of correlation present in the adjacent targets of the rolling window.

The structure of matrix follows from assuming that the forecast errors can be decomposed as proposed in equations (4) and (5) and from assuming that the survey participants are taken individually. We follow such a structure and we explicitly model the forecast errors autocorrelations.

In order to clarify our point we present in figure 1 a schematic representation of the forecast error structure adapted from Davies and Lahiri (1995). The horizontal line represents a period of one year, set from January 2002 to January 2003 as an illustration, with the vertical bars marked off in months. Each vertical bar represents the date forecasts that were collected by the Focus system in each month.

In the upper part of the figure we show in the brackets the range over which the aggregate shock can occur considering the two forecast horizons in which we are interested, namely 3 and 6 months. These shocks will affect the error that each institution makes for the target month of January 2003. The common sub-range contains the source of autocorrelation that occurs across the two forecast horizons for the same target date.

In the lower part of the figure we show in the brackets the range over which the aggregate shock can occur considering that the targets are adjacent. These shocks will affect the error that each institution makes for the target month of December 2002. In this case, since we are considering the rolling window regression, we observe that there are sub-ranges common to this range and those defined for the two forecast horizons in the upper part of the figure limited by the dotted vertical lines for illustrative purpose.

**Figure 1**

*Schematic representation of the forecast error structure*

Monthly aggregate shock range for h = 6

Monthly aggregate shock range for h =3

Jan/2003

Dec/2002

Jan/2002

Shock range for 12/2003 target, h= 3

Shock range for 12/2003, h = 6

Shock range for 11/2003 target, h= 3

Shock range for 11/2003 target, h= 6

Shock range for 10/2003 target, h= 3

Shock range for 10/2003 target, h= 6

Shock range for 09/2003 target, h= 3

Shock range for 09/2003 target, h= 6

Shock range for 08/2003 target, h= 3

Shock range for 08/2003 target, h= 6

Shock range for 07/2003 target, h= 3

Shock range for 07/2003 target, h= 6

From equation (4) and observing figure 1 we can infer that the covariance between two typical forecast errors has two components. The first one given by the correlation present in the forecast horizons for the same target date, which in our case is simply given by:

(8)

Equation (8) shows that because we have only two different forecast horizons, namely 3 and 6 months according the upper part of figure 1, there are only three common months in the range for the same target date in which we observe shocks affecting the forecasts.

Matrix represents the variance covariance for this first component:

(9)

Our matrix has a similar structure of that proposed by Davies and Lahiri (1995). The only difference is that the authors use eleven forecast horizons whereas we have only two.

The second component is more intricate since the correlations are generated by the rolling window structure, therefore considering the adjacent target dates and also the different forecast horizons. In this case we have correlations that are generated by the adjacent targets keeping the same forecast horizon as well as by adjacent targets but with different forecasts horizons.

Again using figure 1, one can gain an insight on the structure. For example consider initially the problem of the same forecast horizon for adjacent targets, namely the six horizons forecast and assume that we are interested in the October 2002 target. For this target we can observe shocks from April 2002 through September 2002, whereas the forecasts for January 2003 are subject to the shocks from July 2002 through December 2002. Therefore we have two common months (August and September 2002) that represent a source of correlation across adjacent targets. The vertical dotted line shows the maximum range of common shocks is five for the three and six horizons, namely from August 2002 through December 2002 in figure 1. The minimum range of common shocks is therefore one,which corresponds to the December 2002 target itself.

Now assume that we are still interested in the October 2002 target but consider the three horizon forecast and adjacent targets. For this target we can observe shocks from July 2002 through September 2002 but for the January 2003 target the shocks run from October 2002 through December 2002. As a consequence the correlation is zero. The first correlation only appears for the November 2002 target when the shocks run from August through October 2002 whereas for the January 2003 target the shocks run from October through December 2002. As we can infer from figure 1 the minimum range of common shocks for the three steps horizon is therefore one and the maximum is two.

Finally, consider the third source of correlation that corresponds to the correlation between the two different forecast horizons when we are dealing with adjacent targets. For example the six steps horizon for the January 2003 target and the three steps horizon for the November 2002 target. As we notice above the shocks for January 2003 target run from July 2002 through December 2002. The shocks for the November 2002 target correspond to August, September, and October. Overall weobserve three common shocks. As we can infer from figure 1,extending the same logic structure to the other targets, the maximum range of common shocks is three and the minimum is one.

Matrix represents the covariance for this second component:

(10)

Our matrix is quite different from that proposed by Davies and Lahiri (1995). The main difference is in the fact that in our case there is an extra source of correlations present in the consecutive adjacent targets that is represented by elements which is not present in their case because they are considering only a specific sequence of targets from 18 to 11 months horizons which are annual. Therefore two consecutive targets present a gap of 12 observations between them, whereas our targets are consecutive months. Because of our use of the monthly targets there is an overlapping structure represented in our case by the correlations between the three and six horizons for different consecutive target dates that is not present in the Davies and Lahiri (1995) structure.

Finally using both sub-matrices we can construct matrix which is given by:

(11)

It should be noticed that matrix depends on the estimation of the fundamental parameter . We use the estimator proposed in Davies and Lahiri (1995). Let to represent the individual’s vector of forecasts. The vector is constructed in such a waythat we have first the target month and second the forecasts horizons and takes the following form: where the first target month corresponds to April 2002 for and to July 2002 for whereas the last target month corresponds to September 2006 for and to December 2006 for . We estimate the variance of the monthly aggregate shocks using the following:

(12) and

(13)

where in equation (9) the first sum runs across the forecast horizons and after that overall target months and in equation (10) the sum runs over the survey participants.

According to Davies and Lahiri (1995), because:, a consistent estimator for is obtained regressing the vector of dimension on a vector of horizon indices . In our case this vector is simply 6 and 3.

**3.Data and empirical results**

Inflation targeting was adopted by the Central Bank of Brazil (CBB) in June of 1999, with the objective of monetary policy being the achievement of an explicit inflation target as defined by the National Monetary Council.[[3]](#footnote-4)In practice, the main task of CBB in the management of monetary policy is to set the Selic rate (this rate is associated with domestic public bonds issued by government, and it is equivalent to the American Federal Fund rate) in order to achieve the target of 4.5%, plus or minus 2 percentage points for annual inflation measured by IPCA (National Consumer Price Index (extended) – official price index). As stated by the current governor of the CBB – AlexandreTombini – the main task is to coordinate the expectations.

Since June 21, 1999 (Decree No. 3088), CBB is committed to atransparency based on three points: (i) the targets will be considered to have been met whenever the observed accumulated inflation during the period January-December of each year falls within the respective tolerance range; (ii)in the event of failure to achieve targets, the Chairman of CBB will publish an open letter to the Finance Minister explaining the causes of the failure, the measures to be adopted to ensure that inflation rates return to established limits, and the expected period for such measures to be achieved; and (iii) the CBB will issue a quarterly inflation report that will provide information on the performance of the inflation targeting regime, the results of the monetary policy actions, and the inflation outlook.

With the objective of evaluating if the forecasters, through observation of institutions in the Focus Market readout use information released by the CBB, an empirical analysis is performed. In other words the orthogonality property as presented in the previous section is tested. The idea is to observe if there exists some relation between inflation forecast errors from institutions in the Focus Market readout and the set of information in the period surrounding the release of the COPOM minutes.

Therefore in order to preserve the difference among the institutions, the estimation was made separately for each of the 17 institutions in this sample (52 observations, each one for the period from January 2002 to April 2006) taking into account to account two forecasts horizons (three and six months ahead).Figure 2 shows the existence of disagreement among individual forecasts for both horizons (3 and 6 months) before and after the release of the minutes. It is important to highlight that the period under analysis cannot be updated because the disaggregated information for each institution is not available from the CBB after this period.

The inflation forecast error is the result of the difference between observed inflation and inflation expectations collected in the week immediately after the release of the minutes. In addition of this variable, the empirical analysis uses the following as control variables:

(i) In Brazil, the basic interest rate level (*IR*–Over/Selic rate - accumulated in the month in annual terms gathered from CBB’s Time Series Management System) is defined through meetings of the COPOM with the objective of achieving the inflation target. As a consequence, a change in the interest rate changes the public’s expectations regarding the actual and future performance of the economy.

(ii) Inflation (*Inf*) - measured by IPCA accumulated in the last 12 months - gathered from CBB’s Time Series Management System. A high inflation rate can imply a great chance of the inflation target being breached and thus generating deterioration in the capacity of the CBB leads the expectations to the target. On the other hand an inflation rate near the center of the tolerance interval can improve the efficiency of the CBB to guide inflation expectations.

**Figure 2**

*Individual and average forecast for the inflation rate*

|  |  |
| --- | --- |
| 3 months before | 3 months after |
|  |  |
| 6 months before | 6 months after |
|  |  |

(iii) Opacity index of exchange rate - The exchange rate is a major component of the inflation forecast. However, the Central Bank of Brazil makes its predictions based on a fixed exchange rate. The gap between the exchange rate used in the prediction of inflation and the effective rate (3 or 6 months ahead) call opacity.

(iv) Opacity index of interest rate - Likewise, Copom makes their inflation forecasts assuming that the interest rate will be constant. The difference between the interest rate held (3 or 6 months ahead) and the rate used in the prediction of inflation is a measure of opacity.

Importantly, the central bank has control of interest rates through its actions in the interbank market for reserves. Furthermore, it uses a model of exchange administered and therefore may influence the exchange rate. This reinforces the concept of opacity (economic) in both cases, since the central bank can control these variables. De Mendonça and SimãoFilho (2008) highlight the effects of economic transparency on financial market participants, and therefore, this variable can be a source of explanation for the errors of prediction.

The empirical analysis is divided into two parts. The first makes an analysis regarding the possible bias among the forecasters in the sample. Hence a regression of the inflation forecast errors as dependent variable and the constant (*C*) is made. The result (see table 1) shows that all institutions in the sample, taking into account both horizons (3 and 6 months), do not present forecast bias. In other words, the null hypothesis that the constant can explain the inflation forecast errors was rejected[[4]](#footnote-5).

***Table 1***

*Bias test*



The second part of the analysis takes into account the inclusion of the control variables in the estimation thus permitting to analyze the orthogonality property. With this intention two specifications are considered (see tables 2, 3 and 4).

Specification 1 considers the effects of the interest rate and the inflation rate on on the prediction errors of the agents participating in the FOCUS. The first variable represents the inflationary inertia and the interest rate is a measure of transparency of monetary policy decisions. These controls were not relevant to explain the inflation forecast errors. The coefficients of determination not have significance for all the institutions with the horizons of 3 and 6 months (Table 2). The results from the Chi-square test for independence show that the null hypothesis that there exists independence between inflation forecast error and the regressors.

***Table 2***

*Orthogonality tests (Specification 1)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *3 months* | | | | | |  | *6 months* | | | | | |
| *Inst* | *C* | *IR* | *Inf* | *R2* | *Chi* | *p-value* |  | *C* | *IR* | *Inf* | *R2* | *Chi* | *p-value* |
| 0 | 0.768 | -0.497 | 0.150 | 0.043 | 1.194 | 0.755 |  | 0.901 | -0.349 | -0.425 | 0.161 | 3.704 | 0.295 |
| 1 | 0.441 | -0.248 | 0.133 | 0.020 | 1.018 | 0.797 |  | 0.781 | -0.292 | -0.278 | 0.088 | 2.163 | 0.539 |
| 2 | 0.707 | -0.450 | 0.179 | 0.044 | 1.471 | 0.689 |  | 0.901 | -0.352 | -0.283 | 0.089 | 2.523 | 0.471 |
| 3 | 0.818 | -0.505 | 0.061 | 0.042 | 0.801 | 0.849 |  | 0.985 | -0.375 | -0.465 | 0.181 | 4.471 | 0.215 |
| 4 | 0.569 | -0.337 | 0.122 | 0.023 | 0.974 | 0.807 |  | 1.182 | -0.535 | -0.394 | 0.169 | 3.765 | 0.288 |
| 5 | 0.643 | -0.407 | 0.141 | 0.037 | 1.024 | 0.795 |  | 0.576 | -0.145 | -0.269 | 0.068 | 2.061 | 0.560 |
| 6 | 1.057 | -0.681 | 0.110 | 0.067 | 1.340 | 0.720 |  | 0.891 | -0.329 | -0.383 | 0.144 | 3.335 | 0.343 |
| 7 | 0.527 | -0.274 | 0.111 | 0.018 | 1.226 | 0.747 |  | 0.900 | -0.352 | -0.286 | 0.101 | 2.527 | 0.470 |
| 8 | 0.669 | -0.374 | 0.094 | 0.024 | 1.121 | 0.772 |  | 0.885 | -0.259 | -0.570 | 0.235 | 6.182 | 0.103 |
| 9 | 0.714 | -0.434 | 0.093 | 0.027 | 0.883 | 0.830 |  | 0.781 | -0.247 | -0.424 | 0.134 | 3.685 | 0.298 |
| 10 | 0.957 | -0.639 | 0.147 | 0.061 | 1.317 | 0.725 |  | 0.910 | -0.357 | -0.376 | 0.140 | 3.181 | 0.365 |
| 11 | 0.570 | -0.381 | 0.239 | 0.060 | 1.829 | 0.609 |  | 0.727 | -0.240 | -0.294 | 0.084 | 2.347 | 0.504 |
| 12 | 0.554 | -0.330 | 0.112 | 0.022 | 0.857 | 0.836 |  | 0.632 | -0.188 | -0.288 | 0.081 | 2.126 | 0.547 |
| 13 | 1.098 | -0.727 | 0.103 | 0.074 | 1.263 | 0.738 |  | 1.154 | -0.551 | -0.390 | 0.165 | 3.523 | 0.318 |
| 14 | 0.609 | -0.338 | 0.063 | 0.019 | 0.794 | 0.851 |  | 0.804 | -0.259 | -0.394 | 0.125 | 3.443 | 0.328 |
| 15 | 0.593 | -0.382 | 0.199 | 0.042 | 1.503 | 0.682 |  | 0.933 | -0.298 | -0.534 | 0.213 | 5.632 | 0.131 |
| 16 | 0.752 | -0.496 | 0.193 | 0.057 | 1.524 | 0.677 |  | 0.774 | -0.268 | -0.315 | 0.095 | 2.539 | 0.468 |

In this sense these errors can not be explained by the Selic rate and the inflation rate of the day prior to the publication of the minutes of the Monetary Policy Committee.

Second specification amplifies the previous model with the inclusion of a new dimension of transparency of the central bank: the economic transparency. In order to represent this dimension are used as explanatory variables the opacity indexes of exchange rate and interest rate. The results are different to those observed in the first specification (see Tables 3 and 4). The main difference in comparison with specification 1 is that the coefficients of determination are significant in both horizons (3 and 6

***Table 3***

*Orthogonality tests (Specification 2 to 3 months)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *3 months* | | | | | | | | | |
| *Institution* | *C* | *IR* | *Inf* | *RInd* | *OpEX* | *OpIR* | *R2* | *Chi* | *p-value* |
| 0 | -12,926 | -0.128 | -0.123 | 0.040 | -0.086 | 0.110 | 0.440 | 14,138 | 0.028 |
| 1 | -16,945 | 0.077 | -0.163 | 0.043 | -0.150 | 0.109 | 0.479 | 16,256 | 0.012 |
| 2 | -14,510 | -0.093 | -0.104 | 0.043 | -0.080 | 0.112 | 0.470 | 14,464 | 0.024 |
| 3 | -11,363 | -0.112 | -0.181 | 0.036 | -0.001 | 0.108 | 0.454 | 12,752 | 0.047 |
| 4 | -17,123 | -0.002 | -0.177 | 0.046 | -0.085 | 0.114 | 0.488 | 16,372 | 0.011 |
| 5 | -13,719 | -0.081 | -0.110 | 0.040 | -0.008 | 0.103 | 0.452 | 11,335 | 0.078 |
| 6 | -0.9114 | -0.248 | -0.144 | 0.035 | -0.050 | 0.113 | 0.444 | 14,149 | 0.028 |
| 7 | -16,408 | -0.014 | -0.170 | 0.046 | -0.069 | 0.102 | 0.468 | 13,687 | 0.033 |
| 8 | -14,134 | 0.030 | -0.172 | 0.039 | -0.042 | 0.114 | 0.448 | 14,923 | 0.020 |
| 9 | -14,139 | -0.068 | -0.195 | 0.042 | -0.118 | 0.113 | 0.422 | 16,544 | 0.011 |
| 10 | -11,420 | -0.247 | -0.120 | 0.040 | -0.036 | 0.113 | 0.452 | 13,799 | 0.032 |
| 11 | -14,943 | -0.003 | -0.035 | 0.039 | -0.089 | 0.111 | 0.491 | 13,692 | 0.033 |
| 12 | -16,361 | 0.011 | -0.170 | 0.044 | -0.059 | 0.111 | 0.487 | 14,960 | 0.021 |
| 13 | -10,850 | -0.278 | -0.165 | 0.040 | 0.008 | 0.121 | 0.511 | 15,386 | 0.017 |
| 14 | -13,180 | 0.071 | -0.182 | 0.035 | -0.032 | 0.109 | 0.408 | 13,632 | 0.034 |
| 15 | -15,296 | -0.016 | -0.087 | 0.041 | -0.112 | 0.112 | 0.453 | 14,921 | 0.021 |
| 16 | -12,571 | -0.055 | -0.061 | 0.036 | -0.024 | 0.115 | 0.487 | 13,305 | 0.038 |

***Table 4***

*Orthogonality tests (Specification 2 to 6 months)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *6 months* | | | | | | | | | |
| *Institution* | *C* | *IR* | *Inf* | *RInd* | *OpEX* | *OpIR* | *R2* | *Chi* | *p-value* |
| 0 | -0.927 | -0.419 | -0.502 | 0.047 | 0.124 | 0.040 | 0.494 | 16.302 | 0.012 |
| 1 | -1.141 | -0.344 | -0.384 | 0.049 | 0.038 | 0.043 | 0.488 | 13.734 | 0.033 |
| 2 | -1.010 | -0.392 | -0.364 | 0.048 | 0.105 | 0.044 | 0.463 | 13.348 | 0.038 |
| 3 | -0.815 | -0.354 | -0.515 | 0.043 | 0.146 | 0.047 | 0.493 | 16.744 | 0.010 |
| 4 | -0.828 | -0.575 | -0.493 | 0.050 | 0.067 | 0.046 | 0.545 | 17.681 | 0.007 |
| 5 | -1.103 | -0.347 | -0.358 | 0.048 | 0.146 | 0.026 | 0.421 | 11.473 | 0.075 |
| 6 | -0.946 | -0.352 | -0.445 | 0.045 | 0.145 | 0.044 | 0.514 | 14.828 | 0.022 |
| 7 | -0.829 | -0.376 | -0.336 | 0.043 | 0.162 | 0.042 | 0.465 | 11.337 | 0.079 |
| 8 | -0.876 | -0.277 | -0.624 | 0.043 | 0.154 | 0.043 | 0.532 | 20.198 | 0.003 |
| 9 | -1.230 | -0.269 | -0.516 | 0.050 | 0.076 | 0.048 | 0.488 | 18.578 | 0.005 |
| 10 | -0.926 | -0.315 | -0.435 | 0.043 | 0.111 | 0.049 | 0.496 | 14.598 | 0.024 |
| 11 | -1.180 | -0.337 | -0.383 | 0.050 | 0.120 | 0.040 | 0.477 | 13.708 | 0.033 |
| 12 | -1.128 | -0.224 | -0.334 | 0.044 | 0.190 | 0.042 | 0.465 | 11.547 | 0.073 |
| 13 | -0.732 | -0.552 | -0.447 | 0.046 | 0.155 | 0.047 | 0.512 | 15.343 | 0.018 |
| 14 | -1.157 | -0.297 | -0.474 | 0.049 | 0.117 | 0.046 | 0.489 | 16.794 | 0.010 |
| 15 | -0.858 | -0.345 | -0.612 | 0.045 | 0.099 | 0.041 | 0.503 | 19.845 | 0.003 |
| 16 | -1.098 | -0.261 | -0.395 | 0.045 | 0.069 | 0.046 | 0.452 | 13.797 | 0.032 |

months). In addition the results based on Chi-square test for independence reject the null hypothesis that there exists independence between inflation forecast error and the set of independent variables under consideration. This can be observed in the estimations of all institutions and indicates that the BC opacity influences the prediction errors of participants FOCUS. Then economic opacity had negative effect on the conduction of monetary policy.

**4. Conclusion**

The main focus of the analysis in this paper was the orthogonality property. With this in mind, and taking into account the heteroskedasticity of the errors in the survey of forecasts we developed an econometric framework based on a rolling window variant of the rationality forecast test. The findings from the application for the Brazilian case initially did not indicate the presence of bias among the inflation forecasters (table 1).

The introduction of inflation rates (measure of inertia) and interest rates (measure of transparency of policy monetary decisions) did not alter the outcome of the test containing only constant. The specification 1 (table 2) did not indicated correlation between errors of prediction and the information of agents. Then transparency of policy monetary decisions has limited effect on these errors.

On the other hand in the specification 2 are included the central bank opacity indexes (tables 3 and 4). The opacity measures becomes significant in explaining the forecast errors (no orthogonality) confirming the relative lack of economic transparency in the Brazilian case.

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2. “Following Newey and West (1987), they used Bartlett weights to ensure positive semi-definiteness of the covariance matrix. Unfortunately, under rationality, this is not consistent with the logical decline of variances and covariances in *b* and *c* as the target date is approached.” (Davies and Lahiri, 1995, 212) [↑](#footnote-ref-3)
3. Regarding the adoption of inflation targeting in Brazil and the role of the credibility guiding private-sector decision makers’ expectations about future inflation, see de Mendonça (2007). [↑](#footnote-ref-4)
4. We consider a level of 5% significance in all estimations. [↑](#footnote-ref-5)