



Quality of Monetary Policy in Brazil: Adherence and COPOM's Directors Turnover Effect

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Abstract: The objective of this paper is to analyze the social cost of monetary policy in Brazil. The monetary adherence and the Copom's director turnover are used as way to test the quality of the monetary policy. We estimated two reaction functions using structural vector autoregressive techniques. The result of the two reaction functions indicates that the turnover of director in the monetary policy committee leads to the increase in the interest rate in order to keep inflation rate around the desired target level. Thus, the turnover produces a high social cost to the economy through monetary policy. Moreover, the monetary adherence measured by the deviation of monetary aggregates from its optimal level seems to be the ultimate exogenous variable that causes changes in output gap and inflation. Thus, the economy would have less social cost if policymakers pay closer attention to the deviations of monetary aggregates to its optimal level.

Keywords: Central bank independence, turnover index, monetary programming

1. Introduction

The control of inflation is a very important issue in monetary policy since it reduces social costs. The quality of monetary policy is directly linked to its capacity to administer the overall price level in the economy. While some countries have managed to successfully achieve and maintain price growth at a low level through its monetary policy, others have gone through serious crises of currency stability due to inflation. Up to 1994 Brazil was the example of losing control of inflation.¹ After 1994 with the real stabilization plan inflation curbed down with the Copom – Monetary Policy Committee played a very important role in this process.² In the Brazilian case the Copom decides the monetary policy to be executed by the Central Bank. Therefore, it is highly important to know how adherent is the monetary policy being practiced and its effect on controlling inflation.

Also important is the credibility of Copom's members. In our view its rotation may affect the quality of monetary policy. Both subjects are the focus of this paper. In this paper we argue that the cause for the lack of Central Bank independence in Brazil is because the Central Bank President is not as responsible for monetary policy as are the members of Copom – Committee for Monetary Policy. These members,

¹ Nazmi (1995).

² Copom was established in June, 1996. And it is formed by 08 directors (Deputy Governors) of Central Bank of Brazil plus its President (Central Bank Governor). They have meetings every 45 days analyzing the quality of the monetary policy and setting the basic interest rate (the interest rate for overnight interbank loans collateralized by government bonds registered with and traded on the Sistema Especial de Liquidação e Custódia), called SELIC rate.

they should pursue the adherence of monetary policy. Therefore, the focus of research should be on the rotation of such members and the adherence of their monetary policy and not so much on Central Bank president turnover.

The turnover of Copom's Directors and the adherence of the monetary programming policy are both associated with a more broad literature regarding central bank independency. For instance, Kydland and Prescott (1977) address the problem of dynamic inconsistency of monetary policy. According to the authors policymakers are subject to an inflationary bias and might influence Central Bank to pursue policies that might lead inflation to high level. As we can see in their view even the composition of central bank policymakers might affect inflation. Therefore, Central Bank Directors must be independent from government with respect to their focus on the inflation level.

The literature grew wider with the researches by Rogoff (1985), Grilli, Masciandaro and Tabellini (1991), Cukierman, Webb and Neyapty (1992), Alesina and Summers (1993), where they all agree that an independent central bank would be better for the economy. The institutional arrangement must be such to prevent the Central Bank policymakers to use the economic policy to obtain short-term gains in the unemployment and inflation rate tradeoff. After 1999 Brazil follow this widely recommended modern way of doing monetary policy and moved to an inflation-targeting regime. The main instrument to maintain inflation within its target was the interest rate.³ Since then the Copom's members are in charge of studying, analyzing and deciding the best monetary programming and the interest rate level to control inflation within its target level. In this paper we focus on a more recent period of Copom's monetary policy in 2001 – 2011. The reaction function for this period will be estimated and two quality variables will be considered: i) the adherence of monetary policy and ii) the Copom's Directors turnovers.

These two quality variables have been shown to have important effects on the quality of US monetary policy by Cukierman, Webb and Neyapty (1992). However, our study differs from these authors since we do not focus on the Central Bank President turnover, but rather on the members of Copom as in Teixeira, Dias and Dias (2013). Secondly, the adherence of monetary policy is computed not as an index, as suggested by the authors, but rather by the difference in the monetary aggregates from their targets. These two variables are regarded by the literature as a way of measuring Central Bank independence. In this paper we see them as more related to the quality of monetary policy rather than independence.

In sum, this paper investigates the monetary authorities' reactions to deviations from preset targets. In this way, by setting the interest rate the monetary aggregates became endogenous. By looking to the deviations of the monetary aggregates from the preset targets, the Copom may shift its interest rate goals in order to achieve a more stable quantity of money in the economy. We expected that, a lack of reaction from the Copom to systematic displacement between the predicted values and effective ones of quantity of money in the economy may cause substantial damage to the monetary policy being practiced. Along with this introduction, this paper has two main parts. The first part is a brief review on the theoretical discussion of central bank independence and also on empirical evidence. On the second topic, the econometric methodology and the data set are presented. Then, the results of econometric applications are discussed. Following there is some overall considerations.

³ Fraga, Golfajn and Minella (2003).

2. Quality of monetary policy review

Throughout the last decades, some countries were successful in maintaining price stability while others have gone through serious crises and periods of hyperinflation. The range of observed values for inflation in different countries has encouraged studies to explain the possible causes of these dispersions in prices. One of the main focuses on the studies of monetary policy quality is the independence role played by the Central Banks' Presidents.

Many authors have worked with the idea that countries with higher levels of independence could, over time, keep prices more stable than the countries in which the central bank was relatively more dependent or less autonomous from overall government policies. One of the main empirical arguments in favor of delegating greater autonomy to central banks is due to the success of price stability obtained by central banks of Germany and Switzerland. These experiences led to a range of countries delegating greater sovereignty to their respective central banks during the decades of the 80s and 90s (Mendonça, 1998).

On the theoretical side there are three lines of arguments favoring Central Bank independence (ICB). First it is the one made by public choice theory. According to this theory the monetary authorities are exposed to strong political pressures so that they are forced to behave according to the preferences of the rulers. These pressures exerted by political authorities could be, for example, the explanation of political business cycles investigated by Allen (1986), and motivated by the study of pre-election periods cycles of Nordhaus (1975). In such cases, from the point of view of public choice theory, the degree of independence of Central Bank (ICB) matters for the results of monetary economic policy.

The second argument in favor of Central Bank independence is presented by Sargent and Wallace (1981). For these authors, there is a clear distinction between monetary and fiscal authorities. According to them if the central bank authorities do not act independently there may be monetary instability. If fiscal policy is dominant, the monetary authorities cannot control the money supply, because it ends up becoming endogenous to the system. In this case, the monetary authorities will be forced to finance the public deficit by money creation. On the other hand, if monetary policy is dominant, the tax authorities will be required to reduce the deficit, or repudiate part of it. The higher the degree of ICB, the less monetary authorities would be coerced to finance government deficits through money creation.

The third and main theoretical argument used to support studies concerning central bank independence is regarded as the problem of time inconsistency, first developed by Kydland and Prescott (1977). This research subject was improved by Calvo (1978) and Barro and Gordon (1983). The problem of dynamic inconsistency starts when the best plan prepared in the present to some future period differs from the plan that would be optimal economically. In this situation, although the policy chosen by the policymaker is consistent, it is not socially optimal, leading to higher rates of inflation without a consequent increase in the level of output. This is due to the fact that agents behave under rational expectations. Thus, the institutional apparatus of an independent central bank would be able to reject the possibility of using inflation surprise in order to gain real variables improvement in the short run (Mendonça, 2001).

The importance of the ICB is related to two possible advantages arising from this institutional arrangement. First, with the ICB, the board of governors would be free of the political pressures to monetize budget deficits and so explore the tradeoff between inflation and unemployment. The second

advantage is associated with the objectives of the central bank. The more independent the central bank is, the more prone it will be to pursue its "natural target", which should be the pursuit of price stability (Mendonça, 2001).

Table 1 summarizes some studies that indicate mainly negative relationships between inflation and legal independence of the central bank for industrialized countries. However, in developing countries, this result does not hold. Still according to table 1, for developing economies, there is not yet a consensus regarding the negative relationship between inflation and ICB. Depending on the variable and the method used, the results differ substantially. In general, Central Bank president turnover does affect price stability in developed economies, but not so much in developing economies.

Table 1. CBI empirical evidence

Authors	Sample	Type of index	Results
Grilli, Masciandaro & Tabellini (1991)	Industrialized Countries	Political and Economic Independence	Negative relation between independence index (CBI) and inflation, with no relation to growth rate of product
Cukierman, Webb & Neyapty (1992)	Industrialized Countries and Developing Countries	Turnover Rate, Legal Independence, Survey, and Aggregate	CBI index and inflation are negative in industrialized countries. Turnover rate are significant in developing countries.
Alesina & Summers (1993)	Industrialized Countries	Legal Independence, Political and Economic Independence	CBI index shows negative relation with inflation but no relation to real economic variables.
Campillo & Miron (1997)	Industrialized Countries and Developing Countries	Turnover Rate, Legal Independence, Survey and Aggregate (CWN index)	The relation between CBI and inflation presented low significance.
Mangano (1998)	Industrialized Countries	Legal Independence, Political and Economic Independence	No significant relationship between CBI and inflation.
Mendonça (2001)	Brazil	Survey/Questionnaire	CBI index has no negative relationship with inflation
Mendonça (2006)	Brazil	Turnover Rate and Legal Independence	Neither significant relationship between CBI index and inflation, nor between inflation and turnover rate.
Anastasiou (2009)	39 countries of OCDE	Legal Independence	Negative significant relationship between CBI index and inflation.
Klomp & Haan (2010)	100 countries	Turnover Rate and Legal Independence	Negative relationship between CBI index and inflation only for some countries.

Sources: Author's collection

Although the turnover rate of the presidents of CB is an interesting attempt in the direction of independency, we must look for other variables that could be used as a proxy for independence. Furthermore, finding a series that is monthly or even quarterly and that satisfies the proxy condition for Central Bank Independence degree is another barrier to overcome. Therefore, we follow the Mutter, Dias and Dias (2013) and use the percentage of rotation of directors of the Monetary Policy Committee

(Copom) as a proxy to capture the degree of actual independence of CB. This enables us to build a monthly indicator of CBI. Finally, most of the studies reviewed use cross-section regressions. Therefore, the overtime performance of the Central Bank president and monetary policy adherence is accounted for. In our view this is important omitted information since the dynamics of inflation in each country is not well captured. Our strategy is to estimate a SVAR (Structural Vector Autoregressive) for Brazil in order to capture the long run dynamics of monetary policy associated with its adherence and Copom members' rotation.

3. Reaction function and turnover of directors

From the late 1980s to the early 1990s, along with Bade and Parkin (1988), Cukierman (1992), and Alesina and Summers (1993) pointed that institutions, especially those who controlled monetary policy, could be crucial to explain the differences between the behavior of prices in various countries. The main theoretical argument increased with the rational expectations revolution, first proposed by Muth (1961), further developed by Lucas (1972), and consolidated and systematized by Kydland and Prescott (1977) on the problem of dynamic inconsistency of monetary policy. Kydland and Prescott (1977) argued that the way in which monetary policy was implemented implied that policymakers were tempted to follow a behavior that would cause an inflationary bias without any increase in real output. Thus, the establishment of an institution of independent monetary policy goals and unique stabilization of prices could be a possible solution to the problem of inflation bias.

Since then, empirical studies have tried creating or using some index of central bank independence and relating this information with the level of inflation in the countries, notably Cukierman, Webb and Neyapti (1992), Alesina and Summers (1993), Campillo and Miron (1997), Mendonça (2006), and Haan and Klomp (2010). Because there is no consensus over the results about the effects of ICB on inflation in developing countries, the authors, except Alesina and Summers (1993), used the turnover rate of the president of central banks as a proxy for independence and tested it against inflation. In general, for developing countries the results showed a negative relationship between turnover rate and inflation.

Considering the Brazilian experience, in recent years, especially after the stabilization of prices in 1994, the turnover rate of the President of the Central Bank of Brazil (BCB) has decreased significantly. Since the beginning of the Real Plan (*Plano Real*) eight different presidents occupied the head office. Specifically after the inflation-targeting regime, the president of the BCB has only been replaced twice. However, although there has been a significant drop in turnover of the BCB's president, there were 29 replacements of directors of the board of governors with voting power decisions in the Monetary Policy Committee (Copom) from 2001 to 2011. Then, on average, all members of the board were replaced four times during the period analyzed here.

The question to be examined is whether the rotation of directors of Copom may have somehow influenced the conduct of monetary policy in the post-inflation targeting regime in Brazil. More specifically, did the turnover of Directors influences the determination of interest rates in the Brazilian Economy? Dias, Teixeira, and Dias (2009) applied a VAR model to the reaction function of the Brazilian Central Bank, adding a *dummy* variable to account for rotation of directors of Copom. The dummy had the value 1 for those occasions when there was a replacement of one or more directors and zero otherwise.

In this context, one aim of this paper is deepening the work of Dias, Teixeira and Dias (2009), innovating with respect to the estimation method by using a structural VAR model and treating the variable rotation of the directors of Copom in percentage terms, rather than a dummy variable. The use of dummies to represent the turnover is considered a limitation by the literature. Furthermore, the expanded sample period allows greater robustness to the results. Therefore, a reaction function for the Central Bank of Brazil is estimated, including the variable turnover among the explanatory variables of the model (ROTATIPERCENT).

4. Monetary programming and reaction functions

The index created by Cukierman, Webb and Neyapti (1992) has been replicated by many studies on central bank independence. Accordingly, countries with targets to monetary aggregates tend to have a more independent central bank against those who have not. The greater the grip in relation to pre-established goals, the greater the commitment of the central bank, thereby having a higher independence index. In general, good adherence occurs when the value of the monetary aggregate for a given period is inside the predicted one by the monetary authority.

In Brazil, although there is no commitment to monetary targets explicitly, there is monetary programming in which the predicted values are set in advance to monetary aggregate variation. Monitoring monetary aggregates has long run relationships to average price levels. Deviations from expected future values of money may affect inflation-desired values. In this respect, the European Central Bank is a well-known example of a committed monetary authority to monetary programming. Thus, this topic has the following objectives: to investigate what is the adherence of the Central Bank monetary program; to identify possible causal relationships between adherence in relation to goals and other variables such as interest rates, inflation and inflationary expectations; and lastly, to investigate whether the monetary authorities manage the interest rate when there is a deviation of the expected values and occurred ones during the period of monetary program.

Here, the monetary aggregate used for analyses is the means of payments (demand deposits plus currency held by the public, M1), and the variable defined to represent adherence is called Monetary Aggregate Target (MAM). Given its role in the efficiency of the inflation-targeting regime, this study about the monetary programming adherence in Brazil contributes with this new indicator of independence of BCB and the empirical methodology employed. The time series analysis applied with structural VAR model can identify precedence and relations for the long run, making use of Granger causality tests, impulse response functions, and variance decomposition.

5. Empirical methodology

5.1. The macroeconomic variables

The proposed economic variables below related to the reaction function theory are supposed to capture the Copom's members influence on monetary policy. The monthly data used for adjusting the reaction function is from July 2001 to December 2011. Two things did influence the chosen period. First, the rate of expected inflation is available only after July 2001. Second, this period excludes the period of transition goals for the currency inflation-targeting regime, which was a period of adjustment to the new regime,

leading to relatively higher volatility in the data. The source of the variables is Central Bank of Brazil⁴; otherwise is indicated in the footnote. The variables and their explanations are as follows.

Inflation Rate (CPI): National index of consumer prices - wide concept (IPCA)⁵ - percentage variation in 12 months provided by IBGE⁶.

Inflation Expectations (EXPCPI): Expected average Inflation (IPCA) - accumulated rate for the next 12 months, provided by the Central Bank of Brazil through the FOCUS Report.

Desvio: Difference between CPI accumulated in 12 months and the target set by the National Monetary Council (CMN) in period "t".

Expdesvio: Difference between accumulated inflation expectations in the next 12 months available through the FOCUS Report and the inflation target set by (CMN) in period "t".

Selic: Nominal interest rate set by the Monetary Policy Committee (Copom). Since the Meeting on 04/Mar/1999, this rate was defined as the main monetary policy instrument.

Gapproduto1: Difference between the current product and its potential level. The Industrial Production Index (PIND) was used as a proxy for the monthly economic performance. The potential output is determined by the trend of PIND, which in turn is obtained by applying the Hodrick-Prescott Filter technique. Therefore, the calculation of the gap of the product (GAPPRODUTO) can be performed as follows,

$GAPPRODUTO = (Real\ Product) - (Potential\ Product),\ or$

$GAPPRODUTO = (PIND) - (Trend\ of\ the\ Industrial\ Production\ Index).$

Rotati percent: Variable that represents the turnover rate of the directors (governors) of Monetary Policy Committee (COPOM). This series was constructed from the Copom's meeting report provided by BCB.⁷ This is an index proposed by Dias, Teixeira and Dias (2013). It is an alternative to the turnover rate of the president of Central Bank used by Cukierman, Webb and Neyapty (1992), Campillo and Miron (1997), Mendonça (2006), and Klomp and Haan (2010).

For the calculation of the variable, divide the number of Copom's directors with the right of voting that were replaced in a particular meeting to the number of members present, more specifically: *Turnover Rate*⁸ = Quantity of directors replaced/Total directors present in the Meeting.

Monetary Aggregates Target (MAM): Difference between the quantities of money (M1) actually occurred and the programmed one by the monetary authority in a given period:

⁴ www.bcb.gov.br

⁵ IPCA: *Índice de Preços ao Consumidor Amplo* (CPI, broad concept).

⁶ IBGE: *Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute of Geography and Statistics).

⁷ Although admitting that the higher the rotation of the president of Central Bank, the lower would be the degree of independence, Cukierman (1996) gives attention to for situations in which low substitutions may indicate high subservience from Central Bank representatives to government goals, characterizing high degree of dependence.

⁸ A study on the causes of the replacement of the directors of the Central Bank would be interesting; however, these factors are not available to the general public, so we will treat only the quantitative issue.

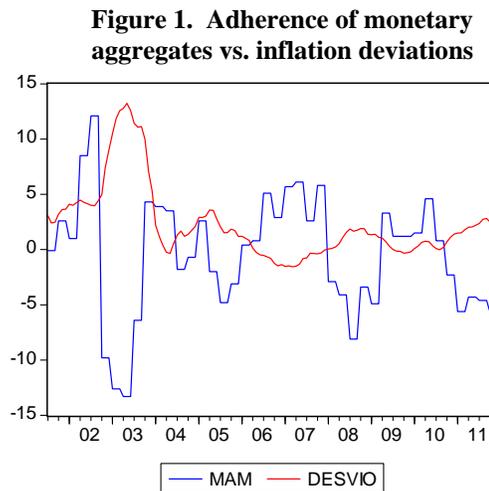
$$MAM_t = (Effective\ Variation)_t - (Predicted\ Change)_t$$

A higher adherence of monetary aggregates means that the effective changes are very close to the predicted one in M1.

5.2. Inflation targeting and monetary aggregates

The behavior of monetary aggregates in Brazil is summarized in figure 1. The variable (MAM) represents the difference in percentage terms between occurred variation of M1 and its predicted variation reported by policymakers in the monetary program, quarterly. The variable DESVIO is the difference in percentage terms between the price index accumulated in 12 months (IPCA) and the inflation target pursued by the government during 2000 through 2011, quarterly.

Figure 1 indicates there is a relative volatility in MAM, the difference of the actual value of the means of payments from its predicted one by policymakers. Note the inverse relation between these deviations and the deviations of inflation from target. The bias in MAM coincides with a deviation of the inflation from its target level with lags. Also, there is a sharp volatility in the period from 2001 to 2003, in which the difference between the predicted values and actual ones exceeded 10% in some quarters. However, for latter periods, the series show lower volatility compared to the initial one. In general, it is clear that in many periods, the actual values exceeded or were below predicted ones over several periods, showing a low grip to the monetary aggregates.



5.3. Granger causality tests

In order to identify the relationship between the variable (MAM) and the other system variables, Granger causality tests are performed. Table 3 displays relationships of precedence among the variable system.⁹

Table 2 implies temporal precedence from MAM to the variable system at the significance level of 5%, including DLSELIC, DLDESVIO, DLEXPDESVIO, GAPPRODUTO. On the other side, DLSELIC can Granger cause MAM, at 5% significance, while DLEXPDESVIO, GAPPRODUTO could precede MAM at 10% level of significance. These results indicate some feedback relationship among the variables. One interpretation is that deviations from the value of the monetary aggregate in relation to its predicted values may be an important leader indicator to anticipate changes in inflation and agents' expectations.

Table 2. Granger causality tests

Null Hypothesis	F statistics	Probability
MAM does not Granger Cause DLSELIC	7.85383	8.20E-05

⁹ Granger causality tests were performed to all pair of variables in the system. These helped deciding the equation to be tested in the VAR system.

DLSELIC does not Granger Cause MAM	3.31906	0.02239
MAM does not Granger Cause DLDESVIO	4.64192	0.00422
DLDESVIO does not Granger Cause MAM	1.23742	0.29945
MAM does not Granger Cause DLEXPDESIVO	6.87636	0.00027
DLEXPDESIVO does not Granger Cause MAM	2.29582	0.08145
MAM does not Granger Cause GAPPRODUTO	2.67544	0.05047
GAPPRODUTO does not Granger Cause MAM	2.32577	0.07840

Note: 03 lags, 122 observations, monthly observations.

6. Empirical modeling

6.1. The basic SVAR model

Identifying and measuring the response of monetary authority to stabilize inflation and output around their predetermined values and demonstrating the effects of actual independence of BCB on the interest rate required estimations of reaction functions à la Taylor (1993), incorporating expectations, as in Clarida *et al.* (1998), Meyer (2001), Arestis and Sawyer (2002), among others.

The hypothesis tested here is that if the substitution of directors entitled voting took place through political pressure, then the BCB would be less independent than ideal. Therefore these changes would be negative to the interest rate because it is assumed that higher turnover implies a lower level of independence of BCB until a certain threshold. Being less independent, the BCB would give less attention to the control of inflation, which would translate into more flexible policies regarding the interest rate. Moreover, the variable MAM refers to the deviation from the target monetary aggregate to the value provided by the monetary authorities to a particular period. It therefore measures the adherence to the monetary intermediary targets. This accounts for the degree of independence of BCB, according to the methodology proposed in Cukierman, Webb and Neyapty (1992). The higher the adherence of the goals to monetary aggregates, the higher the independence of BCB.

The structural VAR model studies the effects of rotation of BCB's directors of Copom and the adherence of monetary aggregates through a reaction function. With this, can be verified the long-run relationship among the variables during inflation target regime in Brazil. The Structural VAR allows us to test whether the effects of explanatory variables treated as exogenous remain in the long run. Accordingly, the structural model specification is:

$$Y_t = \begin{bmatrix} \text{MAM} \\ \text{GAPPRODUTO} \\ \text{ROTATIPERCENT} \\ \text{DLEXPDESIVO} \\ \text{DLDESVIO} \\ \text{DLSELIC} \end{bmatrix}; C = \begin{bmatrix} C_{11} & 0 & 0 & 0 & 0 & 0 \\ C_{21} & C_{22} & 0 & 0 & 0 & 0 \\ C_{31} & C_{32} & C_{33} & 0 & 0 & 0 \\ C_{41} & C_{42} & C_{43} & C_{44} & 0 & 0 \\ C_{51} & C_{52} & C_{56} & C_{54} & C_{55} & 0 \\ C_{61} & C_{62} & C_{63} & C_{64} & C_{65} & C_{66} \end{bmatrix}; e_t = \begin{bmatrix} m_t \\ g_t \\ \text{rot}_t \\ \text{exp}_t \\ d_t \\ \text{in}_t \end{bmatrix} \quad (1)$$

Accordingly, the coefficients C61, C62, C63, C64, C65 and C66 represented in the empirical model are long run effects over the interest rate instrument of the following variables, respectively: MAM,

GAPPRODUTO, ROTATIPERCENT, DLEXPEDSVIO, DLDESVIO, and DLSELIC. The vector \mathbf{e}_t indicates the sources of the shocks coming from each variable of the SVAR system.

As mentioned before, DLSELIC is the difference of the logarithm of the interest rate (basic Selic rate); DLDESVIO is the logarithm of the rate of inflation minus its target level in the first difference; DLEXPEDSVIO is the logarithm of expected inflation from the target in first difference; and ROTATIPERCENT represents the turnover of the Directors entitled to vote in the Monetary Policy Committee (Copom) in percentage terms, in each given month. Including the latter variable aims to identify whether the changes of one or more directors of Copom interfere in the decisions of the Committee over the instrument interest rate and if it does, whether the magnitude is positive or negative. Also, it is expected that the more independent the central bank is, the more the monetary authority will react to stabilize inflation. Thus, it is expected that a positive deviation from the target aggregates (MAM) would translate into a positive movement in interest rates.

As required, the variables were tested for stationarity with Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.¹⁰ The variables GAPPRODUTO and MAM can be considered stationary. By the contrary, interest rate, expectations deviations from target and deviation of actual inflation from its target could not be classified as stationary variables. Then, they are first differences. Selecting the model, another test was the lag length criterion. The results indicated one and three lags, depending on the chosen criterion. This is reasonable considering that monetary policy decisions are based on solid information over a time period, and thus the estimated model used the first and third lags of information. It also accomplished the lag exclusion tests. The results suggested that the lags one and three should not be excluded from the model.

The order of the variables in the SVAR system was chosen according to the Block Exogeneity/Wald Tests. The tests indicated that MAM and GAPPRODUTO had zero probability of being excluded as exogenous variables in the interest rate reaction equation (DLSELIC). Overall, the χ^2 statistics to the system set indicates no probability of exclusion. The variable ROTATIPERCENT has some probability of being endogenous. However, when the rotation is simulated as the dependent variable, all the other variables could not be considered as fully exogenous.

Nevertheless, the test for stationary residuals to the VAR system indicated no unit root for the residuals. It also showed that all characteristic AR roots fall inside the unit cycle. Moreover, the estimation tested two Dummy variables. The first includes the period of June 2002 to June 2003, capturing the crisis of confidence over presidential election because some variables appear more volatile behavior compared with the total period. We also tested a Dummy for the crisis of subprime mortgages of 2008. Considering the objective of a long-run analysis, they were excluded from the SVAR model. The resulting coefficients are displayed in equation (02).¹¹

¹⁰ ADF test comes from David Dickey and Wayne Fuller (1979, 1981) and the PP test follows Phillips and Perron (1988).

¹¹ The stars indicate significance at 1% (***) , 5% (**) or 10% (*) levels.

$$Y_t = \begin{bmatrix} \text{MAM} \\ \text{GAPPRODUTO} \\ \text{ROTATIPERCENT} \\ \text{DLEXPDESvio} \\ \text{DLDESvio} \\ \text{DLSELIC} \end{bmatrix}; C = \begin{bmatrix} +1040 & 0 & 0 & 0 & 0 & 0 \\ (0.00)^{***} & & & & & \\ +0012 & +0077 & 0 & 0 & 0 & 0 \\ (0.00)^{***} & (0.00)^{***} & & & & \\ -0014 & +0028 & +0077 & 0 & 0 & 0 \\ (0.05)^{**} & (0.00)^{***} & (0.00)^{***} & & & \\ +0013 & +0012 & -0011 & +0073 & 0 & 0 \\ (0.07)^* & (0.07)^* & (0.08)^* & (0.00)^{***} & & \\ +0004 & +0049 & +0037 & +0008 & +0097 & 0 \\ (0.78) & (0.00)^{***} & (0.00)^{***} & (0.00)^{***} & (0.00)^{***} & \\ +00119 & +0041 & +0008 & +0006 & +0018 & +0028 \\ (0.015)^{**} & (0.00)^{***} & (0.00)^{***} & (0.06)^* & (0.00)^{***} & (0.00)^{***} \end{bmatrix}; e_t = \begin{bmatrix} m_t \\ g_t \\ \text{rot}_t \\ \text{exp}_t \\ d_t \\ \text{in}_t \end{bmatrix} \quad (2)$$

Note that all coefficients in the SVAR system are significant except C_{51} . The last line of (02) indicates the reaction function of Central Bank of Brazil with the variables turnover and money programming accounting for the efficiency of monetary policy with inflation targeting. The results indicate that there is a significant long-run relationship among the variables of the system and DLSELIC – the interest rate instrument of monetary policy in Brazil. Looking at the above equation it states that the most important variable for monetary policy is MAM (Monetary Aggregates Target) followed by the output gap (GAPPRODUTO), the Copom’s directors turnover (ROTATIPERC ENT), the rate of inflation change from its target from the past twelve months (DLEXPDESvio), and the inflation deviation (DLDESvio). These variables determine the long run changes in the interest rate (DSELIC).

As one may notice both variables accounting for the efficiency of monetary policy and representing some policy independence for the Central Bank of Brazil are significant and positive. Therefore, an increase of 10% in the variations of money from its announced values would increase the growth of interest rate by +0.12% in the long run. Accordingly, a rise in the turnover of Copom’s director would affect the interest rate +0.008 in the long run. This means that if turnover of the Directors of Copom is maintained in the long run, then the Central Bank would be interpreted as less independent, making monetary policy less reliable. This lack of credibility contributes to inflation deviations from its target, which in turn forces the monetary authority to increase the growth rate of interest. Thus, higher turnover rate would demand increases in interest rates over the long run, which causes high social cost to the economy.

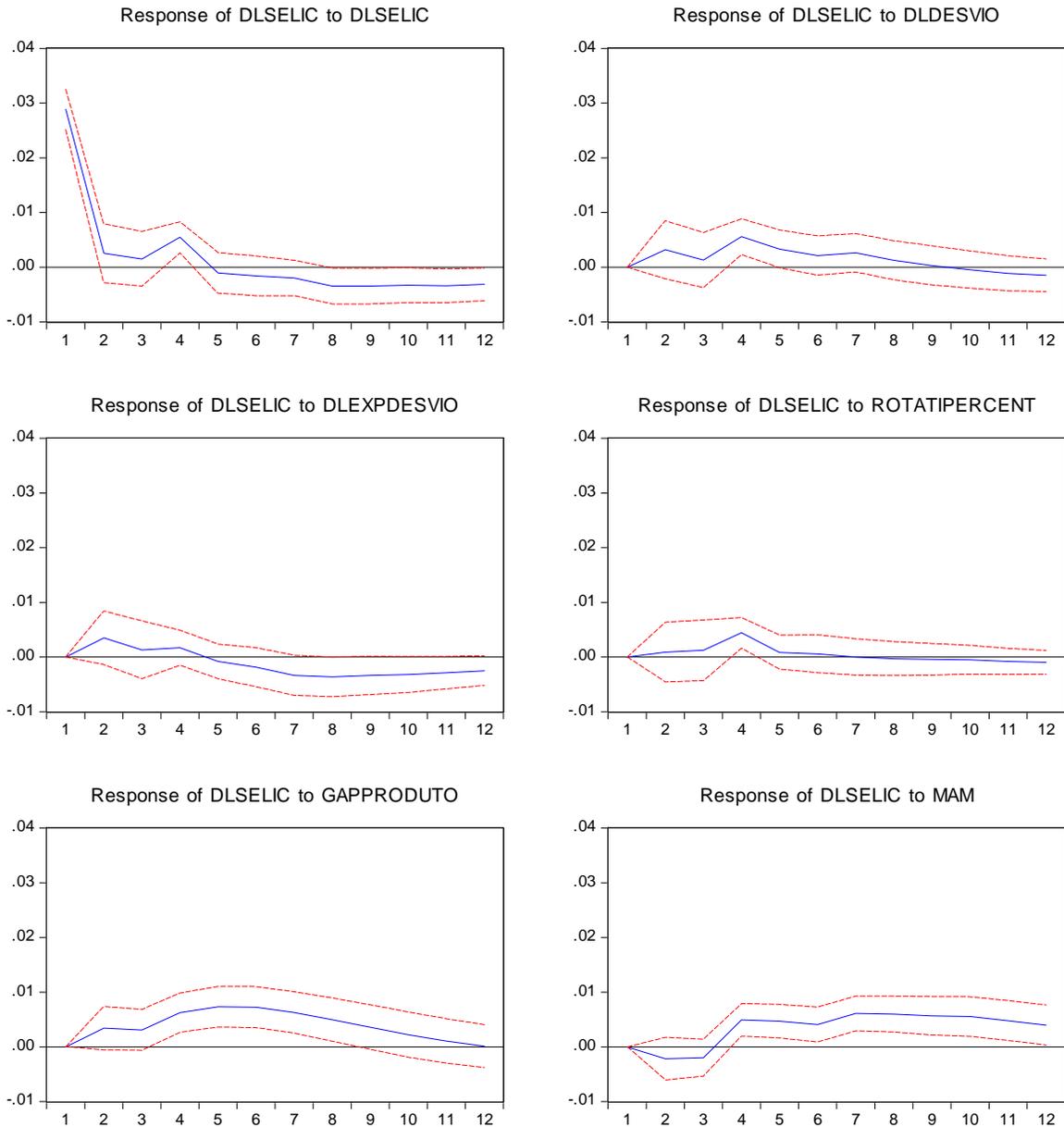
As shown the rotation of the directors of the monetary policy committee at a high frequency may be harmful to the conduct of monetary policy. It somehow signals that the directors do not have sufficient autonomy or are subject to the pressures of political government for purposes other than price stability, which can generate mistrust to the market and thereby affecting the credibility of the monetary authority. Ensuring robustness of the model implies to attend the stability conditions, which were verified. Then, we tested for autocorrelation in the residuals, normality, and stationarity. Results of the impulse response functions, considering the shock of the system variables on the interest rate (DLSELIC) are also displayed.

6.2. Impulse response functions and variance decomposition analyses

Initially, the impulse response functions are shown in figure 2. As expected, there is an inertial component in the interest rate carried over its growth rate. A shock from DLSELIC of the size of its standard deviation causes a positive reaction to itself of 0.03, changing its growth rate. In addition, a shock in the deviation of inflation from its target level causes increases in the interest rate of growth that are dissipated only 10 months later, which is in accordance with a central bank behavior committed to price stability.

Figure 2. Impulse response functions – DLSELIC

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



In relation to the output gap, the results indicate that the monetary authority in the Brazilian economy behaved in a manner sensitive to changes in the product relative to potential output. The impulse response function shows that a one standard deviation shock on the output gap is accompanied by a rise in the interest rates. This implies that the monetary authority has taken into account the current state of the economy in its monetary policy decisions.

Regarding the percentage turnover of the directors of Copom (ROTATIPERCENT), observed through impulse response functions, the variable DLSELIC reacts to turnover of directors following a positive increase. That can be seen especially between the third and fifth months. Despite the small reduction in the

interest rate growth in the first two months, this indicates that the changing of the directors of Copom may not be followed by monetary easing, causing the interest rate growth to increase in the long run.

On the other hand, a shock coming from the variable MAM negatively affects the growth of the interest rate, reducing DLSELIC until the third month. After that, changes in the interest rate become positive, indicating that central bank reduces the growth of the SELIC initially, probably to identify the sources of the shock and the reaction of the market. One quarter later, a time equivalent to two meetings of the Central Bank Committee for monetary policy, policymakers increase the interest rate, which remains higher than average for at least 8 months. In any case, the impact of shocks from directors' turnover can be positive in Brazil because of the recent experience in hyperinflation. Since changes in the rotation of directors of Copom could configure monetary easing, then interest rate growth should increase to offset that interpretation.

Another tool from VAR models is the analysis of variance decomposition of the forecast error, displayed in table 3. The variance decomposition estimates the relative participation of innovations to each endogenous variable in the VAR (Enders, 1995).

According to the variance decomposition results from table 3, the analysis of impulse response functions are confirmed. First, note the inertial characteristic of the interest rate variation (DLSELIC). That is, most of the variance of the interest rate is explained by shocks on itself. The second highest influence on DLSELIC is the output gap, which accounts for 16.54% of the growth rate of interest in the short run in nine months, and goes to about 15.49% after 12 months. The variable accounting for monetary adherence of the policy contributes to the growth rate of interest by 15.28% to its variance. The turnover variable can explain 1.55% of the variance of the interest rate growth. Together, both variables represent the efficiency of the monetary policy of Central Bank of Brazil and can reduce the variance of the interest rate growth about 16.84%, higher than the role of the output gap.

Table 3. Variance decomposition of predicted error

Period	S. E.	DLSELIC	DLDESPIO	DLEXPDESPIO	ROTATIPERCENT	GAPPRODUTO	MAM
1	0.028846	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.029628	95.51771	1.149684	1.383622	0.088251	1.317613	0.543122
3	0.029971	93.59593	1.305796	1.537434	0.245945	2.344873	0.970020
4	0.032316	83.35073	4.087071	1.591825	2.075327	5.736313	3.158738
5	0.033664	76.90561	4.735504	1.526206	1.975178	10.01959	4.837910
6	0.034827	72.06567	4.789848	1.718982	1.872421	13.67244	5.880633
7	0.036218	66.94008	4.940374	2.455801	1.731473	15.64588	8.286395
8	0.037403	63.62915	4.742198	3.253974	1.630540	16.42865	10.31549
9	0.038308	61.47833	4.526971	3.879729	1.567890	16.53632	12.01076
10	0.039048	59.89124	4.371405	4.409538	1.526863	16.23985	13.56110
11	0.039633	58.87827	4.327750	4.810762	1.526012	15.83632	14.62089
12	0.040075	58.20937	4.372655	5.097483	1.552788	15.48941	15.27830

Note: Cholesky ordering is DLSELIC, DLDESPIO, DLEXPDESPIO, ROTATIPERCENT, GAPPRODUTO, MAM.

6.3. SVAR with MAM exogenous

In this empirical application the SVAR model now considers the efficiency of Monetary Aggregates Target (MAM) as exogenous. This variable represents the efficiency of monetary policy being practiced and therefore it conducts in our view the remaining variables. The Block/Exogeneity Wald test performed also corroborates with this view and the sequence of the variables in the SVAR model.

All necessary tests to approve the robustness of VAR system in its lags structure were performed. The number of lags chosen by the tests was one and three, as before. The autoregressive characteristic roots fall inside the unit cycle, resulting in a stable VAR. After estimating the stability conditions of residuals, autocorrelation, normality and stationary conditions were also tested to accept the results. Therefore, all other variables of the SVAR system remained as in equation (01) and (02). Now, the only difference is that MAM is placed as exogenous in the calculations. In addition, no dummy variables were used in this system. The estimated parameters are displayed in equation (03).¹²

$$\mathbf{Y}_t = \begin{bmatrix} \text{GAPPRODUTO} \\ \text{ROTATIPERCENT} \\ \text{DLEXPDESUDIO} \\ \text{DLDESUDIO} \\ \text{DLSELIC} \end{bmatrix}; \mathbf{C} = \begin{bmatrix} +0089 & 0 & 0 & 0 & 0 \\ (0005*** & & & & \\ +0036 & +0077 & 0 & 0 & 0 \\ (0007*** & (000*** & & & \\ +0047 & -0008 & +0090 & 0 & 0 \\ (0008*** & (0008 & (0006*** & & \\ +0102 & +0039 & +0107 & +0099 & 0 \\ (0015*** & (001)*** & (001)*** & (0006*** & \\ +0065 & +0008 & +0022 & +0016 & +0032 \\ (0005*** & (0004*** & (0004*** & (0003*** & (0002*** \end{bmatrix}; \mathbf{e}_t = \begin{bmatrix} \mathbf{g}_t \\ \text{rot}_t \\ \text{exp}_t \\ \mathbf{d}_t \\ \text{in}_t \end{bmatrix} \quad (3)$$

Note that these results are very similar to the system from equation (02), in significance and positive or negative direction of effects. One difference is that the turnover variable can no longer affect the expectations of deviations of inflation from its target level in the long run. Also, some effects were improved. For instance, a change in the expectations of inflation deviations from its target would increase the growth rate of interest by 0.022 in the long run. Interest rates still respond to the turnover of directors of Copom. The turnover thus accelerates the interest rate changes. The higher is the turnover the higher is the interest rate change. This means the cost of doing monetary policy is higher under increasing Copom's directors turnover rates.

From using this model, one can obtain significant results for analysis of the relationships among system variables. Analysis of variance decomposition and impulse response functions, for example, are important instruments to understand the behavior of the variables.

6.4. Impulse response functions and variance decomposition analyses: MAM exogenous

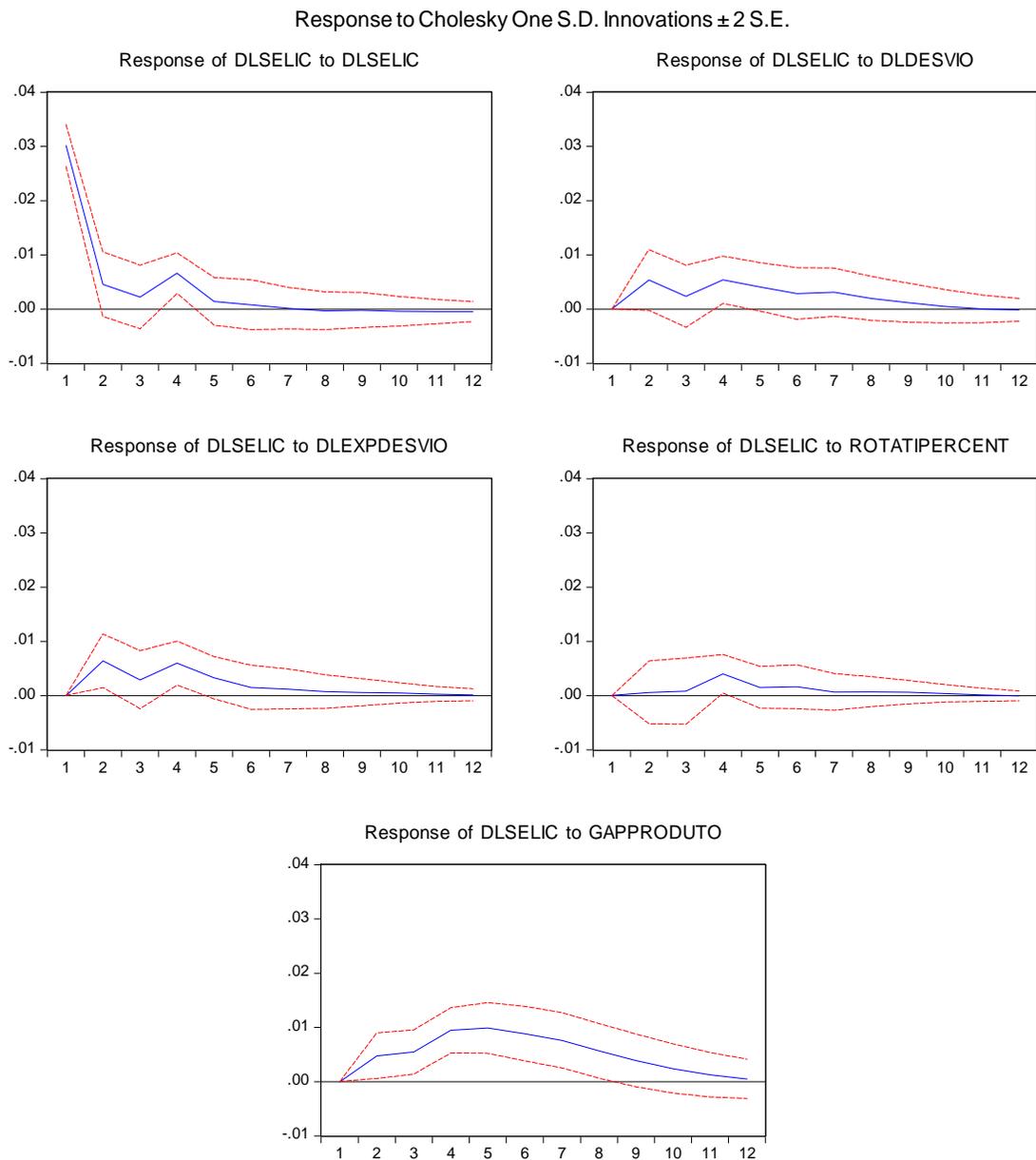
From the impulse response functions, it is possible to dynamically analyze the effect of one standard deviation shock to one of the system variables and the resulting response on the variable selected. Here, we concentrate in the effects over the interest rate determination, in logarithm terms and first difference,

¹² The stars indicate significance at 1% (***) level.

with shocks arising from the interest rate itself, deviations of inflation from its target, expectations of these deviations, turnover of directors, and output gap, considering the efficiency of monetary policy as exogenous to the SVAR system.

Overall, the results from simulated shocks or innovations are similar to those found in figure 3. The degree of inertia in the interest rate growth is observed now with a positive response in the DLSELIC functions from a shock to DLSELIC itself. Also, a shock from the output gap accelerates the growth of interest rate during the 12 months exhibited. Shocks from deviations of inflation from its target or expectations of deviations have the same effect over interest rates, creating a positive fluctuation from its mean over time. These shocks result into two positive peaks until the fourth month.

Figure 3. Impulse response functions: DLSELIC



Note: Results from estimations.

The shock coming from the turnover rate over interest rate growth are very stable during all results of the VAR system, with a peak of 0.04 deviation of interest rate from the mean at the fourth month. Notice that the return of interest rate to its mean is very slow.

The following analysis considers the results obtained by decomposition of the variance of the interest rate growth, according to Enders (1995).

Again, this model indicates a high degree of inertia in DLSELIC, most of the variance of that variable is represented by variations in the variable itself, by 90.99% in the second month. When considering the variable MAM as exogenous to the SVAR system, most of the variance of the interest rate is due to shocks coming from the output gap, showing a concern of the monetary authorities to the economic activity or unemployment. Also, effective deviations of inflation from its target or its expectations have the same impact over interest rates.

Table 4. Variance decomposition of DLSELIC

Period	S. E.	DLSELIC	DLDESPIO	DLEXPDESPIO	ROTATIPERCENT	GAPPRODUTO
1	0.030182	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.031997	90.99657	2.783355	3.996553	0.030065	2.193458
3	0.032756	87.28998	3.170598	4.594631	0.087927	4.856861
4	0.035869	76.20532	4.886438	6.599128	1.316052	10.99307
5	0.037621	69.41042	5.608758	6.758397	1.355520	16.86690
6	0.038819	65.23470	5.804501	6.494776	1.440101	21.02593
7	0.039696	62.38443	6.156908	6.301593	1.404423	23.75265
8	0.040156	60.96951	6.255165	6.188555	1.402282	25.18448
9	0.040369	60.33212	6.272075	6.143838	1.409047	25.84292
10	0.040449	60.10364	6.261789	6.132726	1.412463	26.08938
11	0.040472	60.04919	6.254728	6.130046	1.411630	26.15441
12	0.040478	60.04491	6.254692	6.128938	1.411546	26.15991

Note: Cholesky Ordering is DLSELIC, DLDESPIO, DLEXPDESPIO, ROTATIPERCENT, GAPPRODUTO. Results from estimations.

7. Conclusions

This paper examined macroeconomic monetary policy issues related to the interest rate determination. In particular, Central Bank Directors' turnover and monetary policy efficiency are used to account for interest rate target regime. The empirical analysis of Structural Vector Autoregressive models applied for the Brazilian economy did show that the turnover of the Copom's Directors and the monetary policy adherence matters for the long run monetary economic policy in Brazil in the estimated models. The two estimated models show that directors do look over the amount of aggregated money and its deviation from the optimal one as well as the output gap in order to choose the prevailing interest rate. These variables are the basic ones to be considered in any economic policy. However, it seems that such directors do not pay

any attention to their turnover in the committee. It is worth noting that the number of directors that were exchanged in Copom was relatively high (twenty nine) during the period of analysis.

By adding the Copom's turnover variable we learn that the social cost of doing monetary policy in Brazil is higher than without this variable. The reason is that the increase in the turnover rate leads to positive increase in the rate of change in the interest rate. So, higher interest rate means that the Central Bank is overpaying in order to hold inflation to its targeted level. The consequences of such conduct or the frequency of replacement of directors is that it generates some degree of uncertainty in the market and by extension reduces the Copom's credibility. This influences agent's expectations, making it harder and costly to fight inflation pressures.

Another important result is that in both models Monetary Aggregate Target (MAM), which is the difference between the quantities of money (M1) actually occurred and the programmed one by the monetary authority in a given period, was the ultimate exogenous variable. This variable measures monetary policy adherence. It seems to be the element that determines all the other variables behavior including the output gap, and inflation and interest rate changes. Thus, the low adhesion of monetary aggregates to its optimal level plus the relatively lengthy responses of the monetary authority may be the factors that cause volatility of inflation in the Brazilian economy. Hence, policymakers need to better monitor the monetary aggregates deviations from its optimal level. The payoff of such monitoring could be lower inflation rate deviations and therefore less social cost of monetary policy.

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Appendix

Methodology to Estimate the Degree of the Central Bank Independence

Variables and Definition Codes	Abbreviation	Codes
1. Turnover	rot	
a) Low		1,00
b) Medium		0,50
c) High		0,00
2. Limitations on Lending in Practice	rfsp	
a) Tight		1,00
b) Moderately Tight		0,66
c) Moderately Loose		0,33
d) Loose or Nonexistent		0,00
3. Resolution of Conflicts	rc	
a) Absence of Accommodation in some Cases		1,00
b) All, Except Items a and b		0,50
c) Accommodations in All Cases		0,00
4. Who elaborate the Budget of the Central Bank	obc	
a) The Central Bank		1,00
b) Central Bank and Executive/Legislative		0,50
c) Executive/Legislative		0,00

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5. Who defines Wages and Profit Distribution of the Central Bank?	sl	
a) Central Bank or Law		1,00
b) Central Bank and Executive/Legislative		0,50
c) Executive/Legislative		0,00
6. Quantitative Monetary Stock Targets	mam	
a) Such targets exist; Good Adherence		1,00
b) Such targets exist; Mixed Adherence		0,66
c) Such targets exist; Poor Adherence		0,33
d) No stocks targets		0,00
7. Formal or informal interest rates targets		
a) No	mtj	1,00
b) Yes		0,00
8. Actual Priority Given to Price Stability	pep	
a) First Priority		1,00
b) First Priority assigned to a fixed exchange rate		0,66
c) Price or Exchange Rate stability are among the bank's objectives, but not first priority		0,33
d) No mention of prices or exchange rate objectives		0,00
9. Function as a development bank, granting credit at subsidy rates?		
a) No	fqf	1,00
b) To some extent		0,66
c) Yes		0,33
d) Yes, heavily		0,00

Note: Cukierman, Webb, and Neyapty (1992).

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