The Effect of Central Bank Communication on the Capital Buffer of Banks: Evidence from an Emerging Economy

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ABSTRACT: The global financial crisis has revealed that the coordination between monetary policy and financial stability should be part of economic policy. This study examines the effects of monetary policy on the capital buffer (financial stability proxy) in the Brazilian economy and, in particular, how communication about both monetary policy and normative macroprudential policy affect the capital buffer maintained by banks. The study presents three main results: i) banks react strongly to monetary policy changes by increasing (reducing) the capital buffer in response to an increase (decrease) in the interest rate; ii) banks increase (decrease) the capital buffer when the central bank monetary policy communication signals an increase (decrease) in interest rates; and iii) banks use the capital buffer to accommodate the new measures of regulatory capital: the announcement of restrictive (liberalizing) capital measures reduces (increases) the capital buffer.

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Introduction

Financial stability is fundamental to the performance of the economy. Prior to the global financial crisis (GFC), policymakers viewed financial stability as a typical regulatory problem. The monitoring of bank behavior was not regarded as part of macroeconomic environment analyses (Woodford, 2010). The GFC challenged the assumptions of financial stability and created an environment of uncertainty with potential effects on the conduct of macroeconomic policies. In particular, the GFC has given rise to a new point of view in which the coordination between monetary policy and financial stability is seen as a necessary part of economic policy (Poloz, 2015).

Regarding the financial stability issue, the aftermath of the GFC was the highlight received by new macroprudential policies. In this sense, policymakers face the need to incorporate new macroprudential instruments into the set of policy concerns (Galati and Moessner, 2013). Among the alternatives, the literature identifies the capital buffer as the main macroprudential instrument for financial stability management (Borio, 2011). Capital buffers are capital holdings of banks that exceed the regulatory minimum. The capital buffer can be explained as insurance against the risk of breaching the minimum capital requirement, because (i) banks cannot instantly adjust their capital; and (ii) breach of minimum regulatory capital requirements triggers supervisory actions, which can lead to a high cost penalty for banks (Jokipii and Milne, 2008; Stolz and Wedow, 2011). Furthermore, Carvallo et al. (2015) argue that maintaining the capital buffer above the required minimum is a way to signal financial soundness to the market as well as to take advantage of profitable market opportunities.

One strand of the empirical literature on the capital buffer is concerned with analyzing the effect of business cycle fluctuations on banks' capital buffers. The findings of this literature are mixed about the effect of capital buffers on the business cycle (Ayuso et al., 2004; Lindquist, 2004; Jokipii and Milne, 2008; Stolz and Wedow, 2011; Shim, 2013). Another strand of the empirical literature examines the effect of the capital buffer on the risk-taking of banks. Overall, the literature reveals that banks with a higher capital buffer take less risk than less capitalized banks (Konishi and Yasuda, 2004; Repullo, 2005; Jokipii and Milne, 2011; Guidara et al., 2013). In addition, since the GFC, several empirical studies have investigated the link between monetary policy and financial stability through banks' behavior and the risk-taking channel (Altunbas et al., 2009; Borio and Zhu, 2012; Montes and Scarpari, 2015). Other studies extended this analysis to explain the connection between monetary policy and regulatory capital (de Moraes et al., 2016).

The analysis of the relationship between macroprudential instruments (e.g., the capital buffer) and monetary policy is a new challenge for policymakers. The policy design problem for central banks is how to set multiple instruments to meet multiple stabilization goals. There are theoretical advancements on the interplay between macroprudential and monetary policy that may help in addressing this problem. For example, DSGE models incorporate financial frictions in order to analyze coordination problems between monetary and macroprudential policies (Rubio and Carrasco-Gallego, 2014; Quint and Rabanal, 2014; Paoli and Paustian, 2017). However, empirical analyses of the relationship between capital buffers and monetary policy, as well as the effect of central bank communications on capital buffers, are still rare. Basel Committee on Banking Supervision (2010) points out that central banks do consider the effect of buffer communication on market expectations, on the behavior of their own capital buffer, and on financial stability. Born et al. (2012) highlight the importance of central bank communication to macroprudential supervision and show that the financial market reacts to central bank communication on financial stability issues.

We examine the effects of monetary policy on capital buffers (financial stability proxy) in the Brazilian economy and, in particular, how communication about both monetary policy and normative macroprudential policy affect the capital buffer maintained by banks. Brazil is an important case because it is an emerging economy in which the Central Bank of Brazil (CBB) explicitly aims at price stability and financial stability. In order to evaluate the effect of monetary policy, we use the basic interest rate in Brazil. For documenting the effect of central bank communication, we use two indicators: monetary policy communication and normative macroprudential policy communication. The first, extracted from the Monetary Policy Committee (COPOM) minutes, helps predict the next monetary policy decision of the CBB. The second represents a novel approach to measuring the effect of capital regulatory measures on financial stability.

To our knowledge, this is the first work that analyzes the relationship between the capital buffer, monetary policy, and central bank communication. Our work differs from the existing literature in several aspects. First, we investigate the relationship between monetary policy and financial stability in a different way. Whereas the literature is concerned with analyzing only the effect of monetary policy on bank risk-taking, this study examines the effect of monetary and macroprudential policies on the capital buffer. Second, we analyze the effect of communication about monetary policy and normative macroprudential policy on the capital buffer.

Our work has three main results that contribute to the empirical literature on the capital buffer, monetary policy, and central bank communication. First, the results indicate that banks react strongly to monetary policy changes by increasing (reducing) the capital buffer in response to an increase (decrease) in the interest rate. Second, we present evidence that banks increase (decrease) the capital buffer when the central bank monetary policy communication signals an increase (decrease) in interest rates, affecting more significantly the banks with riskier positions. Third, the central bank normative macroprudential policy communication does not have the desired effect on soundness and safety of the financial system because banks use the capital buffer to accommodate the new measures of regulatory capital: the announcement of restrictive (liberalizing) capital measures reduces (increases) the capital buffer.

The remainder of this work is organized as follows. The next section provides the data and methodology used in this work. Section 2 presents empirical evidence regarding the impact of monetary policy and of communication about both monetary policy and normative macroprudential policy on capital buffers. The last section concludes the work.

1 Data and Methodology

In this section, we present the data and methodology used to provide empirical evidence on the relationships among capital buffers, monetary policy, and central bank communication. The period of analysis runs from January 2006 to December 2016.[1] We gather the monthly data series used in this study from the CBB site.[2] The data used in this work are country-wide and the bank data represent the entire Brazilian banking sector.

The idea of the capital buffer, brought by Basel III, is to use a buffer of capital to protect the banking sector from periods of excess aggregate credit growth that have often been associated with a build-up of system-wide risks (Basel Committee on Banking Supervision, 2010). On the other hand, as pointed out by Carvallo et al. (2015), when banks are unable to build up a capital buffer in times of economic expansion, they can fail to meet the minimum capital requirements during an economic recession. This cyclical behavior of banks amplifies the effect of shocks on economic and financial stability because, in order to meet the minimum capital requirement, banks are forced to deleverage assets and reduce lending to the market (Borio and Zhu, 2012).

The capital buffer ($BUFFER$) is defined in our model as the excess capital held by banks in relation to regulatory capital. It is calculated by taking the difference between the capital adequacy ratio (CAR) disclosed by CBB and the minimum capital requirement in force in Brazil. The higher the $BUFFER$, the more solvent are the banks and the greater is the financial stability.

The benchmark model considers some macroeconomic variables that help to explain the capital buffer held by banks. The return on equity (ROE) is an indicator of the banks' profitability and represents the cost of capital. Generally, the capital buffer is accumulated through retained earnings. As pointed out by Stolz and Wedow (2011), high profits may reflect high charter values and, hence, the ability to consistently generate high profits and increase capital buffers through retained earnings. In this sense, in accordance with Milne

[1]The database begins in January 2006 due to the availability of liquidity index data.
[2]Table A.1 presents descriptive statistics.

and Whalley (2001), high profit banks have less need to hold substantial capital buffers as an insurance against a possible violation of the regulatory minimum. Therefore, it is expected that an increase in ROE implies a reduction of the $BUFFER$.

We also include output gap (GDP_GAP) as a proxy for the business cycle. It corresponds to the difference between the GDP accumulated in 12 months at current values and the potential output (Hodrick-Prescott filter). Some studies show that an increase in GDP_GAP results in a reduction of $BUFFER$, indicating that in a scenario of economic expansion (contraction), banks assume more (less) risks (Ayuso et al., 2004; Lindquist, 2004; Jokipii and Milne, 2008).

The credit gap ($CRED\_GAP$) corresponds to the difference between the credit-to-GDP ratio and the trend of long-term credit (Hodrick-Prescott filter). According to Basel Committee on Banking Supervision (2010), in times of economic expansion, banks are more risk prone and increase the supply of credit. Therefore, it is expected that an increase in $CRED\_GAP$ results in a reduction of the $BUFFER$.

Liquidity (LIQ) measures the volume of liquid assets that Brazilian banks keep available for the "programmed" and "not programmed" cash flow of the next 30 days (21 workdays), under a severe stress scenario. According to the findings of (Stolz and Wedow, 2011), it is expected that greater volumes of liquid assets increase the capital buffer.

Basic interest rate (IR) is the main instrument of monetary policy for inflation targeting in Brazil. We use the natural logarithm of the SELIC annualized interest rate. Montes and Scarpari (2015) showed that banks react to an increase in interest rates with an increase in risk aversion, demonstrated by increasing provisions to mitigate risk. As one of the provisions, the capital buffer is a proxy for bank risk aversion. Therefore, it is expected that an increase in IR will result in an increase of $BUFFER$, indicating that in a scenario of monetary tightening (easing), banks assume less (more) risk.

We also construct two dummy variables to measure the events that affect the capital buffer. $SUBPRIME\ CRISIS$ is a dummy variable for the period prior to the subprime crisis. It is equal to 1 in the period from January 2006 to July 2009 and 0 otherwise. $POLITICAL\ CRISIS$ is a dummy variable for the period of political instability in Brazil. It assumes value 1 in the period from December 2015 to December 2016 and 0 otherwise.

The dummy variables of the monetary policy communication are constructed according to the methodology developed by Rosa and Verga (2007). We apply the methodology using the COPOM minutes (see Table A.2). The COPOM minute is the main document released after each COPOM meeting to decide the basic interest rate. The minutes present information about the economic outlook, the monetary policy decision, and the path of the interest rate. When the central bank indicates an increase to the basic interest rate, the variable D_UP is equal to 1 and 0 otherwise. In turn, when the central bank indicates a reduction in the basic interest rate, the variable D_DOWN is equal to 1 and 0 otherwise.

We build the dummy variables of the normative macroprudential policy communication based on the regulatory capital measures published by the CBB whose purpose is to change the method for calculating the minimum requirement of regulatory capital (see Table A.3). This indicator represents a new methodology for measuring the effect of capital regulatory measures on financial stability. In the months when there are published regulatory capital measures indicating a reduction in the regulatory capital requirement, the variable D_LIB is equal to 1 and 0 otherwise. In turn, in the months when there are published regulatory capital measures indicating an increase in the regulatory capital requirement, the variable D_RES is equal to 1 and 0 otherwise.

The empirical analyses apply ordinary least squares (OLS), one-step generalized method of moments (GMM 1-STEP) with HAC covariance matrix, two-step generalized method of moments (GMM 2-STEP) with Windmeijer (2005) covariance matrix, and quantile regression (QREG). These methods allow straight observation and interpretation of the signal and statistical significance of all the estimated coefficients.

The OLS estimates use the Newey-West covariance matrix to account for the potential problems of heteroscedasticity and autocorrelation of the model. We present the adjusted R^2 statistic, F statistic, and Ramsey's RESET test. Whereas the adjusted R^2 reveals the explanatory power of the model, the F statistic shows the joint significance of the explanatory variables in the model. In addition, the RESET test evaluates whether the model is well specified. The RESET is a general test with the null hypothesis that the linear functional form is appropriate (Ramsey, 1969; Wooldridge, 2009).

The GMM estimator is recommended because it provides robust estimations even in the presence of endogeneity and simultaneity, common in time series analysis (Hansen, 1982). The empirical model developed in this study is subject to these problems. The presence of reverse causality is possible, for example, in the relation between capital buffer and ROE, as well as in the relation between liquidity and ROE.

In order to obtain a more efficient GMM estimator than OLS, it is important to observe the overriding conditions and the orthogonality of the instruments (Wooldridge, 2001). The coefficients estimated by GMM are consistent only if the instrumental variables used in the analysis are exogenous. Therefore, the hypothesis of exogeneity of instruments requires that these variables do not directly affect the dependent variable. We follow the methodology of Johnston (1984) to select the instruments on GMM estimation, that is, the instruments were dated to the period $t-1$ or earlier to assure exogeneity. We calculate the J-statistic to check the instruments' validity. We also present the Durbin (1954), Wu (1974), and Hausman (1978) test of endogeneity of the regressors. The one-step GMM estimations with HAC covariance matrix address robust standard errors in the presence of autocorrelation and heteroskedasticity of unknown form. Moreover, we apply the Windmeijer covariance matrix correction in the two-step GMM estimations to address small-sample downward biases on standard errors.

Finally, the QREG developed by Koenker and Bassett (1978) divides the distribution such that a given proportion of observations is located below the quantile and allows one to observe the estimated coefficient for different levels of the dependent variable. The QREG is a non-parametric technique (no distributional assumptions are required to optimally estimate the parameters) and is adequate for analyzing the relations for a set of variables, presenting more robust coefficients for outliers and non-normality than the OLS regressions (Brooks, 2014). We estimate the QREG with the moving blocks bootstrap (MBB), which provides robust standard errors to heteroskedasticity and autocorrelation of unknown form (Fitzenberger, 1998).

A first condition to analyze previous estimates is to check if the series are stationary. Thus, the augmented Dickey-Fuller test (ADF), Phillips-Perron test (PP), and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) were performed. As observed in Table A.4, all series analyzed are stationary, except LIQ whose result indicates that the use of the series in first difference would be more adequate. As the communication variables representing monetary policy and normative macroprudential policy are dummy variables that assume values of 0 or 1, unit root tests are not necessary, and the variables are stationary.

2 Estimates and Results

In order to verify the effects of monetary policy on financial stability, we estimate the baseline model taking into account the effects of macroeconomic variables on the capital buffer.

$$\begin{aligned} BUFFER_t = \alpha_1 + \alpha_2 ROE_t + \alpha_3 GDP\_GAP_t + \alpha_4 CRED\_GAP_t + \\ + \alpha_5 \Delta LIQ_t + \alpha_6 IR + \varepsilon_{1,t} \end{aligned} \tag{1}$$

The CBB has two economic policy objectives: price stability and financial stability. Blinder et al. (2008) argue that central bank communication is fundamental to economic policy management. However, Born et al. (2012) warn of the differences in central bank communication on monetary and macroprudential policies. Thus, to capture the effect of different forms of central bank communication on financial stability, communication dummy variables were included in the baseline model. Equation 2 includes the monetary policy communication dummy variable and equation 3 includes the normative macroprudential policy communication dummy variable.

$$BUFFER_t = \alpha_7 + \alpha_8 ROE_t + \alpha_9 GDP\_GAP_t + \alpha_{10} CRED\_GAP_t + \\ + \alpha_{11} \Delta LIQ_t + \alpha_{12} IR + \alpha_{13} COM\_MONETARY_t + \varepsilon_{2,t} \tag{2}$$

$$BUFFER_t = \alpha_{14} + \alpha_{15} ROE_t + \alpha_{16} GDP\_GAP_t + \alpha_{17} CRED\_GAP_t + \\ + \alpha_{18} \Delta LIQ_t + \alpha_{19} IR + \alpha_{20} COM\_MACROPRU_t + \varepsilon_{3,t} \tag{3}$$

where $COM\_MONETARY_t$ refers to D_UP and D_DOWN; $COM\_MACROPRU_t$ refers to D_LIB and D_RES; and $\varepsilon_{i,t}$, $i = 1, 2, 3$, are random error terms.

Table 1 presents the estimation results. Due to autocorrelation and heteroskedasticity, the reported t-statistics for the OLS regression are calculated using the Newey-West covariance matrix. Regarding OLS estimates, the F-statistic of all equations indicates the regressions are significant. Furthermore, the outcomes of the Ramsey RESET test indicate the estimations do not present problems of model misspecification. Regarding the GMM estimations, the J-statistic and the Durbin-Wu-Hausman test indicate we cannot reject the hypothesis that the model is correctly specified.

The positive and significant relation between IR and $BUFFER$ indicates that the effect of monetary policy on capital buffers cannot be neglected. The results reveal that banks react significantly to monetary policy changes by increasing (decreasing) their buffers when the central bank increases (decreases) the interest rate. One possible interpretation for this conservative behavior is that banks display forward-looking behavior and are anticipating a deterioration of the credit market in the face of a tightening in the monetary policy.

In relation to the effect of central bank communication on financial stability, the estimates reveal that monetary policy communication affects the capital buffer. The signals of the coefficients D_UP and D_DOWN, having statistical significance in all GMM models, show that when there is an indication of an increase (decrease) in the interest rate, banks respond in a forward-looking manner with an increase (decrease) of their buffers, revealing higher (lower) risk aversion. The reason for this result is similar to that given to the effect of monetary policy changes on capital buffer. That is, banks react proactively to the anticipated future behavior of the credit market based on inferences obtained through central bank communications on monetary policy.

Regarding the effects of normative macroprudential policy communication on the capital buffer, the results show that central bank communications indicating an increase in regulatory capital requirement ($D\_RES = 1$) generate a reduction in the capital buffer held by banks, signaling that banks use the capital buffer to meet new regulatory constraints. On the other hand, central bank communications indicating a reduction in the regulatory capital requirement ($D\_LIB = 1$) generate an increase in the capital buffer maintained by banks, indicating that banks do not reduce their risk aversion due to regulatory capital changes. An explanation for this result is that banks use their own capital excess over the regulated capital requirement (their buffer) to accommodate new capital regulatory measures. This result corroborates the study by Nier and Baumann (2006) for a set of countries in which the capital buffer has an accommodative character for shocks on capital.

Finally, in relation to the coefficients for ROE, $CRED\_GAP$, and GDP_GAP, it is observed that they have statistical significance and the signs are positive. As pointed out by Milne and Whalley (2001), high profit banks can hold lower capital buffers as insurance against a violation of the regulatory capital minimum. The coefficients on $CRED\_GAP$ confirm the view highlighted by Basel Committee on Banking Supervision (2010) that during an economic boom, banks increase credit and reduce the capital buffer, thereby increasing the risk exposure of the entire financial system. In addition, the positive and significant coefficients for GDP_GAP denote that the business cycle exerts pressure to decrease capital buffers. This result is in line with the argument by Ayuso et al. (2004), Lindquist (2004), and Jokipii and Milne (2008) that banks reduce (increase) the capital buffer and increase (reduce) their exposure to risk in times of economic expansion (contraction). Furthermore, the findings regarding LIQ reveal that $BUFFER$ is sensitive to the liquidity conditions of banks. An increase in LIQ variation contributes to an increase in $BUFFER$. One explanation for this result is that more liquid banks tend to take on less risk.

Additionally, we estimate the models using QREG to obtain further evidence on the effect on the capital buffer of monetary policy and central bank communication about both monetary policy and normative macroprudential policy. This estimation method allows measurement of whether the bank's response to macroeconomic issues or central bank communication remains in different quantiles. In this sense, different from the OLS and GMM estimation methods, it is possible through QREG to observe the effect of the control variables and, in particular, the effect of IR, D_UP, D_DOWN, D_LIB, and D_RES on different levels of $BUFFER$.

Table 2 presents the estimates of the quantile regression.[3]Regarding the effect of monetary policy on the different levels of capital buffer, the estimates show that IR is significant in most quantiles of $BUFFER$, being more responsive in the middle quantiles. In general, banks react more strongly to changes in monetary policy in high quantiles. With respect to the effect of monetary policy communication on capital buffer, the results suggest that the indication of an increase in the interest rate ($D\_UP = 1$) is able to affect the $BUFFER$ in low quantiles when the banks present riskier positions. On the other hand, the results do not

[3]Estimates for $CONSTANT$, $SUBPRIME\ CRISIS$, and $POLITICAL\ CRISIS$ were omitted. In all models, these variables presented statistical significance in most quantiles and robust signals with the previously reported OLS and GMM estimates.

show statistical significance for the cases in which the central bank indicates a reduction in the interest rate ($D\_DOWN = 1$).

Regarding the effect of normative macroprudential policy communication on the capital buffer, the quantile regression results suggest that regulatory capital measures indicating a reduction ($D\_LIB = 1$) or an increase ($D\_RES = 1$) in the regulatory capital requirement have an effect on lower quantiles of $BUFFER$. An explanation for this result is that the normative macroprudential policy communication is relevant for banks most prone to risk or likely to violate regulatory capital requirements. As a consequence, banks use the capital buffer to accommodate unexpected shocks to their capital ratio (Nier and Baumann, 2006).

Lastly, in most models, the coefficient signals estimated on ROE, D_GAP, $CRED\_GAP$, and LIQ corroborate the signals found in the OLS and GMM estimates. The $BUFFER$ response to ROE is symmetric, negative, and significant in all quantiles. The signal of GDP_GAP and $CRED\_GAP$ coefficients indicates that $BUFFER$ responds in higher magnitude in the low quantiles. This evidence suggests that the banks are more responsive to the macroeconomic cycles in riskier positions. When $BUFFER$ is high enough, the banks respond less to $CRED\_GAP$ and GDP_GAP.

3 Conclusion

This work has examined the effect of monetary policy and central bank communication on the financial stability of the Brazilian economy during the period from January 2006 to December 2016. This was done by using OLS, GMM, and QREG analyses. The capital buffer, defined as the excess capital held by banks in relation to the regulatory capital requirement in force in Brazil, was used as a proxy for financial stability. In particular, this work investigated how monetary policy changes and central bank communications about monetary policy and normative macroprudential policy affect the capital buffer.

The empirical evidence presented in this work suggests that banks behave procyclically in relation to monetary policy changes, increasing the capital buffer (risk aversion) to protect themselves against a possible scenario of economic deterioration and reducing the capital buffer (risk taking) in a scenario of economic boom.

Regarding central bank communication, the results showed that banks react in a forward-looking manner to central bank monetary policy communication, increasing (decreasing) the capital buffer when monetary policy communication signals an increase (reduction) in the interest rate. Finally, considering the central bank normative macroprudential policy communication, the analysis revealed an undesired behavior in macroprudential terms, as banks increase (decrease) the capital buffer when liberalizing (restrictive) capital measures are announced by the central bank. This result demonstrated that normative macroprudential policy communication did not contribute to increasing the soundness of the banking system, suggesting instead that the capital buffer is used by banks to accommodate regulatory capital shocks (new regulatory capital measures).

The response of the capital buffer to the CBB's communication suggests that the normative macroprudential policy communication should be improved because it is not able to anchor the behavior of banks to the objectives of macroprudential policy. If the normative macroprudential policy communication were conducted in the same way as the monetary policy communication, that is, a regular and systematic communication, it might be better able to anchor the behavior of the banks to meeting the objectives of the capital buffer to guarantee financial stability.

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Table 1: Regression results on $BUFFER$ – OLS and GMM

	OLS				
Regressors	**Eq(1)**	**Eq(2.1)**	**Eq(2.2)**	**Eq(3.1)**	**Eq(3.2)**
CONSTANT	3.752**	3.655**	3.721**	3.607**	3.767**
	(1.680)	(1.615)	(1.745)	(1.663)	(1.668)
	[2.234]	[2.262]	[2.132]	[2.169]	[2.232]
ROE	-0.103**	-0.105**	-0.105**	-0.096**	-0.103**
	(0.040)	(0.040)	(0.042)	(0.040)	(0.040)
	[-2.568]	[-2.614]	[-2.508]	[-2.372]	[-2.545]
GDP_GAP	-1.8E-05***	-1.8E-05***	-1.8E-05***	-1.9E-05***	-1.8E-05***
	(3.1E-06)	(2.9E-06)	(3.2E-06)	(3.0E-06)	(3.1E-06)
	[-5.919]	[-6.296]	[-5.678]	[-6.308]	[-5.898]
CRED_GAP	-0.244***	-0.250***	-0.252**	-0.239***	-0.242***
	(0.088)	(0.088)	(0.099)	(0.086)	(0.088)
	[-2.783]	[-2.825]	[-2.553]	[-2.777]	[-2.763]
$\Delta(LIQ)$	0.272	0.309	0.275	0.213	0.272
	(0.343)	(0.348)	(0.342)	(0.340)	(0.342)
	[0.791]	[0.887]	[0.806]	[0.627]	[0.795]
IR	1.488*	1.527*	1.514*	1.496*	1.485*
	(0.839)	(0.812)	(0.893)	(0.835)	(0.844)
	[1.774]	[1.880]	[1.696]	[1.792]	[1.760]
D_UP		0.069			
		(0.164)			
		[0.418]			
D_DOWN			-0.027		
			(0.181)		
			[-0.152]		
D_LIB				0.530*	
				(0.274)	
				[1.937]	
D_RES					-0.049
					(0.127)
					[-0.388]
SUBPRIME CRISIS	0.988***	1.016***	1.006***	0.944***	0.981***
	(0.306)	(0.311)	(0.310)	(0.305)	(0.309)
	[3.222]	[3.271]	[3.244]	[3.101]	[3.178]
POLITICAL CRISIS	-1.778***	-1.775***	-1.791***	-1.816***	-1.787***
	(0.491)	(0.497)	(0.518)	(0.494)	(0.490)
	[-3.624]	[-3.575]	[-3.456]	[-3.677]	[-3.646]
Adjusted R^2	0.557	0.555	0.553	0.569	0.554
F-statistic	24.357	21.248	21.152	22.424	21.175
Prob. F-statistic	0.000	0.000	0.000	0.000	0.000
Ramsey RESET (1)	2.683	2.847	2.540	2.904	2.735
Prob. Ramsey RESET (1)	0.104	0.094	0.114	0.091	0.101
Rank					
J-statistic					
Prob. J-statistic					
Prob. Durbin-Wu-Hausman Test					

Continued on the next page

Table 1: Regression results on $BUFFER$ – OLS and GMM (Continued)

	GMM 1-STEP				
Regressors	**Eq(1)**	**Eq(2.1)**	**Eq(2.2)**	**Eq(3.1)**	**Eq(3.2)**
CONSTANT	**1.669**	**3.018*** **	**2.856***	**2.217**	**2.814** **
	(1.847)	(1.299)	(1.594)	(1.592)	(1.401)
	[0.903]	[2.323]	[1.791]	[1.393]	[2.008]
ROE	**-0.179*** **	**-0.199*** **	**-0.246*** **	**-0.154*** **	**-0.198*** **
	(0.040)	(0.045)	(0.050)	(0.033)	(0.039)
	[-4.475]	[-4.432]	[-4.878]	[-4.643]	[-5.026]
GDP_GAP	**-2.5E-05*** **	**-2.E-05*** **	**-2.5E-05*** **	**-2.4E-05*** **	**-2.3E-05*** **
	(3.7E-06)	(3.4E-06)	(4.15E-06)	(3.5E-06)	(2.7E-06)
	[-6.875]	[-7.230]	[-6.105]	[-6.958]	[-8.507]
CRED_GAP	**-0.326*** **	**-0.364*** **	**-0.523*** **	**-0.276*** **	**-0.329*** **
	(0.117)	(0.120)	(0.145)	(0.100)	(0.101)
	[-2.793]	[-3.037]	[-3.617]	[-2.767]	[-3.273]
$\Delta(LIQ)$	**2.809** **	**2.110** **	**2.445** **	**2.721*** **	**-0.063**
	(1.202)	(0.883)	(1.206)	(0.704)	(0.731)
	[2.338]	[2.389]	[2.027]	[3.863]	[-0.087]
IR	**2.888*** **	**2.264*** **	**2.809*** **	**2.485*** **	**2.545*** **
	(0.883)	(0.687)	(0.774)	(0.758)	(0.643)
	[3.272]	[3.294]	[3.627]	[3.279]	[3.956]
D_UP		**0.503*** **			
		(0.175)			
		[2.867]			
D_DOWN			**-0.698*** **		
			(0.241)		
			[-2.901]		
D_LIB				**0.751***	
				(0.442)	
				[1.697]	
D_RES					**-0.742***
					(0.404)
					[-1.834]
SUBPRIME CRISIS	**1.350*** **	**1.985*** **	**2.317*** **	**1.259*** **	**1.495*** **
	(0.411)	(0.418)	(0.523)	(0.285)	(0.313)
	[3.288]	[4.746]	[4.433]	[4.423]	[4.775]
POLITICAL CRISIS	**-3.060*** **	**-2.439*** **	**-2.902*** **	**-2.808*** **	**-2.771*** **
	(0.608)	(0.622)	(0.603)	(0.522)	(0.434)
	[-5.031]	[-3.918]	[-4.810]	[-5.380]	[-6.386]
Adjusted R^2	0.256	0.319	0.199	0.301	0.393
F-statistic					
Prob. F-statistic					
Ramsey RESET (1)					
Prob. Ramsey RESET (1)					
Rank	18	21	21	25	23
J-statistic	12.093	11.696	12.921	14.773	17.166
Prob. J-statistic	0.279	0.470	0.375	0.541	0.247
Prob. Durbin-Wu-Hausman Test	0.761	0.833	0.899	0.978	0.971

Continued on the next page

Table 1: Regression results on $BUFFER$ – OLS and GMM (Continued)

	GMM 2-STEP				
Regressors	**Eq(1)**	**Eq(2.1)**	**Eq(2.2)**	**Eq(3.1)**	**Eq(3.2)**
CONSTANT	**1.123**	**2.652**	**2.001**	**0.046**	**2.320**
	(3.191)	(1.982)	(2.504)	(2.899)	(3.223)
	[0.352]	[1.338]	[0.779]	[0.016]	[0.720]
ROE	**-0.193*** **	**-0.195** **	**-0.193* **	**-0.132*** **	**-0.181** **
	(0.067)	(0.088)	(0.103)	(0.049)	(0.089)
	[-2.877]	[-2.209]	[-1.873]	[-2.716]	[-2.032]
GDP_GAP	**-2.8E-05*** **	**-2.7E-05*** **	**-2.5E-05*** **	**-2.7E-05*** **	**-2.5E-05*** **
	(6.7E-06)	(6.5E-06)	(7.5E-06)	(6.0E-06)	(6.0E-06)
	[-4.166]	[-4.093]	[-3.354]	[-4.480]	[-4.210]
CRED_GAP	**-0.320** **	**-0.357** **	**-0.433** **	**-0.275* **	**-0.392*** **
	(0.160)	(0.163)	(0.219)	(0.151)	(0.133)
	[-2.002]	[-2.188]	[-1.977]	[-1.824]	[-2.936]
$\Delta(LIQ)$	**3.097** **	**2.440** **	**3.185* **	**1.609* **	**0.934*** **
	(1.420)	(1.145)	(1.719)	(0.952)	(1.817)
	[2.180]	[2.130]	[1.853]	[1.689]	[0.514]
IR	**3.229** **	**2.390** **	**2.848** **	**3.281** **	**2.717* **
	(1.538)	(1.181)	(1.221)	(1.256)	(1.493)
	[2.099]	[2.023]	[2.332]	[2.612]	[1.819]
D_UP		**0.529** **			
		(0.249)			
		[2.125]			
D_DOWN			**-0.601** **		
			(0.294)		
			[-2.045]		
D_LIB				**1.639* **	
				(0.873)	
				[1.878]	
D_RES					**-1.183* **
					(0.696)
					[-1.700]
SUBPRIME CRISIS	**1.384** **	**1.985*** **	**1.794** **	**0.865* **	**1.221* **
	(0.683)	(0.730)	(0.901)	(0.522)	(0.714)
	[2.026]	[2.717]	[1.991]	[1.657]	[1.709]
POLITICAL CRISIS	**-3.360*** **	**-2.537*** **	**-2.881*** **	**-3.146*** **	**-3.199*** **
	(1.001)	(1.045)	(0.908)	(0.867)	(0.906)
	[-3.357]	[-2.428]	[-3.172]	[-3.627]	[-3.531]
Adjusted R^2	0.145	0.256	0.182	0.323	0.187
F-statistic					
Prob. F-statistic					
Ramsey RESET (1)					
Prob. Ramsey RESET (1)					
Rank	18	21	21	23	23
J-statistic	11.129	10.706	13.804	13.021	12.405
Prob. J-statistic	0.347	0.554	0.313	0.525	0.574
Prob. Durbin-Wu-Hausman Test	0.853	0.904	0.863	0.981	0.809

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1. Standard errors between parentheses and t-statistics between square brackets.

Table 2: Regression results on $BUFFER$ - Quantile regression

	Quantiles				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
ROE	**-0.114*** **	**-0.107*** **	**-0.089*** **	**-0.089*** **	**-0.123*** **
	(0.023)	(0.033)	(0.033)	(0.030)	(0.029)
GDP_GAP	**-1.93E-05*** **	**-2.07E-05*** **	**-2.26E-05*** **	**-2.32E-05*** **	**-2.16E-05*** **
	(2.22E-06)	(1.71E-06)	(1.82E-06)	(1.94E-06)	(1.95E-06)
$CRED\_GAP$	**-0.360*** **	**-0.307*** **	**-0.289*** **	**-0.363*** **	**-0.324*** **
	(0.063)	(0.086)	(0.085)	(0.084)	(0.080)
$\Delta(LIQ)$	**-0.211**	**-0.487**	**-0.367**	**-0.009**	**0.173**
	(0.448)	(0.453)	(0.481)	(0.495)	(0.500)
IR	**0.682** **	**1.307*** **	**1.957*** **	**2.204*** **	**2.407*** **
	(0.285)	(0.416)	(0.339)	(0.391)	(0.446)
ROE	**-0.123** **	**-0.106*** **	**-0.091*** **	**-0.118*** **	**-0.122*** **
	(0.054)	(0.038)	(0.035)	(0.032)	(0.028)
GDP_GAP	**-2.38E-05*** **	**-2.11E-05*** **	**-2.26E-05*** **	**-2.31E-05*** **	**-2.15E-05*** **
	(3.68E-06)	(2.14E-06)	(1.94E-06)	(1.87E-06)	(1.90E-06)
$CRED\_GAP$	**-0.428*** **	**-0.293*** **	**-0.356*** **	**-0.326*** **	**-0.301*** **
	(0.136)	(0.101)	(0.089)	(0.081)	(0.083)
$\Delta(LIQ)$	**-0.117**	**-0.231**	**-0.125**	**0.078**	**0.061**
	(0.698)	(0.470)	(0.488)	(0.429)	(0.442)
IR	**1.032* **	**1.172*** **	**1.864*** **	**2.206*** **	**2.400*** **
	(0.534)	(0.439)	(0.429)	(0.412)	(0.431)
D_UP	**0.349* **	**0.185**	**0.145**	**2.205**	**0.170**
	(0.196)	(0.148)	(0.145)	(0.131)	(0.112)
ROE	**-0.113*** **	**-0.105** **	**-0.090*** **	**-0.125*** **	**-0.124*** **
	(0.019)	(0.043)	(0.033)	(0.034)	(0.031)
GDP_GAP	**-1.90E-05*** **	**-2.05E-05*** **	**-2.27E-05*** **	**-2.21E-05*** **	**-2.15E-05*** **
	(2.18E-06)	(2.91E-06)	(1.86E-06)	(2.04E-06)	(2.02E-06)
$CRED\_GAP$	**-0.369*** **	**-0.312** **	**-0.286*** **	**-0.367*** **	**-0.337*** **
	(0.070)	(0.136)	(0.098)	(0.098)	(0.094)
$\Delta(LIQ)$	**-0.170**	**-0.343**	**-0.327**	**0.027**	**0.284**
	(0.431)	(0.615)	(0.465)	(0.470)	(0.479)
IR	**0.635*** **	**1.346** **	**2.066*** **	**2.473*** **	**2.413*** **
	(0.220)	(0.560)	(0.361)	(0.403)	(0.481)
D_DOWN	**-0.031**	**-0.060**	**0.040**	**-0.132**	**-0.019**
	(0.081)	(0.144)	(0.123)	(0.138)	(0.142)

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Table 2: Regression results on $BUFFER$ - Quantile regression (Continued)

	Quantiles			
	0.6	**0.7**	**0.8**	**0.9**
ROE	**-0.134*****	**-0.120*****	**-0.099****	**-0.100**
	(0.031)	(0.041)	(0.043)	(0.065)
GDP_GAP	**-2.09E-05*****	**-1.76E-05*****	**-1.54E-05****	**-1.49E-05*****
	(2.03E-06)	(2.71E-06)	(3.06E-06)	(4.37E-06)
$CRED\_GAP$	**-0.266*****	**-0.189**	**-0.037**	**-0.074**
	(0.099)	(0.120)	(0.127)	(0.187)
$\Delta(LIQ)$	**0.163**	**0.129**	**-0.073**	**0.205**
	(0.473)	(0.500)	(0.461)	(0.657)
IR	**2.415*****	**2.435*****	**1.736***	**1.603**
	(0.588)	(0.873)	(1.010)	(1.383)
ROE	**-0.126*****	**-0.151*****	**-0.097****	**-0.107***
	(0.030)	(0.036)	(0.038)	(0.060)
GDP_GAP	**-2.09E-05*****	**-1.84E-05*****	**-1.50E-05****	**-1.49E-05*****
	(2.02E-06)	(2.47E-06)	(2.54E-06)	(4.23E-06)
$CRED\_GAP$	**-0.261*****	**-0.215***	**-0.059**	**-0.067**
	(0.098)	(0.126)	(0.112)	(0.158)
$\Delta(LIQ)$	**0.072**	**0.103**	**-0.011**	**0.160**
	(0.440)	(0.435)	(0.431)	(0.589)
IR	**2.381*****	**2.834*****	**1.628****	**1.571**
	(0.518)	(0.741)	(0.797)	(1.340)
D_UP	**0.142**	**0.223**	**0.072**	**-0.036**
	(0.129)	(0.176)	(0.200)	(0.209)
ROE	**-0.142*****	**-0.158*****	**-0.114****	**-0.101**
	(0.036)	(0.047)	(0.054)	(0.078)
GDP_GAP	**-2.09E-05*****	**-1.92E-05*****	**-1.63E-05****	**-1.50E-05*****
	(2.32E-06)	(3.09E-06)	(3.54E-06)	(4.90E-06)
$CRED\_GAP$	**-0.251****	**-0.304****	**-0.041**	**-0.077**
	(0.112)	(0.142)	(0.136)	(0.193)
$\Delta(LIQ)$	**0.087**	**0.211**	**-0.087**	**0.195**
	(0.496)	(0.517)	(0.492)	(0.766)
IR	**2.548*****	**2.942*****	**2.068***	**1.657**
	(0.688)	(0.913)	(1.104)	(1.473)
D_DOWN	**-0.110**	**-0.277**	**-0.126**	**-0.013**
	(0.160)	(0.240)	(0.302)	(0.381)

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Table 2: Regression results on *BUFFER* - Quantile regression (Continued)

	Quantiles				
	0.1	**0.2**	**0.3**	**0.4**	**0.5**
ROE	**-0.102*** **	**-0.107** **	**-0.089*** **	**-0.121*** **	**-0.123*** **
	(0.018)	(0.033)	(0.035)	(0.035)	(0.030)
GDP_ GAP	**-2.10E-05*** **	**-2.07E-05*** **	**-2.26E-05*** **	**-2.18E-05*** **	**-2.18E-05*** **
	(1.60E-06)	(1.90E-06)	(1.76E-06)	(2.14E-06)	(1.91E-06)
CRED_ GAP	**-0.364*** **	**-0.307** **	**-0.288*** **	**-0.277*** **	**-0.304*** **
	(0.045)	(0.090)	(0.086)	(0.090)	(0.084)
$\Delta(LIQ)$	**-0.154**	**-0.487**	**-0.367**	**-0.183**	**0.056**
	(0.310)	(0.449)	(0.492)	(0.488)	(0.431)
IR	**0.725*** **	**1.307** **	**1.925*** **	**2.362*** **	**2.430*** **
	(0.236)	(0.384)	(0.327)	(0.391)	(0.445)
D_ LIB	**0.510*** **	**0.365**	**0.447**	**0.384**	**0.442**
	(0.176)	(0.495)	(0.424)	(0.658)	(0.530)
ROE	**-0.131*** **	**-0.107** **	**-0.095*** **	**-0.133*** **	**-0.122*** **
	(0.023)	(0.035)	(0.035)	(0.031)	(0.030)
GDP_ GAP	**-2.07E-05*** **	**-2.07E-05*** **	**-2.26E-05*** **	**-2.20E-05*** **	**-2.15E-05*** **
	(2.19E-06)	(2.03E-06)	(1.92E-06)	(2.03E-06)	(1.94E-06)
CRED_ GAP	**-0.367*** **	**-0.307*** **	**-0.283*** **	**-0.312*** **	**-0.332*** **
	(0.071)	(0.094)	(0.090)	(0.090)	(0.083)
$\Delta(LIQ)$	**-0.614**	**-0.487**	**-0.177**	**-0.284**	**0.297**
	(0.444)	(0.569)	(0.464)	(0.498)	(0.507)
IR	**1.333*** **	**1.307** **	**2.023*** **	**2.443*** **	**2.395*** **
	(0.330)	(0.430)	(0.383)	(0.402)	(0.462)
D_ RES	**-0.339* **	**-0.065**	**-0.097**	**-0.084**	**0.021**
	(0.200)	(0.219)	(0.207)	(0.203)	(0.176)

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Table 2: Regression results on *BUFFER* - Quantile regression (Continued)

	Quantiles			
	0.6	**0.7**	**0.8**	**0.9**
ROE	**-0.136*****	**-0.116*****	**-0.098****	**-0.099**
	(0.031)	(0.043)	(0.047)	(0.081)
GDP_ GAP	**-2.08E-05*****	**-1.82E-05*****	**-1.66E-05****	**-1.49E-05*****
	(2.09E-06)	(2.93E-06)	(3.19E-06)	(5.04E-06)
CRED_ GAP	**-0.248****	**-0.191**	**-0.094**	**-0.075**
	(0.089)	(0.126)	(0.129)	(0.211)
$\Delta(LIQ)$	**0.009**	**0.101**	**0.107**	**0.196**
	(0.448)	(0.546)	(0.479)	(0.766)
IR	**2.423*****	**2.112****	**1.715***	**1.615**
	(0.583)	(0.891)	(1.035)	(1.540)
D_ LIB	**0.264**	**0.403**	**0.686**	**0.507**
	(0.568)	(0.727)	(0.686)	(2.422)
ROE	**-0.134*****	**-0.122*****	**-0.099****	**-0.100**
	(0.033)	(0.042)	(0.033)	(0.069)
GDP_ GAP	**-2.08E-05*****	**-1.71E-05*****	**-1.54E-05****	**-1.49E-05*****
	(1.99E-06)	(2.63E-06)	(2.45E-06)	(4.53E-06)
CRED_ GAP	**-0.264****	**-0.188**	**-0.037**	**-0.074**
	(0.096)	(0.120)	(0.108)	(0.208)
$\Delta(LIQ)$	**0.155**	**0.147**	**-0.073**	**0.204**
	(0.476)	(0.520)	(0.341)	(0.723)
IR	**2.411*****	**2.274****	**1.736****	**1.611**
	(0.632)	(0.903)	(0.804)	(1.437)
D_ RES	**-0.004**	**-0.120**	**-0.080**	**-0.001**
	(0.186)	(0.226)	(0.178)	(0.459)

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1. Standard errors are between parentheses

A Appendix

Table A.1: Descriptive Statistics

Variables	**Mean**	**Median**	**Maximum**	**Minimum**	**Stand.Dev.**
BUFFER	5.744	5.640	7.650	3.960	0.807
CRED_GAP	-5.8E-12	-0.003	1.771	-1.962	0.668
D_DOWN	0.326	0.000	1.000	0.000	0.470
D_LIB	0.038	0.000	1.000	0.000	0.192
D_RES	0.136	0.000	1.000	0.000	0.344
D_UP	0.409	0.000	1.000	0.000	0.493
GDP_GAP	-5.1E-07	-463.766	70955.55	-107446.1	39840.61
LIQ	2.004	1.900	2.800	1.400	0.352
IR	2.417	2.424	2.871	1.961	0.214
ROE	17.011	15.860	25.160	11.260	4.198

Note: Authors' elaboration

Table A.2: Classification of key words and expressions from COPOM minutes

Dummy variable	**key words and expressions from COPOM minutes**
D_UP	- The monetary policy should remain especially vigilant. - Maintenance of the interest rate represents a nonnegligible risk for meeting the target (projected inflation above target). - Potential inflationary impacts of supply shocks yet to materialize. - Monetary policy should remain vigilant in order to avoid the propagation of shocks and exchange rate depreciation. - Monetary policy firmly committed to meeting the inflation targets. - Inflation remains high/monetary policy should be firm. - The monetary authority will be ready to adopt an active posture if projected inflation diverges from the target. - Inflation trend incompatible with the target. - COPOM will need to be less tolerant if shocks threaten to raise inflation above the target. - The Central Bank will not allow supply shocks to lead to an increase in the inflation rate. - The Committee understands that it is appropriate to continue the adjustment pace of the monetary conditions underway. - The monetary authority must remain vigilant so that short-term pressures do not contaminate longer time horizon. - The monetary authority should be ready to adjust the pace and magnitude of the interest rate adjustment process to the circumstances.
D_DOWN	- COPOM decided to continue the process of monetary easing. - Expected inflation below target/expectations consistent with the inflation risks/targets are less significant. - Consolidation of favourable perspectives for inflation in the medium term/COPOM considers that there is still room for. further cuts in the selic rate in the future. - Benign scenario for the evolution of inflation (with reduction of uncertainties/favourable external scenario). - Economic activity consistent with supply conditions, with low probability of inflation pressures. - The gradual easing of the monetary stance will not compromise the important achievements made in lowering inflation.

Note: Authors' elaboration

Table A.3: Classification of capital regulatory measures

Date	**Restrictive regulation**	**Date**	**Liberalizing regulation**
Feb/2007	Resolution CMN 3,444	Dec/2008	Resolution CMN 3,674 and Circular BCB 3,425
Aug/2007	Resolution CMN 3,490	Jul/2014	Circular BCB 3,711
Jan/2008	Resolution CMN 3,535	Aug/2014	Circular BCB 3,714
Dec/2008	Resolution CMN 3,655	Nov/2014	Circular BCB 3,730
Oct/2009	Circular BCB 3,471	Aug/2016	Circular BCB 3,809
Dec/2009	Resolution CMN 3,825 and Circular BCB 3,476		
Jun/2010	Circular BCB 3,498		
Dec/2010	Circular BCB 3,515		
Nov/2011	Circular BCB 3,563		
Dec/2011	Circular BCB 3,568		
Aug/2012	Circular BCB 3,608		
Aug/2012	Circular BCB 3,608		
Mar/2013	Resolution CMN 4,192; 4,193 and 4,195		
Jul/2013	Law 12,838		
Sep/2013	Resolution CMN 4,271		
Oct/2013	Resolution CMN 4,277 and 4,279; Circular BCB 3,674; 3,676; 3,677 and 3,679		
Jan/2014	Circular BCB 3,696		
Dec/2014	Circular BCB 3,741		
Feb/2015	Circular BCB 3,748		
Oct/2015	Circular BCB 3,768; 3,769 and 3,770		

Note: Authors' elaboration

Table A.4: Unit Root Test

Variables	**I/T**	**Lag**	**Test**	**Critical values** 1%	5%	10%
			ADF			
BUFFER	1	0	-2.917	-3.481	-2.884	-2.579
ROE		12	-1.854	-2.584	-1.943	-1.615
GDP_GAP		3	-4.182	-2.583	-1.943	-1.615
CRED_GDP		12	-4.280	-2.584	-1.943	-1.615
LIQ		0	-0.200	-2.583	-1.943	-1.615
$\Delta(LIQ)$		0	-12.609	-2.583	-1.943	-1.615
IR	I	2	-3.130	-3.482	-2.884	-2.579
			PP			
BUFFER	I	0.852	-2.917	-3.481	-2.884	-2.579
ROE		1.4	-1.730	-2.583	-1.943	-1.615
GDP_GAP		7.64	-2.644	-2.583	-1.943	-1.615
CRED_GDP		3	-2.076	-2.583	-1.943	-1.615
LIQ		1.52	-0.178	-2.583	-1.943	-1.615
$\Delta(LIQ)$		0.132	-12.609	-2.583	-1.943	-1.615
IR	T/I	16.1	-1.998	-4.030	-3.444	-3.147
$\Delta(IR)$		2.49	-3.367	-2.583	-1.943	-1.615
			KPSS			
BUFFER	T/I	18.8	0.063	0.119	0.146	0.216
ROE	T/I	50.7	0.153	0.119	0.146	0.216
GDP_GAP	I	59.1	0.156	0.347	0.463	0.739
CRED_GDP	I	33.5	0.097	0.347	0.463	0.739
LIQ	T/I	33.1	0.147	0.119	0.146	0.216
IR	I	70.9	0.194	0.347	0.463	0.739

Note: ADF test based on Schwarz criterion. PP and KPSS test bandwidth is Andrews using Bartlett kernel. Based on Schwarz criterion, intercept (I) or time trend (T/I) was applied.

Table A.5: Residual diagnostic tests

	Eq(1)	**Eq(2.1)**	**Eq(2.2)**	**Eq(3.1)**	**Eq(3.2)**
LM Test (1)	65.528	63.605	64.035	60.197	64.665
Prob. LM Test (1)	0.000	0.000	0.000	0.000	0.000
LM Test (2)	33.023	32.219	32.264	30.581	32.849
Prob. LM Test (2)	0.000	0.000	0.000	0.000	0.000
ARCH (1)	19.182	18.318	19.716	17.331	18.432
Prob. ARCH (1))	0.000	0.000	0.000	0.000	0.000
Jarque-Bera	0.377	0.269	0.346	0.698	0.464
Prob. Jarque-Bera	0.828	0.874	0.841	0.705	0.793

Note: Authors' elaboration