Reserve requirements as a macroprudential instrument in Brazil and Colombia: Some empirical evidence

Míriam O. S. Português[1]
Antonio Luis Licha[2]

Abstract

Reserve requirements re-emerged in academic debates as a counter-cyclical tool that plays a supervisory role in the economic system. This paper develops a vector autoregressive (VAR) model to investigate certain macroeconomic relationships particularly regarding Brazil and Colombia, and for assessing the impact of changes in reserve requirements on variables like aggregate output, inflation, credit volume, money supply, and bank spread. The results suggest that an increase in the reserve requirement rate can influence the variables, as predicted in monetary economic theory, such as an increase in bank spreads in both countries. The magnitude of the reduction in credit in Brazil is not as noticeable as that in Colombia (where it turns over more quickly and intensely), suggesting that the Brazilian central bank offers liquidity that substitute the available reduced deposits.

Resumo

Os depósitos compulsórios ressurgiram no debate acadêmico como ferramenta anticíclica que desempenha um papel de supervisão no sistema econômico. Este trabalho desenvolve um modelo vetor autoregressivo (VAR) para investigar certas relações macroeconomicas, particularmente no Brasil e na Colômbia, avaliando o impacto das mudanças no compulsório sobre as variáveis como produto agregado, a inflação, o volume de crédito, oferta de moeda e *spread* bancário. Os resultados sugerem que um aumento na taxa de reservas obrigatórias podem influenciar as variáveis, como previsto na teoria econômica monetária, tais como um aumento dos *spreads* bancários nos dois países. A magnitude da redução do crédito no Brasil não é tão perceptível como que na Colômbia (onde ele reduz de forma mais rápida e intensamente), sugerindo que o banco central brasileiro oferece liquidez que substitue os depósitos reduzidos disponíveis.

Keywords: Reserve requirements, macroprudential instruments, transmission mechanisms.

Palavras-chave: Depósito compulsório, instrumento macroprudencial, mecanismos de transmissão.

JEL classification: E44; E47; E58.

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[1]PhD candidate at the economic institute of the Federal University of Rio de Janeiro (IE/UFRJ) and Visiting Scholar at Columbia University. Email: miriamoportugues@gmail.com
[2] Professor at the economic institute of the Federal University of Rio de Janeiro (IE/UFRJ). Email: licha@ie.ufrj.br

1 INTRODUCTION

According to Lopes and Rossetti (2005), the tools of monetary policy are means to control the liquidity of the economic system in order to fulfill certain goals. The purposes of monetary policy vary according to the dominant political goals and the set of social values and economic problems particular to the society and era. On the other hand, macroprudential policy is understood, in the framework of the administrative and regulatory financial systems, as comprising a set of instruments intended to ensure the financial stability that will render the financial system robust enough to absorb shocks, and also to contain weaknesses and systemic financial risks. Gameiro et al. (2011, p. 21, our translation) add: "Macroprudential policy is thus close to macroeconomic policy in terms of goals, but close to microprudential policy in terms of instruments."

In light of the current economic crisis, examining the relationship of financial stability policy to monetary policy may have some utility for current macroeconomic debates. Blanchard et al. (2010) suggest that certain macroeconomic variables can serve as indicators of financial stability, and that the latter has to be considered as a policy goal that can be achieved with the proper instruments.

Recent scholarly literature on reserve requirements focuses on their prudential function, because some countries, especially in Latin America, use this instrument in addition to monetary policy and have employed it to reduce the effects of the 2008 crisis, thereby increasing liquidity (Montoro and Moreno, 2011). The main objective of the prudential tools is the control of systemic risk, a risk that can be represented by a set of measures of a financial system's fragility such as maturity mismatch, interconnectivity measurements, aggregate credit growth, evolution of asset prices and leverage increases. A reserve requirement can be used to influence one dimension of this set of vulnerabilities: the credit evolution, given its effects on the availability of money for banks' credit concessions.

The aim of this paper is to capture the macroeconomic effects of the requirement of reserves on credit supply, inflation, and the real economy in Brazil and Colombia, mainly because their central banks use this tool as an auxiliary to monetary policy, with the explicit aim of controlling macroprudential policy. In the 2000s, these two countries were the most active in Latin America in using reserve requirements to complement monetary policy in order to increase or reduce the credit volume (Banco Central do Brasil, 2011; Montoro and Moreno, 2011). Our research question is: Can a reserve requirement act so as to influence financial stability and affect the supply of credit? And, what are its effects on the economy? Despite their prudential purpose (through their influence on credit), reserve requirements can also have effects on the real economy (price and output). The methodology of our analysis involves a vector autoregression (VAR) model using the period from 2003 to 2012. The model examines the transmission mechanism of the effective rates of reserve requirements on several variables, including aggregate output, inflation rate, credit volume, money supply, and banking spread.

To meet the proposed objectives, this article is structured in five parts, including this one. The second section summarizes some common points in the theoretical discussion in the traditional literature on this topic, suggesting the incorporation into monetary policy of both the financial stability concept and macroprudential measures. The third section explains the effects of reserve requirements on economic policy, as well as the structure of the Brazilian and Colombian banking systems, and the role played in them by these requirements. Chapter four presents an econometric estimation performed through VAR. The last section presents the conclusions.

2 IMPLICATIONS OF THE PRESENT CRISIS FOR ECONOMIC THEORY

The global crisis of 2008 affected the international financial system and especially the real economy of many developed countries, creating recessions and domestic debt crises. Due to the

consequences of the crisis, the authors of the New Consensus[3] launched several articles that aimed to rethink macroeconomic policy, including Blanchard et al. (2010), Eichengreen et al. (2011), and Bean et al. (2010). Among the main topics of this discussion are the relationship between monetary policy and financial stability, and the role played by central banks in this new context. The discussion of the lessons of the financial crisis has suggested some new implications of the traditional monetary theory that should be considered, studied, and modeled in an effort to define a new framework for macroeconomic policy.

Blanchard et al. (2010) suggest including the discussion of financial stability in considerations of macroeconomic policy. Eichengreen et al. (2011) call these instruments macroprudential tools; they include capital reserves, restrictions on bank credit, and capital requirements. These tools support financial stability as a whole, and thus can also help in ensuring the stability of individual financial firms.

Bean et al. (2010, p. 20) argue that monetary policy is not an effective tool for containing credit bubbles and asset prices: "In order to avoid financial instability, one really wants another instrument that acts more directly on the source of the problem. That is what 'macroprudential policy' is supposed to achieve." They claim that such policy tools have multiple effects: making the banking system robust in relation to shocks (while recognizing the interconnectedness between financial institutions), and aiding lending against credit bubbles and asset price inflation (through the use of anti-cyclical capital buffers, and more micro-economically, increasing the use in calculations of weights representing the credit risks of banks).

Another implication relates to the debate about the role of central bank actions in providing liquidity more broadly; that is, whether central banks should intervene in capital markets in normal times as well as in crisis periods. Blanchard et al. (2010) mention, of central banks in this period, that "[t]hey extended their liquidity support to non-deposit-taking institutions and intervened directly (with purchases) or indirectly (through the acceptance of the assets as collateral) in a broad range of asset markets" (p. 14). The argument for central bank intervention is based on the case of market imperfections, such as coordination failures or, in certain markets, the disappearance of some investors.

Woodford (2011) proposes the inclusion of financial stability policy in the traditional model. The model's objective is to show how we can understand the inter-relationships of monetary policy and financial stability. Within a country's economic structure,[4] the financial stability measure is the aggregate credit spread, determined endogenously by the leverage in the financial sector, so that when the leverage is at or near a minimum of its normal range, there is no credit distortion, but when it is above a critical point, the shocks required to generate a crisis will be at a lower level, producing credit distortion (increasing the probability that negative shocks will trigger a wave of bankruptcies in financial institutions). Thus, as the objective of financial stability is to reduce the incidence of financial crises, it is important to try to stabilize the level of credit distortion near its optimum. Svensson (2012) notes that, in this model, monetary and financial stability policies are implemented separately and through different instruments.

Agénor and Silva (2011) present a macroeconomic model following that of Woodford (2011), and which analyzes the interaction between prudential and monetary policies, involving variations in reserve requirements and imposing an upper limit on the leveraging ability permitted to banks.

[3] Set of proposals concerning the practices of the central banks associated with New Keynesian school of thought. The consolidation of this agreement took place at the conference called New Challenges for Monetary Policy in 1999..

[4] The model presented was developed by Licha (2012), following Woodford's (2011) proposal and Svensson's (2012) comments.

The Central Bank of Brazil (Banco Central do Brasil, 2012b) also built a model, with six equations,[5] which evaluates the gains from using an optimal monetary rule for reserve requirements adopted in conjunction to optimal monetary rule for interest rates. The model results suggest that there are stability gains with the inclusion of reserve requirements as a supplementary tool, and that this can be seen in two perspectives: monetary or prudential.

3 RESERVE REQUIREMENTS

Reserve requirements are cash deposits or securities (placed with an eligible central bank) relating to a pre-determined fraction of the bank liability that should be passed to the monetary authority. Banks are required to follow the requirements, and otherwise will be subject to a penalty imposed by the central bank (Torres, 1999).

The reserve requirement is a policy tool that has many functions and activities in the money market, so this instrument has different purposes depending on the financial system structure of each country and the relevant economic policy goals.

3.1 FUNCTIONS[6]

The use of reserve requirements with the purpose of achieving monetary control works to contain the monetary aggregates, in the sense of trying to stabilize the relationship between the monetary base and the money supply; that is, the multiplier. Thus, the central bank adjusts the monetary base in order to control the broad monetary aggregate according to the policy goals that have been set.[7]

Gray (2011)[8] explains that in this monetary control rationality, there is another channel of influence for reserve requirements: the impact on the spread of interest rates. Especially in the case of compulsory deposits that are not remunerated, because they affect the interest rates that make up the mechanism of the bank's profitability spread (that is, the reserve requirement rates influence the differential between the lending rate and deposit rate since the reserves do not earn interest), the banks consider them as an opportunity cost of maintaining idle resources, transferring part or all of them to passive and/or active rates.

On the other hand, the purpose of a bank's using reserve requirements to manage its liquidity is to stabilize the demand for banking reserves.[9] This control (with reserve requirements) is performed using a method that calculates the average of reversals at the end of the day during a maintenance period, with the average value equal to or greater than the required level, though on any particular day it may be lower or higher. This helps interest rates remain within the stipulated target, for since banks tend to have trouble with cash settlement, they can use cash values within the reserve requirements margin without pushing interest rates. Thus, these mechanisms allow the stabilization of supply and demand for reserves, and enable the predicted resource flows from the central bank.

The reserve requirements in the prudential framework ensure liquidity for banks and the banking system as a whole. The microeconomic aspect of prudential reserve requirements was elucidated in discussing the previous effects, which uses the average daily reserves method.

In a macroeconomic sense, compulsory deposits provide liquidity to the banking system, forcing banks to have a margin account with the central bank, and thus reducing the likelihood of illiquidity problems arising when financial panics occur. This mechanism prevents banks from

[5] The model has the following equations: Phillips curve, inflation of imported goods, the Taylor rule, IS, banking spreads, and credit gap. A description of the model is presented in the article.

[6] The three functions are defined by Gray (2011). Torres (1999) adds two more: credit control (Gray includes this function under monetary control) and providing revenues to the central bank (no longer used).

[7] This is the basic model illustrated in any manual of monetary economics. (Carvalho, 2001; Rosetti and Lopes, 2005).

[8] Gray discusses the current practice of requiring deposit reserves for 121 central banks.

[9] The volunteer resources demand can be very unstable because of variations in short-term liquidity flows, economic shocks (variability of demand for precautionary reasons), and changes in the structure of the payments system (Gray, 2011).

having high leverage degrees, since in crisis times a bank run could be reduced with a liquidity injection by the central bank making use of the compulsory resources. This tool reduces fluctuations in the credit volume during the economic cycle, since it restricts credit and prevents financial imbalances at peak times, and it decreases the reserve requirement (with the possibility of using the accumulated reserves of the previous phase) in the valley cycle so as to increase liquidity.

3.2 STRUCTURE IN THE BRAZILIAN FINANCIAL SYSTEM

Reserve requirements in Brazil, according to the Central Bank of Brazil (Banco Central do Brasil, 2012b), impact on monetary conditions in two ways: first, by affecting the monetary multiplier, and secondly, by creating a predictable demand for bank reserves. However, the Central Bank of Brazil (CBB) also incorporates a financial stability control, calling it an instrument that ensures the stability and soundness of the international financial system, which "in the past was regarded as a monetary policy instrument, but gradually became seen as a means of preserving financial stability" (Banco Central do Brasil, 2012b, p. 6, our translation).

According to the Banco Central do Brasil (2014), the following forms of compulsory deposits are prevalent: compulsory payment on the demand deposits; reserve requirements on term deposits; required resources on savings deposits; reserve requirements on collateral resources realized; additional requirements on deposits (demand deposits, term and savings deposits).[10,11]

The Monetary Policy Committee (COPOM) sets the rates of reserve requirements. Table 1 shows the evolution of rates from 2000 to 2012, highlighting the high percentages at the beginning of the decade, the reduction between 2003 and 2008, and the return, beginning in June 2010, of elevated rates, mainly in the form of additional liabilities.[12]

Table 1: Aliquots of compulsory deposit of Brazil (%)

Period	Demand deposits		Term deposits		Savings deposits	
	Rate	Add. Liab.	Rate	Add. Liab.	Rate	Add. Liab.
Mar/00	55					
Jun/00	45					
Sep/01			10			
Jun/02			15			
Jul/02						
Aug/02		3		3	20	5
Oct/02		8		8		10
Feb/03	60					
Aug/03	45					
Feb/05						
Oct/08	42	5		5		
Dec/08				4		
Sep/09			13,5			
Feb/10		8	15	8		
Jun/10	43	12	20	12		
Jul/12	44					
Jun/14	45					

Source: Banco Central do Brasil (2014)

The CBB applies remuneration on some types of reserve requirements, which in December 2011 included reserve requirements on term deposits, on savings deposits, and "Additional Requirements on Deposits." The main issue highlighted by the CBB regarding remuneration of reserve requirements is that it reduces borrowing costs for banks, implying that lower interest rates were charged on active operations. Moreover, compulsory payments for demanded resources are not compensated because the financial institutions do not remunerate deposits of this type. Also important is that the total balances of most reserve requirements are represented by the remunerated accounts, so that in December 2011, the accounts were remunerated at 82% of their total balance.

[10] In its time series database, the Central Bank of Brazil shows reserve requirements on demand deposits, term deposits, savings deposits, and additional liabilities.

[11] The Central Bank of Brazil (Banco Central do Brasil, 2014) details several types of reserve requirements, including three that are currently at a zero rate.

[12] Calculations of the details of the effective rates of reserve requirements can be found in Banco Central do Brasil (2012b).

After the financial crisis of 2008-09, reductions in reserve requirements for big banks were permitted if they provided liquidity to small and medium banks (Dawid and Takeda, 2009; Banco Central do Brasil, 2012b). In 2010, the CBB started a process of reversing actions with the aim of containing credit growth in specific segments (Dawid and Takeda, 2011).

3.3 THE STRUCTURE OF THE COLOMBIAN FINANCIAL SYSTEM

Colombia's Banco de La República (BANREP), like the CBB, uses reserve requirements as a counter-cyclical policy instrument to control the stability of the financial system in order to smooth out fluctuations in liquidity and credit (Montoro and Moreno, 2011; Vargas et al., 2010).

In September 2012, the prevailing rate of reserve requirements were 11% for banks' spot liabilities of less than 30 days, fiduciary deposits, savings deposits in financial institutions, repurchase agreements, and term deposits. The rate of 4.5% was effective for certificates of deposit (CDs) and bonds of up to 540 days (18 months).

Table 2 shows the evolution of compulsory reserves policies in Colombia. BANREP was using its reserve requirement before the financial crisis, as an unconventional tool to fight the domestic credit growth in 2006-07 (Vargas et al., 2010).

Table 2: Evolution of reserve requirements in Colombia

Date	Average reserve requirements	Marginal reserve requirements	Remuneration of reserve requirements
2000-2007	13% demand deposits 6% savings deposits 2.5% CD and bonds with maturity ≤ 18 months	----	75% of the inflation target in compulsory savings deposits 100% of the inflation target in reserve and CD titles ≤ 18 months
May 2007	Unchanged	27% demand deposits 12.5% savings deposits 5% CD with maturity ≤ 18 Months	The marginal are not remunerated The medium remain unchanged
June 2007	8.3% demand deposits and savings deposits 2.5% CD and bonds with maturity ≤ 18 months	27% demand deposits and savings deposits 5% CD and bonds with maturity ≤ 18 Months	The marginal are not remunerated Average: • 37.5% of the inflation target in the compulsory demand deposits and savings deposits • 100% of the inflation target in reserve and CD titles ≤ 18 months
June 2008	11.5% demand deposits and savings deposits 6% CD and bonds with maturity ≤ 18 months	Eliminated the marginal reserve requirements	Unchanged
October 2008	11% demand deposits and savings deposits 4.5% CD and bonds with maturity ≤ 18 months	-----	Unchanged
January 2009	Unchanged	-----	Average: • 0% inflation target in reserve demand deposits and savings deposits • 100% of the inflation target in reserve and CD titles ≤ 18 months
July 2009	Unchanged	-----	Remuneration on average reserve requirement eliminated
September 2012	Includes electronic deposits at the rate of 11%	-----	Unchanged

Source: Vargas et al. (2010) and BANREP.

Vargas et al. (2010) created a vector autoregressive parameterized model (VEC) to measure the effect of reserve requirements on the inflation-targeting regime in Colombia that lasted from 2000 to 2010. They concluded that reserve requirements are important determinants of long-rate loan terms, and are effective in strengthening policy transmission to both deposit and lending rates. That is, the requirements reinforce the monetary policy mechanism, but also impose costs on financial intermediation. The authors point out that the model featured an asymmetry in the policy rate transmission, so that a fall in the policy rate yields a larger response in market rates than an increase.

4 THE MODEL

The model aims to investigate the influence of reserve requirements as a macroprudential instrument in Brazil and Colombia. More specifically, the intent of the analysis is to verify if that affects the credit volume. Also considered in the model is the indirect impact on output and inflation, despite the prudential character of the actions recently undertaken by the central bank, which, beyond credit, have also impacted on activity and prices. However, our purpose is to define not the relationship between the microeconomic effects of reserve requirements and the banking system, but that of its macroeconomic variables, so that this instrument is considered as a variable that influences not only money creation, but also the financial system as a whole, especially when seen as a financial stability control variable.

The methodology of the proposed analysis is the vector autoregressive (VAR) model. The procedure involves considering together several endogenous variables, which are determined by the lagged values, without defining a priori the order and causality of determination between them. Considering the main variables—inflation, aggregate output, banking spread,[13] money supply, credit volume, and reserve requirement effective rate—the model allows us to analyze dynamically all the changes in the variables in the model.

The theoretical justification for the choice of variables is outlined by the transmission channel within in the traditional monetary control function, and concerns the effect of the requirements on control of the money supply. The mechanism works through adjustments to the monetary base made in order to increase or decrease the money supply. It depends on the monetary regime: if it is quantitative, an increase in the reserve requirements reduces the money supply and available credit for a given monetary base.

On the other hand, in an inflation-targeting regime, the central bank provides and ensures the liquidity necessary to maintain the current market interest policy rate. This is the case for Colombia and Brazil. This transmission channel will be through influence on credit, money supply, and/or the spread rates of the banks. The effect on the banks' rates shows that the transmission channel between the variation in the reserve requirements rate and asset prices, assuming that the bank transfers the opportunity cost of these idle resources onto their rates, functions like a tax. If the liquidity guaranteed by the central bank is a perfect substitute for deposits, an increase in the reserve requirement will lower the deposit rate, but the credit and money supply (as well as the lending rate) will be unchanged.

If the liquidity guaranteed by a central bank is an imperfect substitute for deposits (because of uncertainty about the future path of short-term policy rates, maturity mismatches, or other things), an increase in the reserve requirement rate would lessen both the volume of credit and the money supply, and occasion an increase lending rates; and these two directions of change can be treated as different transmission channels. The former explains the *direct effects* of the reserve requirements that are set so as to affect the amount of money available for deposit in banks that are organized to provide loans; that is, increasing or reducing the credit concessions, which in turn can affect activity and prices. The latter clarifies *the indirect effects* of an increase in the reserve requirements rate, indicates variations in the spread rate, and hence in the lending rate, thereby decreasing the credit volume (for instance, through the higher costs to borrowers), which in turn reduces output and inflation. This case occurs when the reserve requirements are not remunerated or when the rate of remuneration is lower than the market rate. Whether there are higher lending rates or lower deposit rates depends on the market structure of the banks (Alencar et al., 2012; Tovar et al., 2012).

Moreover, the instrumental analysis underlying VAR models, through the impulse-response functions, allows analyzing the sensitivity of economic variables to shocks around a specific error

[13]The proposed model assumes that the banks can pass on the effects of reserve requirements to the lending rate (which is the active interest rate) and/or the deposit rate (the passive interest rate).

term in a given period, and the variance decomposition enables analysis of the contribution of each of the variables due to individual shock in component of K's variables in the model.

The VAR in reduced form can be illustrated as follows:

$$Y_t = \mu + \Phi Y_{t-1} + \cdots + \Phi_p Y_{t-p} + \varepsilon_t \qquad [1]$$

where ε_t is a vector of errors (innovations) not autocorrelated, with zero mean and contemporary Covariance Matrix $E[\varepsilon_t \varepsilon'_t] = \Omega$, i.e., white noise; μ is a vector of exogenous variables; Y_t is a vector of q endogenous variables with p lags, and Φ_t is a matrix of the coefficients of the endogenous variables. The equations can be estimated separately by ordinary least squares (OLS), producing consistent estimators. By construction, the structural shocks (u_t) are related to the error vector in the VAR reduced form: $A\varepsilon_t = Bu_t$, where A is an invertible square matrix. Multiplying the above equation by A yields the structural model:

$$AY_t = \mu + B_t Y_{t-1} + \cdots + B_p Y_{t-p} + Bu_t \qquad [2]$$

Our concern here is to analyze how the vector Y_t responds to structural shocks, represented as u_t (in this case, monetary shocks). As $E[\varepsilon_t \varepsilon'_t] = \Omega$ can be estimated consistently by OLS, it is necessary to impose restrictions on A, because the reduced model does not estimate enough elements of this matrix to identify the dynamic response of Y_t to monetary shocks. Therefore, we adopted the Choleski decomposition as a recursive method that allows identification of the parameters of the structural equations system, allowing orthogonal errors in the reduced form by setting a lower triangular matrix P , such that $\Omega = PP'$. This procedure is susceptible to an ordering of the variables that imposes a particular chain of causality between them, which can be justified by economic theory.

4.1 SOURCES AND TREATMENT OF THE DATA

In order to observe the transmission mechanism of the reserve requirements in an economy, the data used in the reference model are: (1) the reserve requirements effective rate; (2) the credit volume growth rate; (3) the broad monetary aggregates growth rate (M2 - Brazil and M3 - Colombia);[14] (4) the bank spread rate; (5) the industrial production index growth rate; (6) inflation. The main hypothesis is that the effective rate of reserve requirements affects the credit volume, assuming the existence of an influence on lending rates or deposit rates (*indirect effect)*, and/or money supply (*direct effect)*. That is, an increase in reserve requirement rates can reduce credit concessions, by decreasing the money supply available to large banks and/or through the increase in bank spreads. Furthermore, these two channels have an effect on both aggregate demand and inflation.

The proxy chosen for gross domestic product (GDP) chosen was the physical production (quantum) industry index that is usual in the empirical literature. The need for a monthly series was one major factor in choosing this as a proxy for the aggregate demand behavior. For a robust analysis we added: exchange rate, commodity index (petroleum) rate, and a dummy for effect of the 2008 financial crisis. Details of the variables for each country are in Appendix A. All variables are in logarithms, except the inflation (annual change - %). The data set consists of monthly observations from January 2003 to December 2012.

4.2 UNIT ROOT AND COINTEGRATION TESTS

First, before performing the tests, we must analyze the graphs of the variables, because they influence the assumptions behind the unit root tests. An important appointment is that the credit volume and industrial production functions show a similar behavior for variables without constants or trends, while the others resemble variables with them. According to this analysis, we applied the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests for defining the order of integration, since the ADF test presents a null hypothesis (H0) with the

[14] Each monetary aggregate was selected according to the incidence of reserve requirements in the broad monetary aggregate of each country.

presence of a unit root, whereas the KPSS places H0, such that the series is stationary [I(0)]. As the ADF and KPSS tests are biased in the presence of structural breaks and outlier additives, we also performed the Zivot and Andrews and Lee-Strazicich tests, which include among their assumptions the presence of breaks. Zivot and Andrews[15] test present a null hypothesis: a random walk with drift and without structural breaks; while the Lee-Strazicich[16] test indicates for H0 a random walk with drift and with breaks in the level and/or trend.

The Brazil test results are represented in Table 3. The reserve requirements effective rate (rate), spread, inflation, and exchange rates present favorable evidence to be in at least three tests at a 5% significance. The Zivot and Lee test, and the Andrews-Strazicich test differ, in some cases, from the results of the ADF and KPSS tests, because the latter two tests show a bias in the presence of structural breaks. The credit volume (credit), industrial production (output), M2, and commodities show indications of being stationary in all four tests, converging at 5% significance.

Table 3: Unit root tests for Brazil

Variables	ADF (level)	ADF (diff.)	KPSS (level)	KPSS (diff.)	Zivot and Andrews	Lee-Strazicich
Rate (larc)	-2.0463 {c e t}	-10.5022*** {c}	0.11450 {c e t}	NA	-4.6832 [Model C] Feb. 2010	-5.087626 [Model C] Level Aug. 2008/Trend Aug. 2008*** Level May 2010/Trend May 2010***
Spread (lsp)	-2.7096 {c e t}	-9.8289*** {c}	0.7443*** {c}	0.1858 {c}	-3.2589 [Model A] Jun. 2008	-2.622397 [Model A} Level Dec. 2007*** Level Dec. 2010
Credit (lvc)	-2.7673***	NA	0.09675 {c}	NA	-9.4453*** [Model B] Apr. 2004	-6.205176*** [Model A] Level Jan. 2008
Output (lpi)	-9.7767***	NA	0.04596 {c}	NA	-9.3043*** [Model B] Nov. 2008	-8.48952*** [Model A] Level Jul. 2008
Inflation (ipcaa)	-3.2190 * {c e t}	-4.4367***	0.2296 *** {c e t}	0.1344 {c e t}	-5.25301 ** [Model C] Apr. 2007	-3.278845 [Model A] Level Aug. 2004 Level Jun. 2007
M2 (lM2)	-2.6459** {c e t}	NA	0.24347 {c}	NA	-11.9607*** [Model A] Dec. 2008	-11.24624*** [Model C] Level May 2010/Level Nov. 2011 Level Jan. 2009/Trend Jan. 2009***
Exchange (lcambio)	-1.17264 {c e t}	-8.4184*** {c}	0.2315*** {c}	0.0846	-2.4886 [Model A] Apr. 2011	-2.4886 [Model A] Level Apr. 2011
Commodity (comd.)	-3.6160 ** {c e t}	sNA	0.0802 {c e t}	NA	-6.0925*** [Model A] Sep. 2008	-3.922096 [Model A] Level Jun. 2009

Source: Developed by the authors based on research data.
Notes: (1) In all tests, we use the Schwartz information criterion for selecting the number of lags in the test equation; (2) the ADF and KPSS tests were performed by the E-views software; (3) The Zivot and Andrews test, and the Lee-Strazicich test were performed by the R software. In both tests, it was assumed that the structural break in the relevant series occurred for both level and trend; (4) the symbols *, **, *** indicate a rejection of the null hypothesis for the unit roots 10%, 5%, and 1%, respectively; (5) the NA term does not apply; (6) term included in the model: c = constant and t = trend.

Table 4 shows the Colombia unit root tests. Only two variables present evidence in favor of a unit root in the form I(1) — spread and inflation, while at least three tests agree for those series stationary at the 5% significance level. The variable spread has an interesting behavior, because the tests with a structural break indicate a unit root, while the ADF and KPSS tests do not. This variable will be addressed in its differences, by indicating the structural break.

[15] The Zivot and Andrews test includes: For H0: a random walk with drift and without structural breaks. Opposed to this are three types of alternative hypotheses: H1A - trend-stationary, with a break in the level; H1B - trend-stationary, with a break in the trend; H1C - trend-stationary, with a break in the level and trend (Zivot and Andrews, 1992).
[16] The Lee-Strazicich test can be accomplished with one or two structural breaks. Model A: H0 - a random walk with a drift and a break in the level; H1 - a stationary tendency with breaks in the level. Model C: H0 - a random walk with a drift, with breaks in the level and trend; H1- a stationary tendency with breaks in the level and trend (Lee and Strazicich, 2003).

Table 4: Unit root tests for Colombia

Variables	ADF (*level*)	ADF (*diff.*)	KPSS (*level*)	KPSS (*diff.*)	Zivot and Andrews	Lee-Strazicich
Rate (larc)	-9.3859*** {c e t}	NA	0.1761**	NA	-9.3832*** [Model C] Aug. 2008	-9.266489*** [Model A] Level Sep. 2008 Level Aug. 2011
Spread (lsp)	-4.8163*** {c e t}	NA	0.0589	NA	-4.1371 [lModel C] Apr. 2009	-4.740233 [Model C] Level May 2009/Trend May 2009*** Level Jan. 2011/Trend Jan. 2011***
Credit (lvc)	-15.900***	NA	0.0635	NA	-13.890*** [Model A] Sep. 2008	-13.93646 *** [Model A] Level Oct. 2009
Output (lpi)	-15.5937***	NA	0.4060	NA	-15.1180*** [Model A] Nov. 2007	-14.20335*** [Model A] Level Feb. 2010
Inflation (ipc2)	-2.9510 {c e t}	-7.506***	1.0967*** {c}	0.0393	-4.1062 [Model C] Apr. 2009	-2.661359*** [Model A] Level Jul. 2006 Level Feb. 2009
M3 (lM3)	-2.2239 {c e t}	-10.339***	0.1139 {c e t}	NA	-11.43413*** (Model B) Nov. 2004	-10.10814*** [Model A] Level Nov. 2007 Level Apr. 2009*
Exchange (lcambio)	-3.9265** {c e t}	NA	0.0821 {c e t}	NA	-4.5257** [Model B] Jan. 2003	-4.65107** [Model C] Level May 2004 Level May 2004***

Source: Developed by the authors based on research data.
Notes: (1) In all tests, we use the Schwartz information criterion for selecting the number of lags of the test equation; (2) the ADF and KPSS tests were performed by E-views software; (3) the Zivot and Andrews test, and the Lee-Strazicich test were performed using the R software. In both tests, it was assumed that the structural break in the relevant series occurred for both level and trend; (4) the symbols *, **, *** indicate rejection of the null hypothesis for the unit roots 10%, 5%, and 1%, respectively; (5) the NA term represent does not apply; (6) the terms included in the model are c = constant and t = trend.

The cointegration tests should be performed in order to study the stable and constant long-term relationships between the variables, which, once omitted from the model, can cause specification bias. The tests did not reject the indication of any cointegration vector in the relationships presented between the series. Note that we tested the combinations in groups of two and three variables, including series with disparities between the unit root tests (M2 and Commodities), and they showed no rejection of the null hypothesis null as well as the variables of Colombia I(1). An important consideration is that one should perform several cointegration tests as well as a unit root test, to make the necessary judgments about the series relationships.

Thus, to construct the model, the variables in I(1) were estimated first for difference (four for Brazil: rate, spread, exchange and inflation; and two for Colombia: spread and inflation) and the stationary variables were estimated in level.

4.3 VARIABLE ESTIMATION

The specification of reference for estimating the autoregressive model for each country uses the following variables: rate (effective rate for reserve requirements), spread, credit, output, and inflation; and to represent the money supply: M2 for Brazil and M3 for Colombia. For a more robust analysis and to control for the influence of the other variables, the model includes the exchange rates as endogenous variables, while the exogenous variable is commodity prices. All models include a dummy-level (d2), assuming the value of 1 between October and December 2008, and 0 for the rest of the period, given that the economic downturn has affected the behavior of several macroeconomic indicators in the period.

Congruent models were found for the Brazil model with four lags, while the Colombia model has two lags. The lag selection criterion tests (using the SC (Schwartz), AIC (Akaike), and HQ (Hannan-Quinn) information criterion were considered as a basis for estimation, so as to find models with no serial correlation and no heteroscedasticity. All specifications are stable for presenting inverse roots of the characteristic polynomial inside the unit circle. The residual diagnostics were made using the LM test (Breusch-Godfrey LM serial correlation), the White test

for heteroscedasticity, and the Jaques-Bera test for normality. According to the tests, the Brazil and Colombia models only had problems of normality, although this does not pose a major problem because the VAR is estimated consistently by ordinary least squares, by adopting the weak hypothesis of normal errors being asymptotically independent and identically distributed, given the large monthly sample.

4.3.1 IMPULSE RESPONSE FUNCTIONS

Our evaluation of the dynamic impact of shocks (random impulse) on the variables system uses the Cholesky decomposition methodology, establishing contemporary relations between variables by imposing a lower triangular matrix on the covariance matrix of residuals. Four different orders were adopted in the model. Table 5 summarizes the set of variable sequences.

Table 5: Ordering of Variables

Model	Ordination
1.a	Output → inflation → rate →spread → M2→credit → exchange
1.b	Output → inflation → rate→ M2 → spread → credit → exchange
2.a	Rate → spread → exchange → credit → M2 → inflation → output
2.b	Rate → M2 → exchange → credit → spread → inflation → output

The orders 1.a and 1.b[17] follows the usual order of VAR models that are used to evaluate the monetary policy transmission channel, such as Minella (2003), Luporini (2008), and Oreiro and Kawamoto (2011), by switching the interest rate place for the reserve requirements effective rate (*rate*), and ordering as follows: output, inflation, rate. The order 1 incorporates the sequences that are most similar to those used in cited works by adding money supply (M2 - Brazil or M3 - Colombia) and exchange, ordering rate[18] after inflation, and money supply after the instrument. The credit and the exchange rate,[19] in this order, will stay after M2 (or M3); and the spread will be between the rate and M2 (or M3).

For 2.a and 2.b, we used the ordering used by Bernanke and Gertler (1995), to test whether the results are dependent on the assumed sequences. In ordering type 2, there is a contemporary causal relationship of output and inflation to the other variables, whereas in type 1, the output responded only to inflation, contemporaneous output, and the lagged values of the other variables). The difference between the a and b specifications is the change in position between spread and M2 (or M3), with a view to checking whether the system model is susceptible to the order of these two variables, representing the two channels of reserve requirement performance.

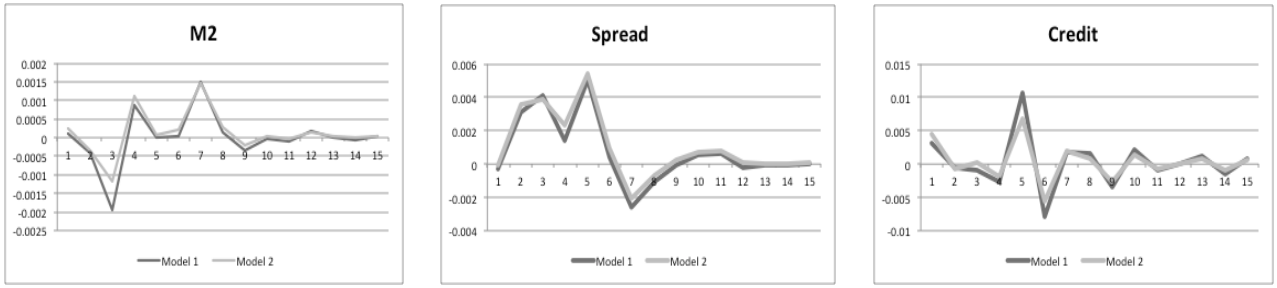
The impulse response functions of the effective rate for the variables in the Brazil model are represented by the solid lines in Figure 1 and 2. The orders 1.a and 1.b, as well as 2.a and 2.b, have the same effects for all variables, given a shock in the reserve requirement rate, so that the charts show only the models 1.a and 2.a (this is the case for the Colombia model also). The specifications estimated in 1.a and 2.a show similar behavior, causing an immediate positive impact on bank spreads, as well as a reduction in broad monetary aggregates (M2) between the first and fourth periods. The credit variable indicates a more erratic behavior of the impulse response functions, includng an unexpected increase in the fifth period, but displays a reduction between the second and fourth periods (and also between the fifth and seventh). The rising spread of banks happens between the first and sixth months. This suggests that the central bank might guarantee a liquidity that is perfectly substitutive for credit and the reserve requirement have more significant impact on banks' rates

[17] Commodity prices and interest rates are exogenous variables.

[18] The effective rate place is an analog of the interest rate.

[19] In model 2(a), the results were not changed by the sequence with the exchange rate between inflation and the effective rate.

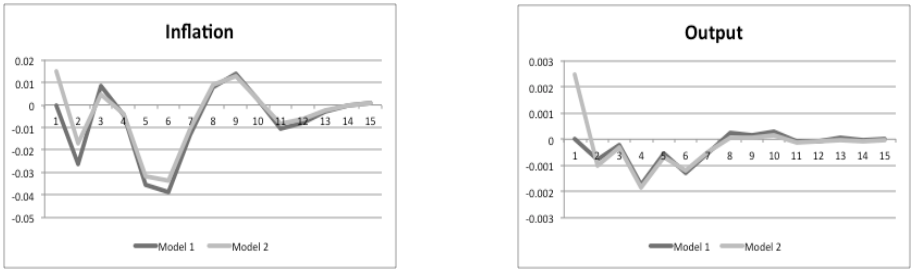
Figure 1: Response of M2, spread, and credit to a shock in the rate – Brazil



Source: Developed by the authors based on research data.

The Figure 2 shows that output is reduced between the second and seventh months, then returns to its trend, as well as displaying a decrease in inflation between the first and eighth months, and an unexplained increase between the third and fourth months. The maximum impact of inflation happens between the fifth and sixth months. Thus, we observe that the data behave as generally expected in economic theory, given the reduction of the money supply; and since the banks could pass the rate increase cost to the spread, this can also lead to reductions in credit, inflation, and output.

Figure 2: Response of inflation and output to shocks in the rate – Brazil



Source: Developed by the authors based on research data.

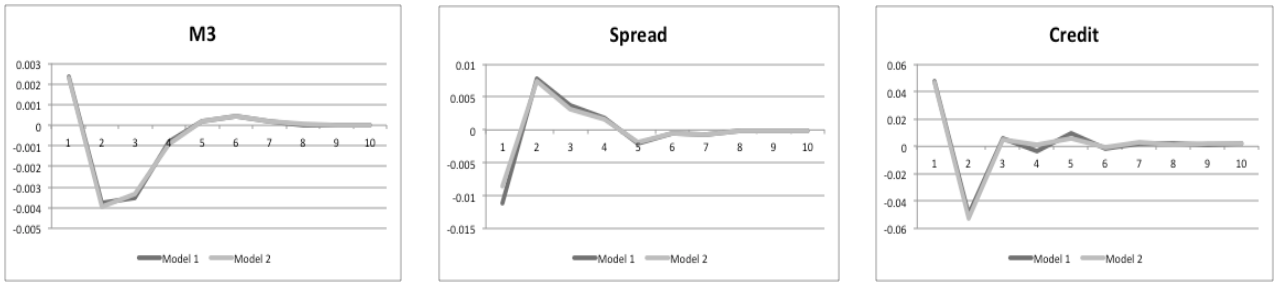
The Brazilian Central Bank (Banco Central do Brasil, 2011) estimated the impact of reserve requirements through a structural model for output and inflation, with least squares and in two stages.[20] The model's application was represented by a permanent shock in the effective rate of the reserve requirements equivalent to an increase of R$69 billion in the total volume of the reserve requirements. The maximum impact on inflation would occur between the third and fourth quarters after the change in the rate.

Sousa, Rodrigues, and Takeda (2004) demonstrate the effect of reserve requirements on the interest rate of banks through a semi-parametric approach, revealing that between 2000-2004, an increase in reserve requirements could raise the spreads, but the opposite was not the case: reducing the rate did not decrease the spread, nor did it occur to a lesser extent.

For Colombia, the dynamic response of selected variables due to rate shock is shown in Figures 3 and 4. As in the Brazil model, it shows only the ordinations 1.a and 2.a, because of the identical movement between 1.a and 1.b, and also 2.a and 2.b. The graphs show, as in the case of Brazil, results that are consistent with economic theory. The unexpected rate shock reduces the credit volume and output between the first and fifth months. Inflation has the greatest impact in the third month in all specifications, but the series has a price puzzle at the beginning of the impulse response function between the first and second months. The money supply reduces between the first and fourth month, as with credit volume. The spread increases between the first and fifth months.

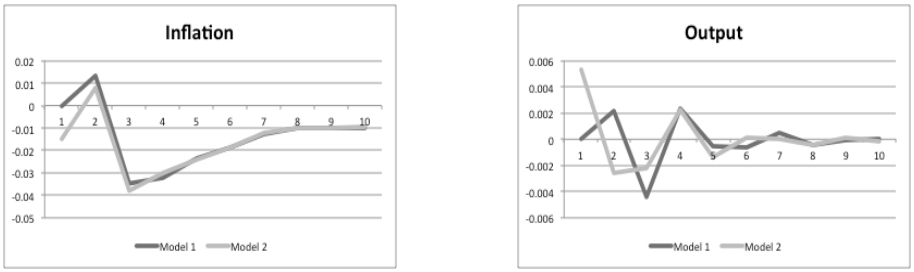
[20] The model is represented by five main equations: the Phillips curve, the Taylor rule, the output gap, the yield curve, and the credit market. It includes the following variables: credit volume, observed interest rate in the credit market, and the effective rate of reserve requirements, and so the requirements directly affect the credit volume growth rate and the lending rates.

Figure 3: Response of M3, spread, and credit to shocks in the rate – Colombia



Source: Developed by the authors based on research data.

Figure 4: Response of inflation and output to shocks in the rate – Colombia



Source: Developed by the authors based on research data.

4.3.2 VARIANCE DECOMPOSITION

The errors in forecasting the decomposition of the variance of the different countries (model 2.b) are presented in Tables 6 and 7. Generally, the decompositions of the variance showed the same results for all ordinations. This method analyzes how structural shocks add to the volatility of the variables (included in the estimated model), providing the proportion of movements in a sequence that is due to shocks themselves versus shocks from other variables in the system.

In Brazil, the credit variance decomposition displays a greater contribution of M2 (35.59%), followed by output (5.68%), and spread (3.44%) in the fifteenth period. It makes sense for credit to be more sensitive to reduction of the money supply, suggesting that the *direct effect* of reserve requirements works to reduce credit concessions. On the other hand, it highlights the *indirect effect* via bank spread of increases that, where possible, are compulsory, for loan interest rates have the effect of reducing the growth of credit concessions, though with a smaller proportion than for the direct effect.

The inflation, especially in the early stages, is basically self-explanatory, and after four periods, the influences of the spread, M2, exchange, and credit are expanded, with 4.99%, 3.61%, 2.90%, and 2.03%, respectively, in the fifteenth period. The large exchange rate participation in this case can be attributed to the greater contribution here of external factors to inflation. The data suggest that the spread makes a slightly larger contribution to prices than to sreducing the money supply.

The spread, credit, rate, and M2, in that order, have a larger importance in the output variance decomposition, as, respectively, 7.98%, 4.77%, 4.24%, and 4.20%, in the fifteenth period. Unfortunately, the output variance decomposition did not show the same contribution order of the variables in all orderings (1a, 1b, 2a, 2b). But a trend can be traced, and then we find that credit, spread, and M2 in all the orderings represent the largest contributions. This logic has an economic sense in terms of the influences of money supply, lending interest rates (if applicable), and credit.

Table 6: Variance decomposition of output, inflation, and credit - Brazil

Variance decomposition of output								
Period	S.E.	Output	Inflation	Rate	Spread	M2	Credit	Exchange
1	0.015499	92.66	0.19	2.52	2.67	0.06	1.71	0.19
5	0.017124	76.42	2.42	3.81	8.03	3.00	4.61	1.72
10	0.017416	74.53	2.74	4.25	7.99	3.95	4.77	1.77
13	0.017451	74.26	2.79	4.24	7.99	4.18	4.78	1.78
15	0.017459	74.22	2.80	4.24	7.98	4.20	4.77	1.79
Variance decomposition of inflation								
Period	S.E.	Output	Inflation	Rate	Spread	M2	Credit	Exchange
1	0.015499	0.00	97.52	0.17	0.89	0.69	0.71	0.03
5	0.017124	0.78	85.81	0.60	5.10	3.39	1.71	2.62
10	0.017416	1.00	84.38	1.13	4.99	3.59	2.02	2.89
13	0.017451	1.07	84.26	1.17	4.99	3.59	2.03	2.90
15	0.017459	1.07	84.24	1.17	4.99	3.s61	2.03	2.90
Variance decomposition of credit								
Period	S.E.	Output	Inflation	Rate	Spread	M2	Credit	Exchange
1	0.015478	0.00	0.00	0.69	0.00	27.05	72.17	0.09
5	0.018188	4.25	1.92	0.80	2.49	37.53	51.54	1.47
10	0.018520	5.66	2.01	1.21	3.40	35.58	49.99	2.15
13	0.018556	5.64	2.01	1.21	3.41	35.65	49.93	2.15
15	0.018565	5.68	2.02	1.22	3.44	35.59	49.90	2.15
Cholesky Ordering: D(LARC), LM2 D(LCAMBIOE), LVC D(LSP), D(IPCAA) LPI								

Source: Developed by the authors based on research data.

In addition, the greatest contribution of M2 and the reserve requirements rate to the spread variance decomposition also occurred in the fifteenth period, where they are, respectively, 32.89% and 6.65%, while the M2 variable is basically self-explanatory (75.26% in the fifteenth period) and the spread makes a major contribution to the M2 variance decomposition, at 6.96%, in the fifteenth period. This trend is shared by the four orderings. The performance of M2 in this analysis is consistent with the monetary theory, because in the inflation targeting model adopted in Brazil, the money supply has to adjust in relation to a given fixed interest rate, so it makes sense for the variable M2 to be self-explanatory, and for the other variables to make a comparatively small contribution.

Table 7 shows the variance decomposition results for Colombia. The data indicate that the credit volume movements are primarily explained by M3 (19.37%), followed by rate (4.41%), inflation (3.34%), output (1.30%), and spread (0.75%), in this order, in the tenth period. The Colombia model stresses the same coherence between the impact of the money supply and the spread in relation on credit as for Brazil, where the reserve requirements have a greater direct effect. This emphasizes a lower contribution of the spread as compared with the Brazilian model, the largest in the M3, and the reserve requirement rate in the Colombian model.

Inflation is influenced by the three main variables that make the greatest contribution to its variance: exchange (8.59%), credit (4.41%), and rate (3.42%), in the tenth period. This result suggests that credit reduction makes a greater contribution to lowering inflation than increases in the spread, by raising the reserve requirement.

The output variable is explained by spread (6.69%), credit (4.69%), rate (3.17%), and M3 (2.00%), in the tenth period. As in the Brazilian model, the decomposition in the output variance

produces different orders of variable contribution for each ordination (1a, 1b, 2a, 2b); however, spread, credit, reserve requirement rate, and money supply represent the largest contributions and all can contribute to the output reduction.

Table 7: Variance decomposition of output, inflation, and credit - Colombia

Variance decomposition of output								
Period	S.E.	Output	Inflation	Rate	Spread	M3	Credit	Exchange
1	0.025922	86.98	1.25	4.14	6.31	0.04	0.82	0.47
5	0.038222	81.48	1.76	3.20	6.70	1.92	4.68	0.27
7	0.038498	81.45	1.76	3.16	6.68	1.99	4.68	0.28
10	0.03852	81.41	1.76	3.17	6.69	2.00	4.69	0.28
Variance decomposition of inflation								
Period	S.E.	Output	Inflation	Rate	Spread	M3	Credit	Exchange
1	0.025922	0.00	95.96	0.27	0.65	0.00	0.00	0.00
5	0.038222	0.28	80.94	2.82	0.81	0.25	4.43	7.17
7	0.038498	0.28	79.98	3.22	0.82	0.26	4.41	7.76
10	0.03852	0.28	79.00	3.42	0.81	0.26	4.41	8.59
Variance decomposition of credit								
Period	S.E.	Output	Inflation	Rate	Spread	M3	Credit	Exchange
1	0.025825	0.28	2.30	2.47	0.21	18.29	76.45	0.00
5	0.037988	1.26	3.34	4.40	0.74	19.37	70.34	0.55
7	0.038241	1.28	3.34	4.41	0.75	19.38	70.29	0.55
10	0.03826	1.30	3.34	4.41	0.75	19.37	70.27	0.55
Cholesky Ordering: LARC, LM3D, LCAMBIOE, LVC, D(LSP), D(IPC2), LPI								

Source: Developed by the authors based on research data.

The rate (11.19%) makes the greatest contribution to the decomposition of the variable M3 (self-explanatory, as in the Brazilian model, with a participation of 85.57%), while the money supply (7.84%) makes the largest contribution to the spread variance decomposition, in, for both variables, the tenth period. In this model, the reserve requirements rate has more influence on the money supply than the other variables.

In short, we find that the reserve requirements affect credit more sharply in Colombia than in Brazil. This may suggest that the endogenous liquidity provided by the central bank substitutes for the reduction of bank reserves in Brazilian banks. This does not seem to happen in Colombia. Both models show a reduction in the money supply, though it is observed in impulse response functions only as an initial reduction credit (until the third period) in the model for Colombia. The credit reduction for Brazil only happens when the increase in the spread grows in importance as a component of credit variance decomposition (from 0% in the first period to 2.49% in the fifth). This leads to a second point: raising the spread rate appears to have more relative influence on credit for Brazil than for Colombia, given by the values of their respective participation in the decomposition of the variance (the model for Brazil of 3.44% in the tenth period, and for Colombia of 0.75% in the fifteenth). That is, it is worth noting the relatively major importance of the direct effect of compulsory payments on credit in Colombia, while a larger relative contribution of indirect effect is observed in the case of Brazil.

5 FINAL REMARKS

For many years, reserve requirements were admitted in the academy as a monetary policy instrument, able to control credit through the multiplier effect and their influence on banking spread rates. After the advent of the New Consensus theory in 1999, based on the principle, attributed to Tinbergen, of the use of only one policy instrument, the interest rate, and a single goal, the inflation

target, manipulated by a central bank that is independent and credible, reserve requirements have lost prominence in the theory and execution of central bank policy.

The use of this instrument by most central banks was limited to the creation of a stable demand for commercial bank reserves, allowing banks greater flexibility in the requirements mechanisms used in the management of their balance sheets. Furthermore, it allowed monetary authorities to have a greater understanding of banks' liquidity management. However, some countries, particularly in Latin America, continued to use this tool as a complement to monetary policy, including during the 2008 crisis, allowing its manipulation as a prudential measure that can smoothe the credit cycle, decrease the leverage of debtors, and increase the financial system's robustness.

Although still very controversial, the use of reserve requirements and other instruments, both in academic theory and for central banks, has changed to take account of the issue of financial stability. This is reflected in the quantity of academic literature reviewing changes in monetary policy after the 2008 crisis. The search is for instruments that confer stability on the financial system and models that determine the relationships between monetary and financial policies.

In the financial systems of Brazil and Colombia there was a prudential regulation using reserve requirements, together with a regime targeting inflation. The VAR model in this paper was designed to explore the relationships of reserve requirements on macroeconomic variables.

The main idea of the model was to explore certain features of the economic systems of Brazil and Colombia. Our models indicate roughly that, for impulse-response functions, the theoretical rationality we have found holds for the reserve requirements mechanism at the levels of prices and output, in order to reduce them by increasing the effective rate, as well as the rise in bank spread, the decrease in the money supply, and the credit volume in both countries. The results suggest that banks transfer their costs of idle resources to their interest rates in the financial markets of Brazil and Colombia. The magnitude of the reduction in credit in Brazil is not as noticeable as in Colombia (where it turns over more quickly and intensely), suggesting that the Banco Central do Brasil offers a liquidity that can be substituted with available reduced deposits. In Brazil, the reserve requirement might not be an effective tool for reducing credit, given its large effect on bank rates and small effect on credit.

In terms of variance decomposition, we could analyze the modus operandi of the reserve requirement for effective channels of transmission of rates, and in general, their influence on macro-economic variables. In the variance for decomposition of credit, the money supply plays a larger role in the models for both countries, showing the importance of the *direct effect* of reserve requirements, but the mechanism of reserve requirement rates through bank spread (in credit) shows more relevance in the Brazilian model than in that for Colombia. In the variance decomposition of inflation in Brazil, a higher spread has more impact on prices than in Colombia, where the reduction of credit shows a greater importance in reducing inflation. Although the use of this instrument has a prudential nature (focused on the credit cycle), according to the model the consequences of their actions reflect on output and inflation.

Another aspect concerns the reserves remuneration. The main focus of the use of this mechanism is to avoid passing the reserve requirements cost on to banks' interest rates, so that the banks will have no incentive to change their interest rates. The result for Brazil contradicts this idea because, in 2011, about 82% of the reserve volume was remunerated, while the VAR model suggests some effect on the banking spread through an increase in the effective rate of the reserve requirement. Obviously, this relationship needs to be explored further, and is only an indication of the need for further research. Nevertheless, during the 2000s, the average remuneration on accounts was 50%, and at the decade's beginning it was about 30%.

Thus, the VAR model allows an exploratory analysis of the macroeconomic variables in order to define some of relationships between reserve requirements and the important macroeconomic variables. However, this study is initial, and there is a need for more research,

sestablishing better relations, perhaps on the microeconomic level, beyond the need to examine the direct effect on interest rates and draw comparisons with other countries. This will be the target of our future research, which will deepen and sophisticate this theoretical perspective.

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APPENDIX A

The econometric specification presented here is based on the following variables:

Brazil:

1. Effective rate of reserve requirements - the ratio between the total volume of requirements and the sum of demand, term, and savings deposits – C.M.U. (thousands) - CBB;
2. Credit volume - Credit operations with non-earmarked funds - Consolidate grantings (accumulated in the month) - General total - C.M.U. (thousands) – IPCA deflator - CBB;
3. Spread - Credit operations with non-earmarked funds (pre-set, post-set, and floating rate) – average spread - general total - P.P. - CBB;
4. Output - industrial production - general industry - quantum - (average in 2002 = 100) - seasonally adjusted index – IBGE/PIM-PF;
5. Inflation - IPCA - general - accumulated in 12 months (%) - IBGE;
6. Money supply – M2 (average working day balance) - C.M.U. (thousands) - IPCA deflator CBB;[21]
7. Real effective exchange rate index (IPCA) – June 1994 = 101 - Index - CBB;

Colombia:

1. Rate of reserve requirements - ratio between the series of banking reserves and total deposits subject to requirements (Pasivos sujetos a encaje - PSE)[22] – pesos in millions - BANREP;
2. Volume of credit - gross bank credit concessions (includes agricultural accounts) – IPC deflator - million pesos - BANREP;
3. Spread - difference between active and passive nominal rate - (% per year) – CEPAL;
4. Output - index of real output of the manufacturing industry - monthly average - (2001 - 100) – DANE;
5. Inflation - IPC - general - variation (% per year) - DANE;
6. Money supply - M3 - currency in circulation + PSE – pesos million – average – IPC deflator BANREP;
7. Real effective exchange rate index (IPC) - geometric average 1994 = 100 - index -BANREP;

- Commodity price index (petroleum) - (Jan. 2005 = 100) - FMI.

[21] M2 = M1 + special deposits + deposits for investments + saving deposits + securities issued by depository institutions.

[22] PSE = current account deposits + quasi-money + bonus + demand deposits + fiduciary deposits + repurchase + notes.