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Leaning against the wind: Effects of macroprudential policy on sectoral

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Abstract. Use of macroprudential policies in recent years has gained relevance in different economies. As a result of the financial crisis in 2008, this instrument was useful in emerging economies to reduce the effects of the adverse international context. The relationship between financial intermediation and the real sector is positive, in response to shocks in productive credit the sectoral growth is 0.15pp in 2016. Likewise, the modification of the reserve requirement rate can provide or with draw liquidity from the financial system, in the first case, the objective is to increase portfolio placement, which affects the development of productive sectors. Therefore, there is a need to evaluate the effect of changes in the reserve requirement rateon sectoral growth in Bolivia, which was offset by the financial cycle because episodes of Credit Crunch affect the real sector (the economic cycle is amplified to the downside). The methodologies used are the Fixed Effects (FE), Random Effects (RA) and Panel Autoregresive Vectors (Panel-VAR) and recursive versions of them. The positive effects of the macroprudential policy and changes in the position that this instrument had over time, depending on the financial cycle, Leaning Against the Wind. Reserve requirement ratedecreasesof the national currency has positive impact on sectoral growth and tests with recursive versions shows positive effects and increase of credit towards the sectoral activity.
Keywords. Reserve requirements, Interest rate, Fixed effects (EF), Random effects (RE), Panel VAR, Recursive estimation, Leaning against the wind.
JEL. C50, E51, E52.

1. Introduction

The change in reserve requirement rate (macroprudential instrument) as a countercyclical or procyclical policy was present in the literature since the 1980s, authors such as Romer, Baltensperger and Fama model this type of instrument. Since the global financial crisis of 2008 and effects in Latin America, the vulnerability of the international financial system and the contagion effect on other economies were highlighted. Thus, the recommendations both by international organizations and by the academy derive in the use of this macroprudential instrument. This aspect is not new, it only becomes relevant due to the empirical effectiveness of many central banks to protect financial stability and avoid Credit Crunch.

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Bolivia had been modifications of reserve requirement rate since 2005 to a greater extent for the foreign currency (upward), contributing to process of re-monetization. In 2006, the financial cycle ledtoCentral Bank of Bolivia (BCB) opting a countercyclical stance to avoid excess credit and leverage of financial institutions. However, since 2017 with this instrument, the BCB changed the position (procyclical). The results of the recursive Autoregressive Vectors model show changes in the effect of the reserve requirement rate in foreign currency.

The financial services law (393) led to the placement of the portfolio to rebound in real activity, showing the positive statistical relationship between loan and sector GDP. In this paper, from panel data estimation the results of Autoregressive Vectors are evident; Central Bank's position through the use of the macroprudential instrument has positive effects on the real sector, shocks in domestic reserve requirement rate is 0.015 percentage point (pp) of contribution to economic growth. Likewise, banking system financing has a positive effect on the sectorial GDP (0.15pp). The law 393 in 2014 changed the path of the financial cycle positively and also affected in 0.25pp the real activity.

Two robust recursive methodologies were chosen, in the quantification of elasticities and shocks in the sectorial growth; i) Fixed Effects and ii) Autoregressive Vectors. The document is organized in: 2) Literature Review, 3) Data Description (stylized facts), 4) Models and Results and finally 5) Conclusions.

2. Literature review

It is important to understand that the macroprudential tool is not new, Simon Gray (2011) indicates the concept of prudential can be traced back to the time of the gold standard, a commercial bank have had to maintain a proportional reserve balance of its deposits in another Bank. This reserve provided protection against liquidity and solvency risks. On the other hand, the monetary control of the central bank (the reserve) can restrict the growth of the balance of a financial entity and the variation of the reserve requirement rate is carried out with the purpose of influencing the margin of the active and passive interest rate, which impacts the growth of monetary aggregates and inflation. Finally, Gray points out the effective use of reserve requirement … "a central bank can immobilize the reserve surplus so that the impact of a surplus on the balance sheet does not lead to inflation or depreciation".

The experience of using macroprudential policy in recent years has gained relevance in Latin America since the financial crisis of 2008, countries such as Peru, Chile, Brazil and Bolivia, among others, adopted modifications to the reserve requirement rate as expansive or contractive measures of monetary policy. However, in the literature (80's) there was already the use of the reserve requirement rate as a mechanism for the transmission of monetary policy, so that many current research recover this instrument as a variable that affects the financial sector and real economy.

Fama (1980) and Romer (1985), find effects of the modification of reserve requirement rate towards the interest rate and this in turn to the performance of the economy in a general equilibrium model. Baltensperger (1982), studies the effect of reserve requirement on the product and price stability, the research concludes that the control of the stock of money in the short term affects the output and price stability in a positive way. Montoro & Moreno (2011), indicate that for economies such as Brazil, Colombia and Peru, reserve requirements have been used to: (i) solve policy dilemmas associated with capital inflows; (ii) improve the effectiveness of monetary control or strengthen the transmission of monetary policy; (iii) restore the transmission mechanism of monetary policy during periods of tension, possibly serving as an alternative to quantitative relaxation or large-scale asset purchases; and (iv) counteract the financial imbalances associated with excessive credit growth. In summary, the control over reserve requirements helped stabilize interbank interest rates, also influences the interest rate that moderates capital flows and affects the smoothing of the credit cycle during expansive and contracting phases of the business cycle.

On the other hand, Tovar *et al.,* (2012), through the use of panel data for Latin American countries (Brazil, Colombia and Peru), found that increases in the reserve requirement rate is an active tool that helped contain excessive credit growth during the expansion phase of the cycle and that decreases in this variable foresees to relieve liquidity pressures during the contractive phase. Finally, Zhang & Zoli (2014), show that for the economies of the Asian continent, the macroprudential instrument and an adequate management of capital flows are of paramount importance to protect the stability of the financial system, these help to reduce systemic vulnerabilities. Finally, they identify the position of macroprudential policy before and after the global financial crisis.

3. Description of data (Stylized facts)

In general terms, the composition of reserve requirement in Bolivia as in other economies has a similar structure. It should be noted that before 2005 the reserve rate in both National Currency (NC) or Foreign Currency (FC) had an almost equal percentage, but the dollarization of the financial system at that time was high, so there was no high effectiveness and space of monetary policy to maintain stable inflation.

Until 2005 there were no major changes in the reserve rate in both MN and ME, it is from the end of that year that there is a change in the reserve rate, essentially for the ME for demand deposits, savings banks and for a fixed term (Fig. 1).

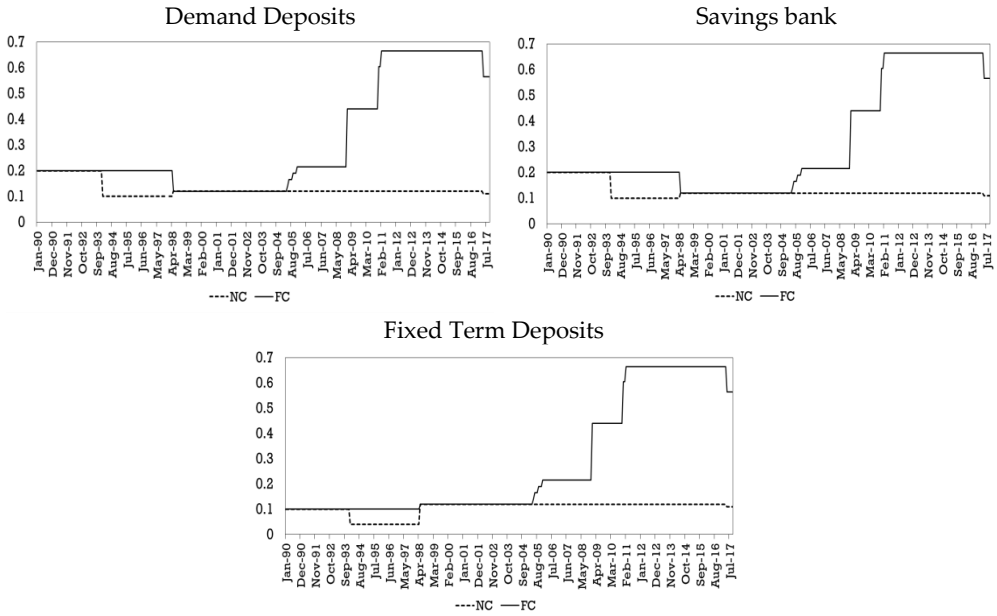

Figure 1. *Reserve Requirement Rate*
Source: Central Bank of Bolivia

This significant increase in the reserve requirement rate in ME, goes from 12% to 19% in September 2005 and remains at 22% between 2006 and 2008. Between January 2011 and April 2017, it reached its highest point (66.5%); however, in May 2017, a 10pp decrease was made in this rate, to provide liquidity to the financial system and to safeguard the stability of the financial system, this in the context of an unfavorable international context of low commodity prices cousins.

Thanks to the financial deepening that exists in the financial system, due to the financial inclusion policy the indicators improved (Fig. 2), in 2002 the deposits/GDP ratio was lower than the portfolio/GDP ratio by 0.5pp. Since 2006, these indicators changed their trend, due to greater access to financial services through service points (between 2010 and 2017, the increase in the number of deposit accounts increased by 107.9% and the number of branches, agencies, ATMs and others at 125.8%. [1]). This change in structure in the financial system led to deposits in relation to GDP being higher than the credit / GDP ratio of 0.7pp in 2017.

[1] According to the Financial Stability Report of January 2017.

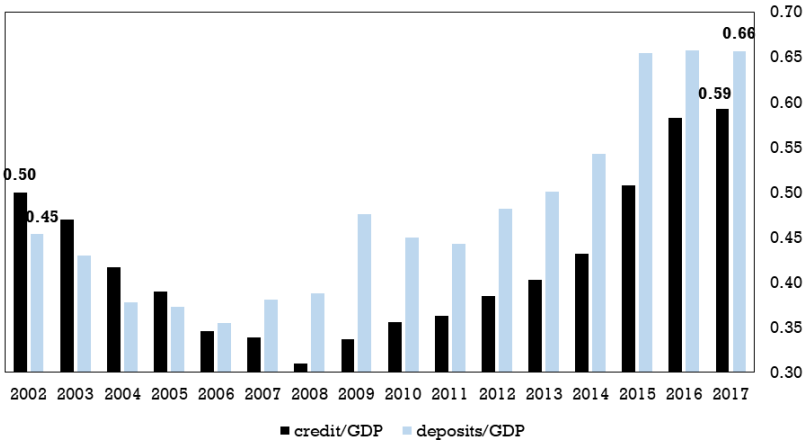

Figure 2. *Indicators of the deepening of the Financial System*
Source: Central Bank of Bolivia

Similarly, the financial cycle since 2007 was improving, thanks to the improvement of indicators of financial deepening, a positive gap is observed in relation to its medium-term trend (Fig. 3), this result is explained by the dynamic provisions that the macroprudential policy in Bolivia (management of reserve requirement rate) as indicated by Tovar C. et al. "This countercyclical tool builds a mattress against the expected losses in good times so that they can be released in difficult times."

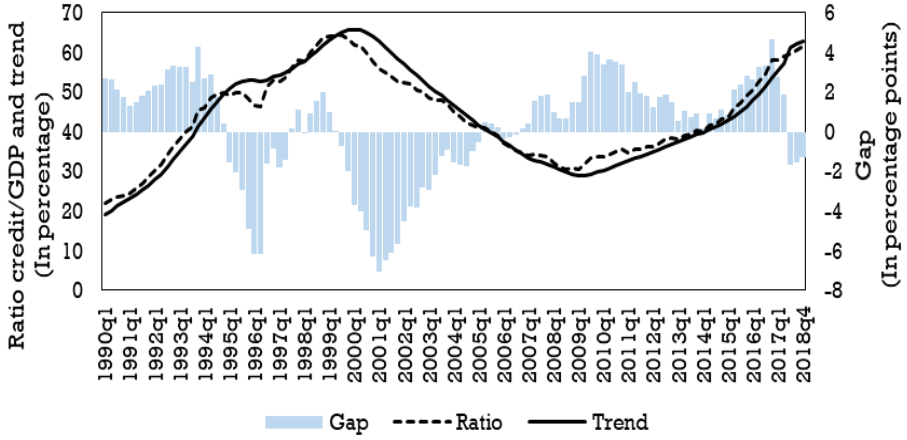

Figure 3. *Financial Cycle*
Note: Authors' elaboration based on data from the Central Bank of Bolivia. The indicator was constructed based on Fendoglu (2017), the credit / GDP gap is obtained through a recursive Hodrick-Prescott (HP) filter with a $\lambda = 1600$, the author defines the value of this parameter for the financial cycle medium term for developing economies.

On the other hand, financial intermediation and the dynamics of loans granted to economic agents boosts real activity, the correlations of GDP by activity and financing to each sector are positive (Fig.4). A relevant fact is

the promulgation of the Financial Services Law (393), in its article 67 it establishes minimum levels of portfolio primarily for social interest housing and the productive sector.

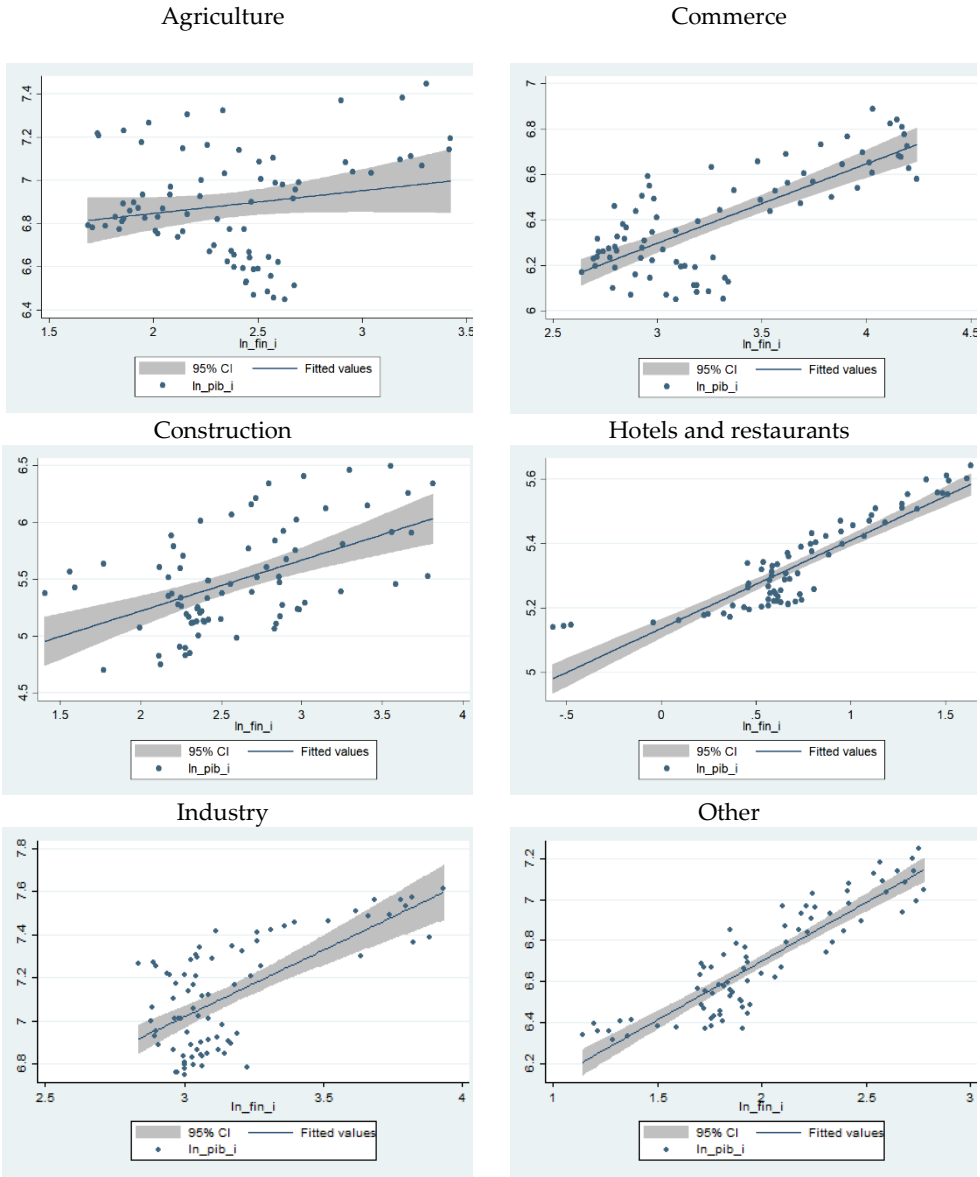

Figure 4. *Financing of the Banking System to the sector activity*
Note: The activity of others includes Electricity, Gas and Water, Financial Establishments, Insurance, Community, Social and Personal Services, Transportation, Communications and Storage.

4. Models and results

Tovar *et al.*, (2012), estimate the effect of macroprudential policy on the growth of Latin America, the selected countries are Peru, Brazil and Colombia; as control variables use private sector credit, the interest rate and dummy variables that capture changes in the reserve rate. The main conclusion that stands out is the complementation of macroprudential policy (reserve requirement) with monetary policy to achieve stability

objectives of the financial system, avoiding market distortions and imbalances of private banking balances, reducing exposure to risk via contagion. .

For the empirical evidence in Bolivia, the construction of the model will be similar to that proposed by these authors, however, instead of the use of dummy variables, the historical series of the reserve requirement rate will be inserted into the model and the effects will be on the sector's GDP from Bolivia. Estimates will be made using the method of Pooled Ordinary Least Squares (POLS), Fixed Effects (EF), Random Effects (EA) and Population-averaged estimator (PA).

$$y_{i,t} = x'_{i,t}\beta + u_{i,t} \qquad i = 1, \dots, N; t = 1, \dots, T \tag{1}$$

In variable $y_{i,t}$ includes the GDP in logarithms of t different activities Industry, Construction, Commerce, Agriculture, among the most important. $x'_{i,t}$ is a 1 × K vector which explanatory variables and β is a K × 1 vector of constant terms (coefficients). The term $u_{i,t}$, is the compound error term.

$$u_{i,t} = \mu_i + \upsilon_{i,t} \tag{2}$$

The error term μ_i refers to the individual effects due to a permanent unobserved heterogeneity over time and $\upsilon_{i,t}$ is an idiosyncratic term, both are IID $\sim (0, \sigma^2)$ and independent of each other.

Table 1 shows the results of the four models estimated by different methods, the first column corresponds to estimates by POLS method, as evidenced by the financing has a positive effect of 0.11, this means that by each increase of 10% of the loans granted by the banking system, the growth in average activities in real terms will increase by 1.1pp. The response of the real activity to variations in the reserve requirement rate in NC is contractive (-0.04), if the Central Bank decided to increase the reserve rate in NC this would mean a reduction in the liquidity of the financial system and the banks do not they could have the necessary resources for portfolio placements, for each 10pp increase in the reserve requirement rate, the average growth rate would reduce by 0.2pp. Finally, the variations in the reserve requirement rate in FC positively impact economic growth, the explanation for this result is due to the process of remonetization of the Bolivian economy and the change in preferences of economic agents with regard to hoarding of this currency (in this POLS model, some coefficients are not statistically significant).

Table 1. *Estimation of Macroprudential Policy in Bolivia*

VARIABLES	Pooled OLS	Fixed Effects	Random Effects	Population-averaged estimator
Financing	0.113	0.0386**	0.0391**	0.0393**
	(0.1210)	(0.0165)	(0.0168)	(0.0164)
Reserve requirement rate NC	-0.0238*	-0.0308***	-0.0307***	-0.0307***
	(0.0106)	(0.0069)	(0.0069)	(0.0069)
Feserve requirement rate FC	0.0219*	0.0284***	0.0283***	0.0283***
	(0.0096)	(0.0035)	(0.0035)	(0.0035)
Financial Services Law	0.174***	0.171***	0.171***	0.171***
	(0.0440)	(0.0241)	(0.0242)	(0.0241)
Financial Cycle	0.0431***	0.0428***	0.0428***	0.0428***
	(0.0076)	(0.0039)	(0.0039)	(0.0039)
Spread	-0.0112**	-0.0124***	-0.0124***	-0.0124***
	(0.0045)	(0.0039)	(0.0039)	(0.0039)
Constant	6.277***	6.427***	6.421***	6.421***
	(0.3270)	(0.0426)	(0.0315)	(0.0312)
Observations	703	703	703	703
R-squared	0.141	0.539		
Number of act		9	9	9
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

Note: Authors' own elaboration, the estimate was made with boostrapping

Meanwhile, the results of the FE, RE and PA models are very similar and statistically significant. The associated coefficient of credit to the product is positive, this indicates that for each 10% increase in the placement of the banking system's portfolio, the sector's GDP would increase by 0.4pp. On the other hand, the reserve requirement rate in NC boosts the sector dynamism, due to 10% decreases the sector growth on average reaches 0.3pp[2].

The coefficient associated with the financial cycle in Bolivia is also positive (0.04pp). Financial stability shows a favorable outlook since 2006 (Fig. 3), this context favored sustained sector growth. Also thanks to the improvement of the indicators of financial deepening, these generate a beneficial environment so that portfolio placement has a greater effect on real activity.

Finally, for the modeling, the spread of rates and a dummy variable that reflects the validity of the Financial Services Law (393) were inserted, in the first case to a larger spread[3], the effect on economic activity is contractive at 0.01pp. And the validity of the financial services law since 2014 was beneficial for economic activity (0.19pp[4]), this is due to article 67 which

[2] In May 2017, the Central Bank of Bolivia decided to reduce the reserve requirement rate in MC and FC by 1pp and 10pp, respectively.

[3] The gap between the active and passive interest rate widens.

[4] The coefficient estimated in Table 1 is not appropriate for the interpretation of elasticity (but statistically significant). In a semi-logarithmic model, the transformation of a dummy variable is es$\delta = ln(1 + g,$ where (g) correctly measures the effect of the dichotomous variable, still in line with Kenndy (1981) and Goldberger (1968) the most robust calculation a dummy variable is: $g^* = \left\{\frac{\exp(\delta)}{\exp[V(\delta)/2]}\right\} - 1$, where $V(\delta)$ is the variance (the standard error

prioritizes the allocation of resources to the productive sector and social housing[5].

All the models proposed have the same meaning in terms of the coefficient, however, there is doubt about the evolution of elasticities over time, which is why a recursive estimate was chosen (the sample contemplates from March 1998 to June 2017)[6]. FE was chosen instead of RE by the Hausman test[7], which we reject the null hypothesis, the estimate by RE provides consistent estimates (appropriate model). In addition, the advantage of the FE model is the transformation that eliminates the effects not observed in μ_i[8].

The recursive perspective (Fig. 5)[9], conclude the impact of the financing of the banking system on the sector's GDP over time was growing and becoming important, reaching its maximum effect of 0.4pp for each additional 10pp in the portfolio placement. The effects until 2008 did not exceed 0.25pp.

The macroprudential policy, reserve requirement rate in NC, was effective from 2010 onwards, from the procyclical or countercyclical position the effect to contain or provide liquidity to the financial system was increasing, this result indicates that depending on the economic and financial cycle the macroprudential instrument is used as "Leaning Against the Wind". Regarding the modification of the reserve requirement rate in FC, the estimated coefficients are positive, but the message should be addressed to the fact that a dollarized economy does not have spaces for the effectiveness of monetary policy, consequently price stability would not be guaranteed. . In summary, this positive effect on the sector's GDP is due to the remonetization (Bolivianization) of the financial system and the recovery of instruments (monetary policy) to guarantee stable inflation.

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squared). Silver (2016) indicates that this is the appropriate way to measure $g^*$with the least possible bias.

[5] Law 393, Article 67:… "(Prioritized Sectors). The minimum levels of the portfolio to be established should prioritize the allocation of resources for social interest housing and the productive sector, mainly in the segments of micro, small and medium urban and rural enterprises, artisans and community economic organizations".

[6] The first estimate was made from March 1998 to December 2004, subsequently a T-observation was added, that is, from 1998 to March 2005 and so on until June 2017. In total, 51 models were made to capture the evolution of the coefficients in time, the proposed model is: $y_{i,t} = x'_{i,t}\beta_t + u_{i,t}$. Where β_t, is a matrix associated with the coefficients of the explanatory variables, for each estimate of the 51 the coefficients vary over time.

[7] See appendix.

[8] The main assumptions presented by this method are:

1. $v_{i,t}$ = Present conditional mean equal to zero: $E(v_{i,t}/X_{i1}, X_{i2}, \dots, X_{it}, \mu_i) = 0$
2. $(X_{i1}, X_{i2}, \dots, X_{it}, v_{i1}, v_{i2}, \dots v_{it})$, $i = 1, \dots, N$ they are i.i.d. extracted from their joint distribution.
3. High outliers are unlikely: (X_{it}, v_{it}) they have finite fourth order moments.
4. There is no perfect multicollinearity.

[9] In addition, the exercise of an individual recursive recovery by activity of the proposed model was carried out, in order to know the positive variable impact of macroprudential policy and of the financing on the GDP of each activity. The results are plausible with the statistical and empirical evidence in the previously developed sections. See appendix.

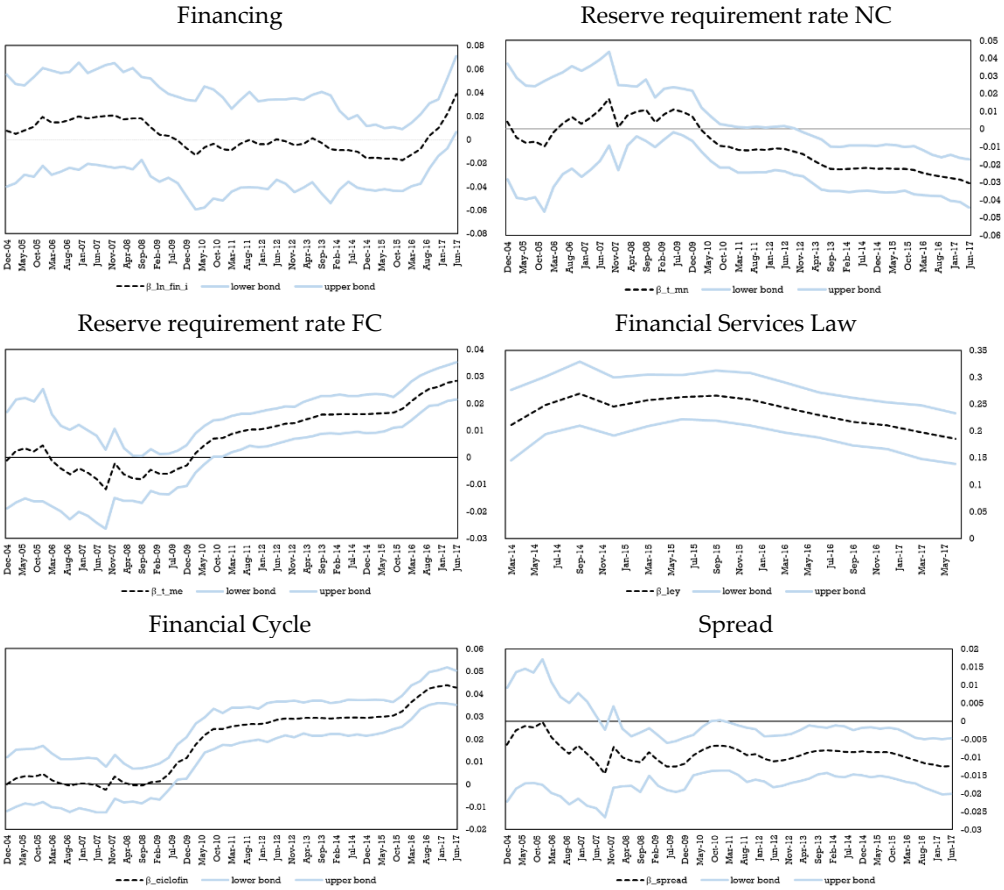


Figure 5. *Recursive Estimate, Fixed Effects of Macroprudential Policy in Bolivia*
Note: Authors' own elaboration, the estimate was made with boostrapping. Regarding the coefficients associated with Law 393, the correction of the bias was carried out in line with Kennedy (1981).

Since 2009, effects of the financial cycle are increasing in real activity, the explanation is that the ratio credit/GDP was expanding, from 30% to 61% approximately (Fig. 3). Evidently between 2007 and 2016 the financial cycle (the gap) was positive and growing, in other words the prosperous conditions of the financial system helped with the appropriate macroprudential policies generate a beneficial environment for economic activity to be boosted and growth to be sustained over time. On the other hand, the positive effect of law 393 was decreasing; the greatest impact was 0.27pp in September 2015, although the effect is less than June 2017, this result is due to the internalization of the change in the economic structure and the agent behavior[10].

The impact evolution of spread in the analysis period was negative, this estimate indicates that the contracting effect on economic growth is explained when banks decide to have a higher profit margin due to financial services intermediation. The reasoning behind, is the largest

[10] It is observed that the financial cycle until the end of 2013 was positive, but below 2pp, when Law 393 enters into force, the cycle again changes trend, achieving a 4pp gap until 2016.

increase in the active interest rate and not that passive, which is quite obvious in the inverse relationship between increases in the interest rate and declines in economic growth, typical response of the IS-LM model.

Autoregression Vector Model

To validate the results of the methodologies proposed in the previous section, a Model of Autoregressive Vectors was created due to the nature of longitudinal data. The variables involved for the development of the system are: sector GDP, financing by activity, a dummy variable (law 393), Reserve requirement in NC and FC[11]:

$$z_{i,t} = \gamma_0 + \gamma_1 z_{i,t-1} + \gamma_2 z_{i,t-2} + \varepsilon_{i,t} \quad (3)$$

$$z_{i,t} = \begin{bmatrix} Economic\ growth \\ Financing \\ Reserve\ requirement\ rate\ NC \\ Reserve\ requirement\ rate\ FC \\ Financial\ Services\ Law\ (Dummy) \end{bmatrix}_{i,t}$$

This system was estimated by the Generalized Method of Moments (GMM, proposed by Holtz-Eakin, Newey & Rosen, 1988). Abrigo (2015) indicates that the inclusion of more lags in the system as instruments has the property of reducing observations especially with unbalanced panels, the solution to this dilemma proposed by Holtz-Eakin *et al.*, (1988) was to create instruments using observations made and with the missing observations replace them with zero, the assumption behind this solution is that the instruments are not correlated with the errors. A Panel VAR (PVAR) model in its reduced form is given by:

$$\tilde{z}_{i,t} = \gamma\, \tilde{z}_{i,t} + \tilde{\varepsilon}_{i,t}$$

$$\tilde{z}_{i,t} = \left[\tilde{z}^1_{i,t}\, \tilde{z}^2_{i,t} \quad \dots \quad \tilde{z}^{k-1}_{i,t}\, \tilde{z}^k_{i,t}\right]$$

$$\tilde{z}_{i,t} = \left[\tilde{z}^1_{i,t-1}\, \tilde{z}^2_{i,t-1} \quad \dots \quad \tilde{z}^{k-1}_{i,t-p+1}\, \tilde{z}^k_{i,t-p}\, \tilde{x}_{i,t}\right]$$

$$\tilde{\varepsilon}_{i,t} = \left[\tilde{\varepsilon}^1_{i,t}\, \tilde{\varepsilon}^2_{i,t} \quad \dots \quad \tilde{\varepsilon}^{k-1}_{i,t}\, \tilde{\varepsilon}^k_{i,t}\right]$$

$$\gamma' = \left[\gamma'_1 \gamma'_2 \quad \dots \quad \gamma'_{p-1} \gamma'_p \phi'\right]$$

Variables with a circumflex denote a transformation of the original variables. The original variables are represented by $z_{i,t}$, while the transformation implies that the treatment of the variables is in first differences: $\tilde{z}_{i,t} = z_{i,t} - z_{i,t-1}$. While the orthogonal deviation is $z_{i,t} = (z_{i,t} -$

[11] All variables are in first differences.

$\bar{z}_{i,t}) \sqrt{T_{i,t}/(T_{i,t}+1)}$, where $T_{i,t}$ is the number available for future observations of panel "i", in "t" and the term $\bar{z}_{i,t}$ is an average.

If we expand the panel's observations on both "i" and "t" the GMM estimator will be:

$$\gamma = \left[\bar{\bar{z}}' Z \widehat{W} Z' \bar{\bar{z}}\right]^{-1}\left[\bar{\bar{z}}' Z \widehat{W} Z' \bar{\bar{z}}\right]$$

The instrument vector is given by $Z_{i,t}$[12], where $x_{i,t} \in Z_{i,t}$. Matrix $\widehat{W}$ is symmetric $(L \times L)$, not singular and semi-positively defined (optimal weights). Under the assumption that $\mathrm{E}[Z'\varepsilon] = 0$ y and that the range is $\mathrm{E}[\bar{\bar{z}}'Z] = kp + l$, the GMM estimator is consistent because the weights matrix ($\widehat{W}$) selects maximum efficiency (Hansen, 1982).

The results will be analyzed by the Impulse Response Functions (IRF), in the same way a recursive version of the model was chosen. The implications of FIRs that vary over time provide more useful information depending on the context that the economy faces in each period[13]. In the first estimate (until 2004), it is observed that idiosyncratic shocks of financing, contrary to intuition, negatively affects sector growth (statistically non-significant result). Positive shocks in macroprudential policy (reserve requirement rate in NC) negatively affects the product, on average after two (2) quarters. Since shocks are symmetrical negative effects on the reserve rate (reduction), sector growth would be approximately 0.013pp[14].

The exercise by the dynamic nature (recursive), until 2010 the FIRs of the reserve requirement rate in NC is less volatile but with a similar result in the whole sample. The most convenient is an analysis for each additional observation in the estimation of the models (51). By teaching the 3D graphics help to visualize the dynamics of the shocks (Figure 6).

- Financing: The FIRs in the sector growth range from negative effects (until approximately 2009, but not significant) to growing positive ones with a maximum in 2017Q1 of 0.15pp.
- Reserve requirement rate in NC: The effects in relation to the dynamics of the macroprudential policy is heterogeneous, it is a final result in the face of negative shocks in said variable is positive in the product, maximum effect of 0.015pp in the last two quarters of the estimate.
- Reserve requirement rate in FC: Between 2004 - 2010, positive shocks of the reserve in dollars positively affect growth, it should be noted that from 2014 onwards the sign of FIRs are negative (0.002pp to 2017). The last result denotes the expansive position of the Central Bank of Bolivia

[12] The instrument set is $L \geq kp + l$.

[13] Similarly, the first estimate is from 1998 to 2004, then an observation in "i" and "t" is added, until 2017 (quarterly frequency).

[14] See appendix for individual results.

(BCB), low Reserve requirementrates in FC provide liquidity to the financial system and this transcends the real sector of the economy (positive response).

- Financial Services Law: In the same way as the recursive estimates of FE, the validity of the law had greater effects in the first quarters (0.25pp) on the different sectors of the economy. The result in 2017 reflects impacts lower than 0.05pp, explained by a downward financial cycle and internalization in the behavior of the agents the measure issued.

Consistency of the recursive results with FE or with the PVAR models is credible, although in the PVAR the financial cycle and the spread cycle are not modeled, the evolution of elasticities and FIRs indicate the same trend[15]. Except for the effects of the reserve requirement in FC that since 2014 in the PVAR model the economic growth response is contractive due to rate increases, this finding is explained by the need of the monetary authority to lower the reserve rate (Leaning Against the Wind). In May 2017, the rate goes from 66.5% to 56.5% (a reduction of 10pp, Fig. 1), taking care of the stability of the financial system through increases in liquidity.

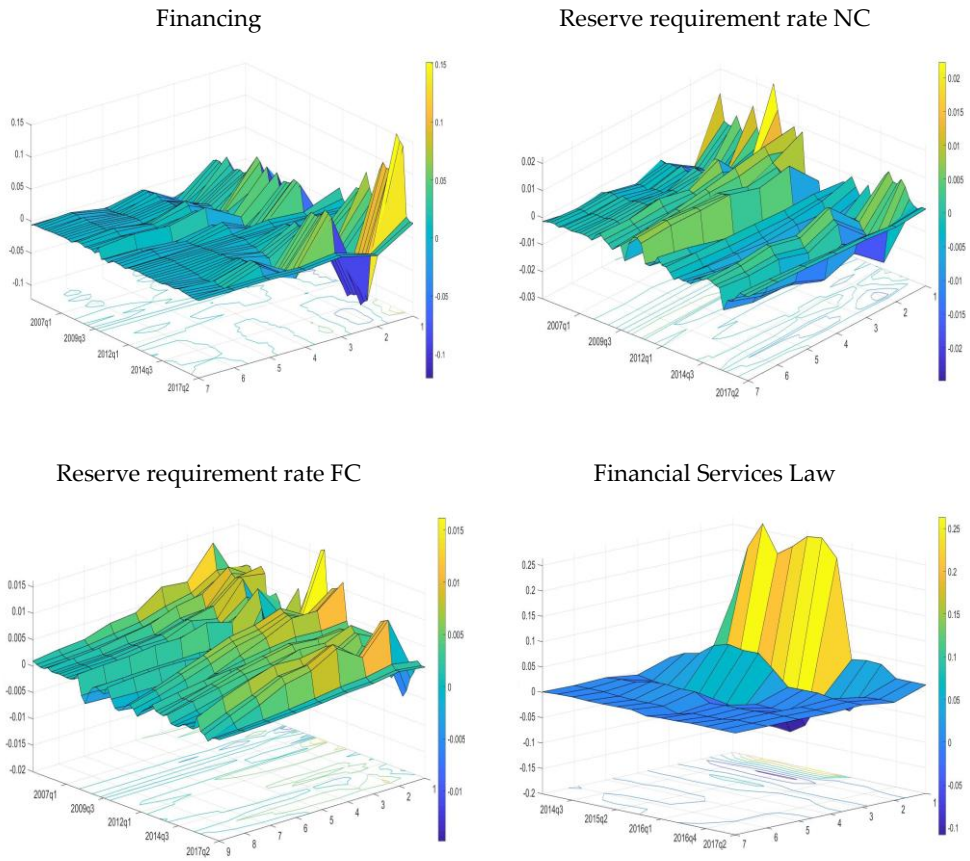


Figure 6. *Recursive Estimation, Models of Autroregressive Vectors (PVAR) of the Macroprudential Policy in Bolivia*

Note: Authors' own elaboration. The stability condition is guaranteed of the 51 models (unit circle, see appendix)

[15] See appendix for comparison of results

The results obtained in the research help to visualize the countercyclical role of macroprudential policy when the financial cycle expands, avoiding excess credit and leverage by banks[16]. In the contracting phase of the financial cycle, the decrease in the reserve rate relieves liquidity restrictions in the financial system, thus operating as a liquidity buffer.

In sum, the macroprudential policy in Bolivia was aimed at reducing or increasing credit dynamics, this is evident with the changes made by the BCB of the reserve requirement in FC and the differentiated effects before and after 2014, results estimated exclusively from the model Recursive PVAR. This deduction is consistent with the identification of inflection points for the financial and economic cycle (under the Harding-Pagan methodology, see appendix). Since 2006 there have been major boom points, which demonstrates an expansive phase of both cycles, in that context macroprudential policy had a countercyclical stance. But since 2014, two points down from the financial cycle have been identified, therefore the BCB could move on to an expansive stance with the instrument, but it did so in 2017 as a result of the monetary authority opting for other transmission instruments in response to an adverse financial cycle[17].

The decrease in the reserve requirement rate either NC or FC help contain systemic risks and to improve the financing structure of the banking system. They can also reduce dependence on external financing (medium-term), mitigating the vulnerability of the banking sector at a rapid tightening of liquidity conditions. From the results of both methodologies FE and PVAR is evident that the management of macroprudential policy BCB first aid to financial stability, and this in turn has affected positively to sustained sector growth.

5. Conclusions

The modification of the reserve requirement rate (downwards) is a tool for the allocation of credits when there are liquidity pressures. In times of stress, the use of the reserve rate causes financial institutions to direct credit to specific sectors of the economy to ease liquidity restrictions. Thanks to Financial Services Lawthis behavior is regulatedwith the purpose that the financial and real sector is integrated while maintaining sustained growth. In a complementary way, the macroprudential policy and the effectiveness of the monetary policy of the BCB are greater to protect price stability, this context helped the sectorial growth of Bolivia through financing by the

[16] Although FE and PVAR are not comparable, because one of them is in first differences and the other is not, this suggests the existence of unit root problems (non-stationary variables). In a future version of the investigation estimates will be made using the cointegration method.

[17] In the monetary policy reports from 2015 onwards, they indicate that the BCB since mid-2014 has an expansive stance, but other instruments: decrease in the balance of monetary regulation securities and the precaution of not generating interest rate increases, which It expanded liquidity in the financial system and thus increased credit to the private sector and positively affecting the real sector.

banking system. The results of the PVAR model indicate that 1% shocks incentivize the sector product by 0.15pp. The Central Bank of Bolivia from 2005 onwards makes modifications to the reserve requirement rates in foreign currency, this results in a remonetization process and an increase in the agents' confidence in the domestic currency and the financial system. In addition to the financial deepening and the expansion of the financial cycle, the orientation of the monetary policy becomes important to stimulate economic activity.

The estimate by FE or PVAR quantifies the impact of the macroprudential instrument (reserve requirement) on economic growth on the different sectors of Bolivia. In the recursive version of both methodologies, an increasing effect is observed over time by changes in the reserve rate in NC, in the last quarters of the sample the effect is greater than decreases in the rate of NC; in terms of elasticities, it goes from a null effect to 0.3pp of growth due to 10% reductions in the reserve requirement rate, from the point of view of shocks (1%), decreases in the reserve requirement rate in NC impact between 0.013pp to 0.015pp along the 51 models made.

On the other hand, the most appropriate way to model the effect of changes in the rate of reserve requirements in FC is the PVAR model. The recursive version shows the heterogeneity of the results, before and after 2014 (Leaning Against the Wind). From 2006 onwards, a remonetization process was established in the Bolivian economy, adding to this process the financial cycle was positive and ascending, so the BCB's position was countercyclical (increases in the reserve requirementrate in FC), to protect the stability of the financial systemavoiding excess credit and leverage of financial institutions, going from a rate of 12% in April 2005 to 21.5% in December of the same management. In 2008 it reached 44% and finally in 2011 it reached 66.5%, in that period the PVAR model shows that shocks in the macroprudential instrument had positive effects on economic growth (0.01pp on average). In 2014 the effects are contrary, the BCB was able to move to an expansive position with the macroprudential instrument (the BCB position did become expansive precisely in that year, but with other transmission tools), the effect estimated by reductions in the reserve rate it stimulates the real activity in 0.002pp.

Meanwhile, the validity of Financial Services Law in 2014 did have a greater impact on the real sector in the first quarters, 0.27pp under the FE model and 0.25pp in the PVAR model. The effects diminish under both approaches (they are still positive), due to the internalization of said policy in the economic structure and in the behavior of the agents.

Finally, only from the estimation of dynamic FE the coefficients associated with the spread and the financial cycle have the expected sign but the magnitude varies with time. With respect to the first variable, spread increases (the gap between active and passive interest rates is greater) generates falls in the sector's GDP, the impact goes from 0.005pp in 2005, reaching a greater effect in 2017 (0.012pp) On the other hand, the

effects of the financial cycle between 2004 - 2009 are practically nil (Fig. 5), the response of the real sector makes sense in that period due to the fall in the credit/GDP ratio from 1998 (61%) to 2008 which reached 30% (negative financial cycle), since the late 90's and early 00's the Bolivian economy was exposed to a credit crunch, however, both the effects of the financial cycle on real activity and its own the position changed in 2009. The financial stability guaranteed by the BCB (positive cycle) has repercussions on sector growth, elasticities ranging from 0.01pp to 0.04pp in 2017.

In conclusion, the management of Bolivia's macroprudential policy, regardless of the position of the financial cycle, helped to safeguard financial stability and maintain sustained economic growth. Since 2017, the BCB passed with the instrument (reserve rate) to be expansive, affecting a greater dynamism in the placement of the portfolio in the productive sector, assisted by Financial Services Law, the results were positive in the sector growth.

Appendixes

Data Processing

The treatment of the data was in real terms, the estimation of the models is from March 1998 to June 2017. The financing of the banking sector to sectors was deflated with the implicit GDP deflator by sectors, the calculation of the spread was through of real active and passive interest rates.

The data by the sector GDP were obtained on the page of the National Institute of Statistics (INE), National Accounts. [Retrieved from].

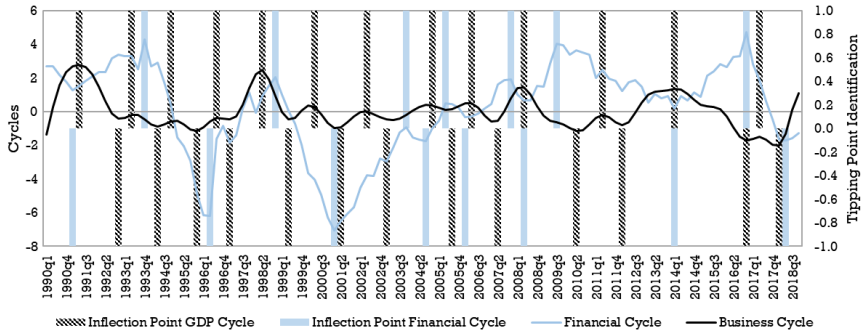
The financing data of the banking system by sectors, evolution of the reserve requirements rate in domestic and foreign currency and the spread of rates were collected on the page of the Central Bank of Bolivia (BCB). In the quarterly newsletters published in BCB for general public access. [Retrieved from].

- *3.01. Banking system - by economic sectors*
- *5.11. Real interest*
- *12.03. Reserve requirements fees*

The credit and deposits of the entire financial system were obtained by the publication of the BCB "weekly statistical information". [Retrieved from].

- *Portfolio in the Financial System*
- *Savings in the Financial System*

The calculation of the credit/GDP ratio is in current terms of annualized GDP.



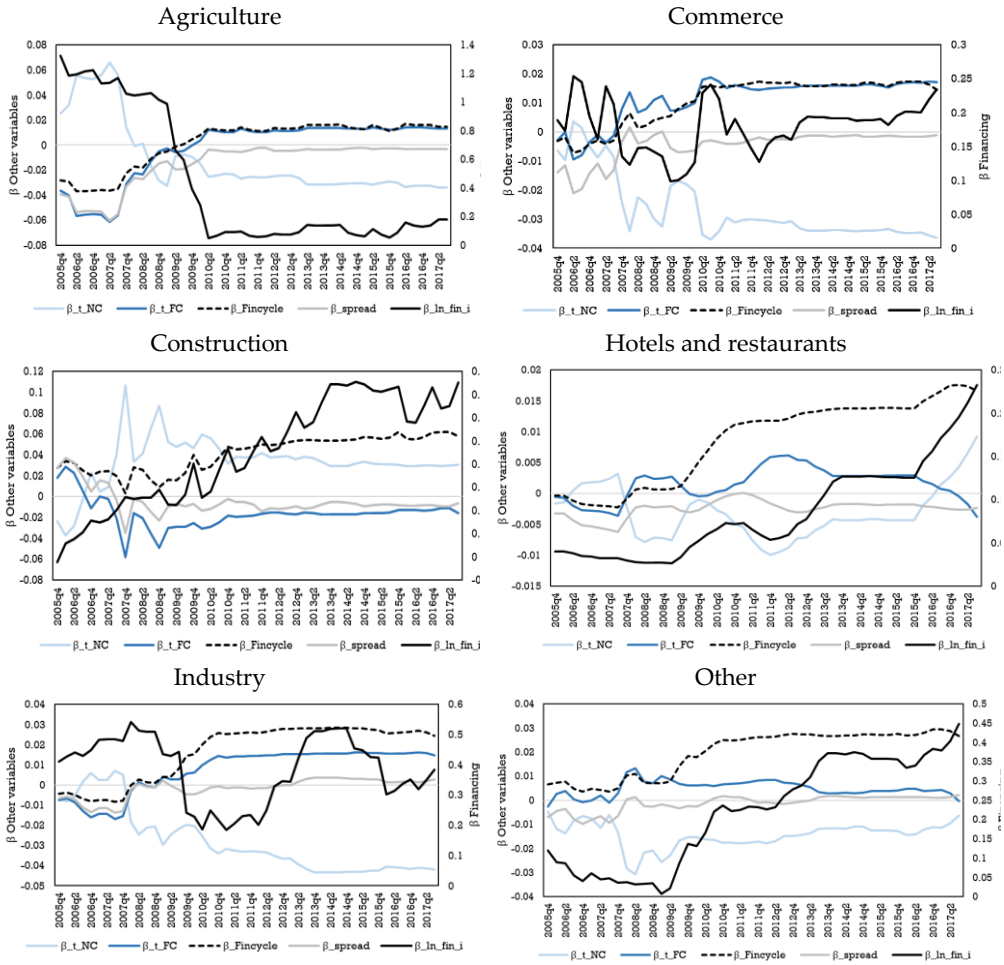
Financial and Economic Cycle
Tipping Point Identification

Note: Authors' own elaboration. The financial cycle was estimated by the Basel III methodology in line with Fendoglu (2017). For its part, the GDP was seasonally adjusted by the methodology of the National Bureau of Economic Rearch (NBER), X-ARIMA13. Subsequently the business cycle was obtained through the Hodrick-Prescott (HP) filter. Finally, inflection points 1 and -1 were identified under the methodology of Harding and Pagan (2002)

Individual Recursive Estimation by Sectors

$$Ln(Activity)_t = \beta_0 + \beta_{1,t} Ln(Financiamiento)_t + \beta_{2,t} Reserve\ requirements\ {}_t^{NC} + \beta_{3,t} Reserve\ requirements_t^{FC} + \varepsilon_t$$

The coefficients estimated by this methodology support the result obtained by the panel data models; the activities of industry, restaurants and hotels, construction, agriculture, commerce and others have positive and increasing effects to changes in the financing of the banking system to the associated activity. Therefore, there is a heterogeneous effect of the coefficients associated with the variations of the reserverequirements in NC, however in most cases there are contractual effects before positive variations of said variable, corroborating the performance of the macroprudential policy aimed at stimulating the economic growth.



Evolution of the Coefficients

Note: Authors' own elaboration

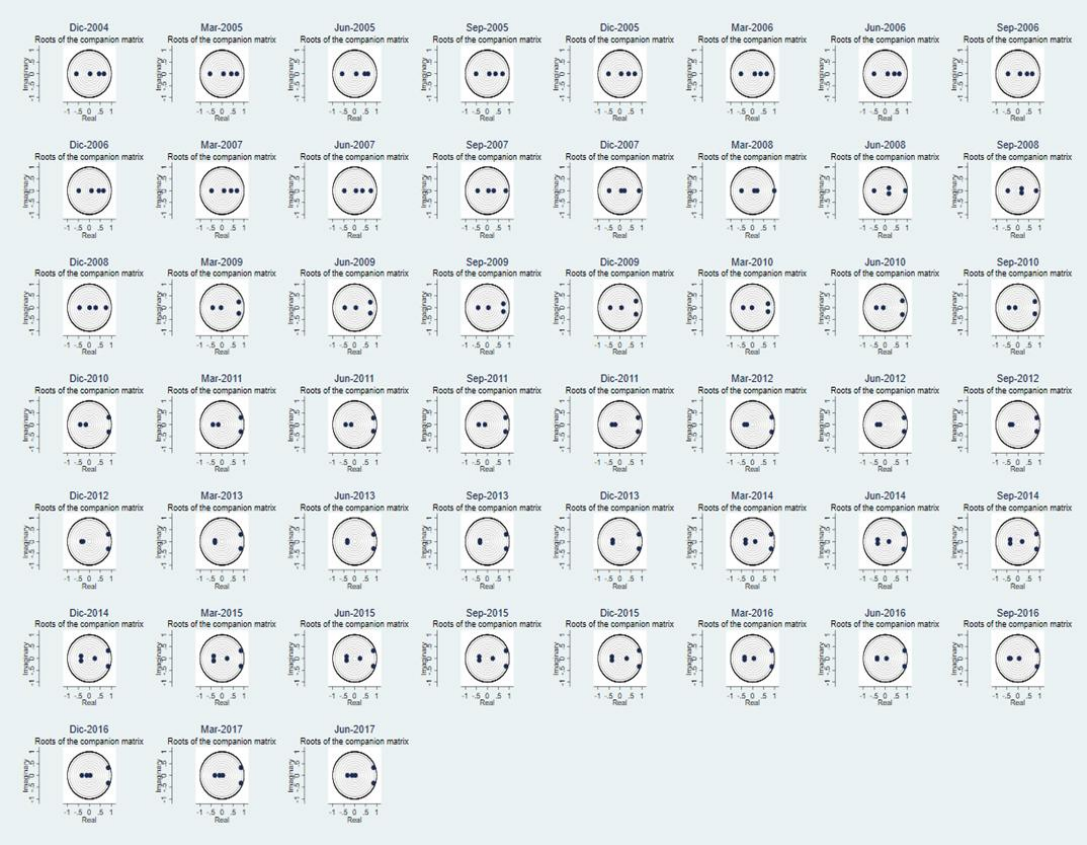
Hausman test robust (Wooldridge version)

```
. test mdln_fin_i mdt_mn mdt_me mdley mdciclofin mdspread

 ( 1)  mdln_fin_i = 0
 ( 2)  o.mdt_mn = 0
 ( 3)  mdt_me = 0
 ( 4)  mdley = 0
 ( 5)  o.mdciclofin = 0
 ( 6)  o.mdspread = 0
       Constraint 2 dropped
       Constraint 5 dropped
       Constraint 6 dropped

       F(  3,     8) =   44.48
            Prob > F =    0.0000
```

Note: Authors' own elaboration



Stability condition of Autoregressive Vectors models (PVAR)

Dec-2004, Jun-2017

Note: Authors' own elaboration

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