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Volatility and Growth: The Role of Bank Financing in Bolivia

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ABSTRACT

The main purpose of the paper is to explain the propagation mechanisms from the credit volatility of banking system. For this, two questions are offered: What determines credit volatility? How does the volatility of bank system affect economic growth? The emphasis is given to a measure of variability of bank credit to the private sector, with differentiated effects between short and long term, by an estimate of one vector corrector error model (VCEM) for the period 1965-2017, based on the Bolivian economy. The results reveal the relevance of aggregate investment as a determinant of credit volatility, since it explains about 1/4 of the variance of bank financing. Therefore, for the first question, the aggregated investment and domestic savings cause credit volatility. Through the approach of one shock of credit volatility, negative fluctuations are generated on the level of savings up to -4%, investment (-3, -5%), trade opening (-2, -3%) and economic growth, between -1 and -5% from the second year to the mid-horizon. Likewise, the disturbances of the volatility in the credit supply could explain about 25% of the variance of economic growth in the medium time horizon, highlighting the importance in the role of bank financing in Bolivia.

INTRODUCTION

At the beginning of the 20th century, the importance of financial development based on credit, risk, uncertainty, and its role in the economy was emphasized (Veblen, 2005; Knight, 1921, Schumpeter, 1967). More recently, the relevance of linking financial market shocks, their amplifications and propagation mechanisms on the real sector was focused on (Nakatani, 2019; Daly, 1999; Bernanke et al., 1999). In addition, the literature raises two related debates: first, the role of financial development (depth) on macroeconomic aggregates; and second, how volatility or the incidence of financial fragility

(Minsky, 1982; 1996) can generate adverse effects on aggregate fluctuations (Loayza and Ranciere, 2002).

On the other hand, one of the macro-aggregate variables, of greater emphasis in the study is economic growth, therefore, it is evidenced that domestic credit and financial volatility—measured as a standard deviation of financing to the private sector—has a direct and negative impact on economic growth, both for a sample of countries (Rajan and Zingales, 1998) and at the sectoral level (industries).

Since seminal papers that have addressed the relationship between financial deepening and economic growth King and Levine (1993a, 1993b), *the debate between the role of the financial system and economic growth has been exacerbated; on the one hand, a positive relationship is found* (Levine, 1997; Levine, and Zervos, 1998; Denizer et al., 2000; Khan, and Senhadji, 2000; Jahfer, and Inoue, 2014), others negatively (De Gregorio and Guidotti, 1992), concluding that there is no clear evidence that financial development leads to economic growth (Venegas, and Rodríguez, 2014) or that the relationship between financial structure and economic growth is not yet clear and determined (Zhang et al., 2020).

In accordance with the above, this document seeks to answer the following questions: *What determines credit volatility? How does the volatility of bank financing affect economic growth?* In order to respond to these questions, the focus is on the main effect on economic growth and its propagation mechanisms: *savings, investment and trade openness.* In this sense, the main objective of this research is to explain the propagation mechanism of a *credit volatility shock*, with the main emphasis on economic growth; likewise, the factors that move or determine credit volatility are pointed out.

Thus, this empirical research aims to expand previous analyses, which have been oriented towards developed economies; in this context, for emerging economies (Bolivia). For this purpose, annual information is considered for the period 1965-2013 with a long-term approach (Vector with Error Corrector, VECM). The relevance of the considered period is based on the fact that in the 1960s, it was a relevant starting point for the authorization of the entry of several national banks (ASFI, 2003), for example: Banco de Crédito de Oruro (1960), Banco de Cochabamba (1962), Banco Industrial S.A. (1963), Banco Santa Cruz (1966). Consequently, the remainder of this document is structured in three sections: the first section presents the theoretical foundation; the second one presents a review of the state of the art and financial context; the third section defines the applied data, methodology, results and their respective discussion; and finally, the general conclusions.

1. THEORETICAL FOUNDATION

Based on the financial framework that accelerates the economy, it is hypothesized that credit market developments amplify and propagate shocks in the economy (Bernanke et al., 1999). Agency theory is a field of organizational theory that addresses two types of problems related to information availability (asymmetry) and risk perspectives among principals (directors) and agents (managers, executives, administrators) in organizations (Eisenhard, 1989). There are two types of agency types: the positivist and the principal-agent theory. The positivist proposal is that performance-based contracts reduce agent (manager) opportunism, as well as information systems are an important source for controlling agent opportunism. The principal-agent theory indicates that the contract is more efficient in scenarios of uncertainty, risk aversion and information.In these approaches, the first one is the importance of information, which must be used in order to control the agents. The second contribution is focused on the issue of risk, the implication is that uncertainty must be accepted within the contract (behavioral contract-based or results contract-based) between the principal and the agent. The subsequent challenge for researchers will focus on analyzing mediating variables (information systems, uncertainty of outcomes, and risk) in order to make further contributions to organizational research (there is little empirical work on this topic).

Now then, how does the agents and principals approach apply to the theoretical accelerator framework of financing? The first is based on the fact that the banking system or the general financial system possesses information (agents), that the rest of the population does not possess in terms of principals, macroeconomic evaluation, behavior of the fiscal, real, monetary-financial sector, expectations of future

growth, internal and external shocks, etc.; consequently, it can take measures to direct the credit supply. The lack of knowledge among the population and loan borrowers, by distorting the variability of financing, leads to an imbalance between planned and executed investments, which has a negative impact on consumption and investment levels, slowing down real output as a negative effect. What is usually mentioned in the theory of accelerator financing is associated to the problem of agents and principals in the credit market, whereby loan borrowers or borrowers of funds do not consider opportunistic actions and behaviors of the entities that offer financial resources for the granting of credit, such as the rationalization of credit, contract tightening and unexpected changes in credit policies based on expectations of economic growth or future shocks that may affect the economy.

The theoretical argumentation of agents and principals is based on Bernanke and Gertler (1989), while the main justification of the addressed topic focuses on the relationship between variability of bank financing, its role on investment under asymmetric information, and the propagation mechanisms among aggregate fluctuations. Subsequently, the following central hypothesis is generated: *the greater the volatility in the credit supply of the banking system, the greater the aggregate future fluctuations on the level of investment, trade openness and savings as propagation mechanisms; therefore, the relationship is negative on economic growth: interpreted as a contractionary shock in a generalized way:*

↑Credit volatility shock→↓Investment→↓ Trade Openness →↓Domestic savings →↓Economic Growth.

The established hypothesis is based on the premise that *shocks* in the credit supply or financial sector can affect the economy as sources of economic fluctuations, therefore, it is interpreted that microeconomic relocation of financial resources can generate macroeconomic results (Khan and Thomas, 2013), as well as the role of credit cycles and their propagation shocks (Azariadis et al., 2015; Kiyotaki, and Moore, 1997). On the other hand, in line with the *Minsky moment* approach, the credit cycle is also related to economic activity, but this time, it is adapted to domestic savings and trade flows:

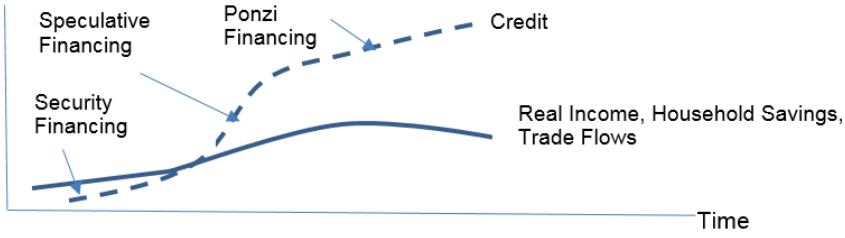

Figure 1. Minsky Momentum adapted to income and financial flows

Consequently, when the growth of real economic activity, domestic savings or trade flows is higher than the path of credit expansion, it is interpreted as security financing; when it is slightly higher, it is speculative financing; finally, when credit expansion is higher than income flows, it is considered a Ponzi financing mechanism.

2. REVIEW OF FINANCIAL DEVELOPMENT AND ITS VOLATILITY, EVIDENCE FOR GROWTH IN LATIN AMERICA AND BOLIVIA

In the case of Latin America: Argentina, Brazil, Chile, Colombia, México, Uruguay and Venezuela for the period of 1990-2011, it was concluded that the first principal component (construct) of certain financial variables such as Bank deposits, cash and cash equivalents, equity capitalization market, central bank assets and financial system deposits, as a proportion of GDP. did not have a consistent and significant impact on economic growth (variation in per capita income) (Venegas, and Rodríguez, 2014).

On the contrary, the role of financial development during 1980 to 2007 was highlighted based on panel data in four countries (Argentina, Peru, Bolivia and Brazil) Financial development is., together with the relevance of macroeconomic stability (e.g. low inflation rates), and the institutional framework (cen-

tral bank independence, fiscal responsibility and deregulation of financial markets); likewise, it was also considered that the financial sector measure M2, which includes liquid assets as a proportion of GDP, has a positive impact on economic growth (Bittencourt, 2012). During 1996-2011, there is negative evidence between financial depth and sectoral economic growth, non-linear relationship, positive incidence in sectors of nine Latin American countries (finance, insurance, public sector) and negative incidence in the construction sector (Aizenman et al., 2015). Also, De Gregorio and Guidotti (1992) examine the relationship between economic growth and degree of financial development, using panel data for Latin America; their results indicate that there is a negative relationship. Similarly, it shows that 1% in the frequency of six types of crises, including financial crises (threshold criteria, 15% in currencies, 20% in inflation, bank failures) presented a negative association in 49% in economic growth for Latin American countries during the period of 1955-2014 (Reinhart and Reinhart, 2015). Consequently, it is evident that uncertainty and credit restrictions negatively affect the investment cycle, both in the short and long term; therefore, the variability of bank financing has a negative impact on economic growth, based on estimates for 21 countries during the period 1960 – 2000 (Aghion et al., 2010).

In the case of financial development in Bolivia, the economic history of credit volatility indicates that its periods of greater volatility, low or high financing in relation to the average, were reflected in the mid-80s (public debt crisis and hyperinflation), mid 90s, and since 2013 (credit financing of social housing) according to Figure 2, which shows a possible negative relationship between the variability of bank financing and economic growth (Figure 3*).*

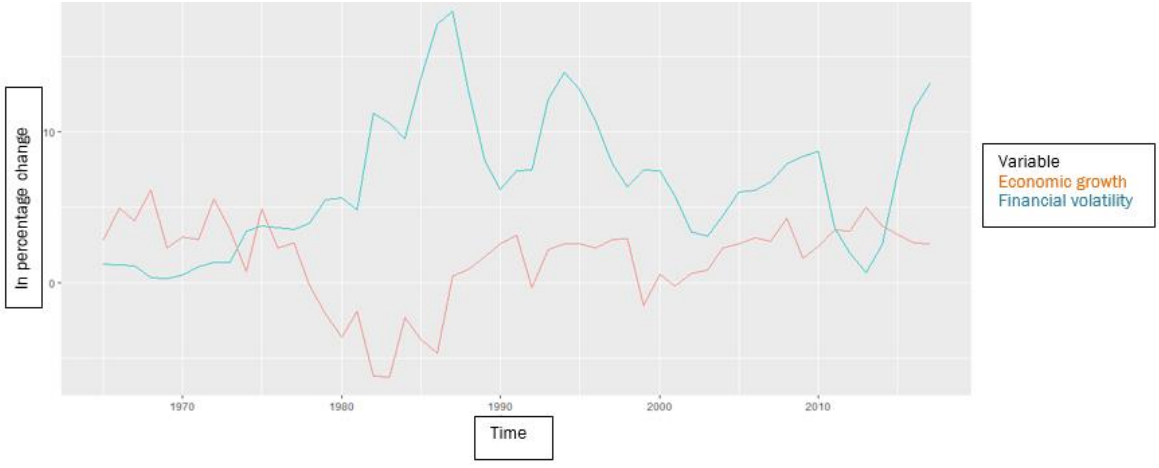

Figure 2. Credit volatility and economic growth in Bolivia 1965-2017

Source: World Bank data

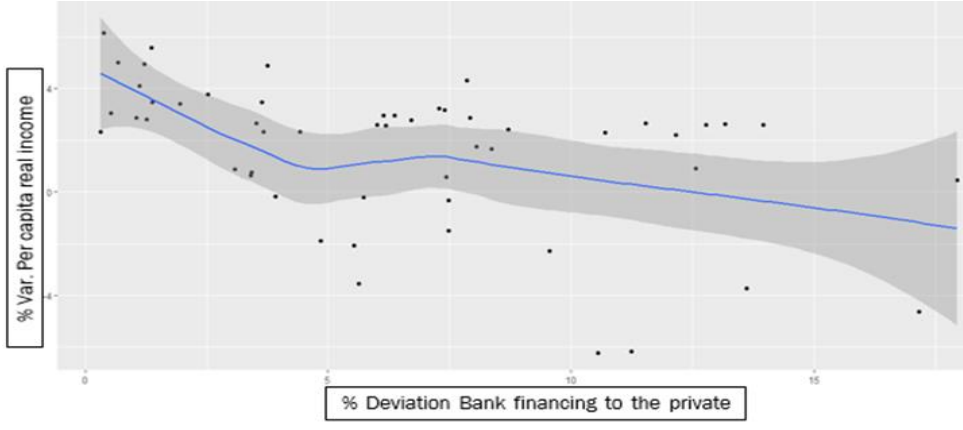

Figure 3. Scatter plot between credit volatility and economic growth in Bolivia, 1965-2017

Source: World Bank data.

In sum, based on the scatter plot presented in Figure 3, one would expect a negative relationship between the variability of bank financing to the private sector, as a *proxy* variable for credit volatility, and the variation in real per capita income.

3. ESTIMATION AND DISCUSSION OF RESULTS - DATA AND METHODOLOGY

From World Bank data, annual information was obtained from 1960 to 2017. To calculate the measure of financial volatility, a dynamic standard deviation was considered for a period of every five years:

$$VolCredit_t = \sigma_{credit_t} = \sqrt{\frac{(CBSP_t - \mu)^2}{n-1}} \qquad (1)$$

Where $CBSP$ denotes bank financing to the private sector (as a percentage of GDP) and μ represents the representative average of the entire full sample: the moving standard deviation considered every five periods (moving window), the final adjusted sample contemplated 52 years of evaluation: 1965-2017 (the first five observations were lost). Likewise, a vector of endogenous variables (Z_t) was considered, consisting of credit volatility $(VolCredit_t)$, domestic savings as a percentage of GDP $\left({}^{Dom.Saving.}/_{y_t}\right)$, aggregate investment as a percentage of GDP (public and private) $\left({}^{Inv.}/_{y_t}\right)$, trade openness as a percentage of GDP, which is a ratio of exports and imports $\left({}^{Trade\ Openn.}/_{y}\right)$, and economic growth, which is measured and operationalized by real per capita income $(GDPpC_t)$;

$$Z_t = \left\{VolCredit_t, {}^{Dom.Saving.}/_{y_t}, {}^{Inv.}/_{y_t}, {}^{Trade\ Opp}/_{y_t}, GDPpC_t\right\} \qquad (2)$$

All variables, except credit volatility, were expressed in logarithmic scale; equally, all variables were assumed to be $I(1)$ (Annex 1). The size of the VECM vector was $p-1$ lags, compared to an Autoregressive Vector VAR model *(p=lags)* with stationary variables (Annex 2). In this sense, a Vector Error Corrector Model (VECM) was estimated:

$$\Delta Z_t = \sum_{\varrho=1}^{p-1} \Gamma(\ell)\Delta Z_{t-\ell} + \Pi(\hbar)Z_{\xi t-1} + \Phi(q)D_t + \epsilon_t \qquad (3)$$

Where $\Pi(\xi) = \alpha\gamma'$ (4)

In (3), Γ and Π are unknown parameter matrices of $n\,x\,n$ size, with an identical, independent, normally distributed error vector with zero mean and constant variance/non-singular covariance matrix (Ω): $\epsilon_t \sim N_{iiD}(0,\Omega)$. The summation of coefficients $\Gamma(\ell)$ corresponds to the short-run dynamics, ℓ represents the number of lags; in addition, possible ξ number of long-run relationships $[\Pi(\hbar)]$ between the endogenous variables were incorporated, by means of the vector $\gamma = (1, \gamma_1, \gamma_2, \ldots., \gamma_n)'$, and a vector of short-run adjustment speed coefficients $\alpha = (\alpha_1, \alpha_2, \ldots., \alpha_n)'$, denoted in expression (4). Finally, D_t corresponds to q −pulse variables, of *dichotomous-Boolean* type in order to correct for anomalous disturbances not explained by the model. In such sense, weak exogeneity tests on the speed of fit coefficients for the five variables incorporated in the model were included, individually $(\alpha_i = 0\ \forall\ i = 1,2,\ldots 5)$, under the null hypothesis that each variable did not respond to the discrepancy of the long-run relationship between the variables (weakly exogenous variable) (Banegas, and Vergara, 2014).

On the other hand, α and γ were determined under hypothesis testing of long-run relationships, if the existence of r cointegrated vectors and imposed restrictions, as stationary linear combinations between the variables is evidenced. In the multivariate cointegration methodology, the proposed approach by Johansen (1988; 1995), is followed to determine the number of independent cointegrating relationships (long run) between the endogenous variables that are part of the vector Z_t, equivalent to the rank Π, and r restrictions or cointegrated vectors (Lütkepohl et al., 2001). The hypotheses were evaluated:

$$H(r_o): rk\,(\Pi) = r_0 \quad versus \quad \bar{H}(r_o): rk\,(\Pi) > r_0 \qquad (5)$$

Λ

$$H(r_o): rk\,(\Pi) = r_0 \quad versus \quad H(r_o+1): rk\,(\Pi) > r_0 + 1$$

The hypothesis test (5) is performed using The Trace and Maximum eigenvalue:

$$LR^0_{traza}(r_o) = -T\sum_{j=r_o+1}^{n}\log\left(1-\lambda_j\right) \qquad (6)$$

$$LR^0_{max.aut}(r_o) = -T\log\left(1-\lambda_{r_0+1}\right) \qquad (7)$$

In this sense, Table 1 shows the four statistical moments[1] in the series used in a stationary sense[2]. In this sense, *credit volatility* reflected the highest level of average variability compared to the other variables analyzed. On the other hand, the greatest dispersion in the data was found in the *percentage variation of investment and savings*; most of the variables presented a negative bias in the data, except for *credit volatility* (with a positive bias). Finally, there were heavy pointed tails with outliers in the variation of *real per capita income and household savings.* When evaluating the condition of normality in the data, it was found that three series present a normal distribution around their mean and standard deviation: the variation of investment, credit volatility and the percentage variation of trade openness. Conversely, the change in *real per capita income and the change in household savings* do not show a normal distribution.

Table 1. Descriptive Statistics

Economic Growth					
Statistics	*% Var. Per Capita real income*	*% Var Inv/Y*	*Credit volatility*	*% Var. Dom. Sav./Y*	*% Var. Trade Openess/ Y*
Media	0.95	0.53	6.60	0.51	0.31
Median	2.32	2.17	6.16	3.26	0.88
Maximum	5.57	47.38	17.95	25.59	22.69
Minimum	-17.00	-49.14	0.31	-53.79	-22.72
Stand. Dev.	3.82	18.79	4.46	17.07	9.60
Asymmetry	-2.34	-0.09	0.57	-1.06	-0.17
Kurtosis	10.73	2.92	2.67	4.26	3.24
Jarque-Bera	177.156***	0.08	3.06	13.25007***	0.36
Num. of years	52	52	52	52	52

*** Statistical significance level at 1%.

The *multivariate cointegration* methodology of Johansen (1988) was then used, performing an initial analysis by means of unit root tests, according to Dickey-Fuller-Augmented (DFA), thus showing that all the series were integrated of first order [I(1)] (Annex 1). Similarly, two long-run equations were determined:

$$log\,GDPpC_t = \widehat{\gamma_0} + \widehat{\gamma_1}\,VolCredit_t + \widehat{\gamma_2}\,log\left(\frac{Dom.Saving}{Y}\right)_t + \widehat{\gamma_3}\,log\left(Trade\ Openn._{/y}\right)_t + u_t \qquad (8)$$

$$log\left(\frac{Inv.}{Y}\right)_t = \widehat{\gamma_0'} + \widehat{\gamma_1'}\,VolCredit_t + \widehat{\gamma_2'}\,log\left(\frac{Dom.Saving}{Y}\right)_t + \widehat{\gamma_3'}\,log\left(Trade\ Openn._{/y}\right)_t + u_t \qquad (9)$$

In (8) and (9), the expression $log\,GDPpC_t$ denotes real per capita income—in logarithmic version—as does investment as a ratio of GDP $\left[log\left(\frac{Inv.}{Y}\right)_t\right]$; similarly, both variables are explained by credit volatility

[1] Time 1, measures of central tendency (mean and median): time 2, measures of dispersion (standard deviation, minimum, maximum); time 3, skewness; time 4, kurtosis).
[2] The mean, variance and auto-covariance are a constant and are independent of the period of analysis.

$(VolCredit_t)$; domestic savings as a percentage of GDP $\left[log\left(\frac{Dom.Saving.}{Y}\right)_t\right]$ and Trade openness as a ratio of GDP $\left[log\left(Trade\ Openn._{/y}\right)_t\right]$.

In addition, in (8) and (9), we obtain respectively a semi-elasticity parameter, interpreted as an absolute variation of one standard deviation in credit financing to the private sector, would exert a contraction on the percentage change of economic growth and a reduction on investment:

$$Dom.Saving._{/y_t}, Inv._{/y_t}, Trade\ Openn._{/y_t}, GDPpC_t$$

$$\partial\ log\ GDPpC\ /\partial VolCredit = \widehat{\gamma_1} < 0 \qquad (10)$$

$$\partial\ log\left(\frac{Inv.}{Y}\right)/\partial VolCredit = \widehat{\gamma_1}' < 0 \qquad (11)$$

The parameter γ_1 measures the relative change in the regressed variable [log (Real per capita income)] given an absolute change in the regressor (financial volatility). By the same time, the parameter γ_1' measures the relative change in the regressed variable [log (Inv./GDP)] given an absolute change in the regressor (credit volatility).

Correspondingly, from (10) and (11), the elasticity of ξ can be demonstrated through basic calculus:

Deriving (8) with respect to Ypc_t:

$$\frac{\partial \log Ypc_t}{\partial VolCredit_t} = \frac{1}{YpC_t} * \frac{\partial y_t}{\partial VolCrediti_{t_t}} \qquad (12)$$

$$\frac{\partial YpC_t}{\partial VolCredit_t} = \widehat{\gamma_1}\ YpC_t \qquad (13)$$

Given that the elasticity is:

$$\xi_{LP,VolCredit-Growth} = \frac{\partial Y_t}{\partial X_t} * \frac{X}{Y} \qquad (14)$$

Then, the Long-Term (LT) elasticity, *Credit Volatility-Economic Growth*, is obtained:

$$\xi_{LP,VolCredit-CGrowth} = \widehat{\gamma_1}\ GDPpC * \frac{VolCredit}{YpC} = \widehat{\gamma_1} * VolCredit \qquad (15)$$

Similarly, we find the Long-Term (LT) elasticity, *Credit Volatility-Aggregate Investment/GDP:*

$$\xi_{LP,VolCredit-Inv./PIB} = \widehat{\gamma_1}\ \frac{Inv}{PIB} * \frac{VolCredit}{\frac{Inv}{PIB}} = \widehat{\gamma_1}' * VolCredit \qquad (16)$$

Table 2. Slope, semi-elasticity and elasticity of economic growth and investment to financial volatility, long-run against financial volatility, long term

Model	*Equation*	*Slope {∂YpC/∂CreditVol}*	*Semi-elasticity {∂ log YpC/∂CreditVol}*	*Elasticity (ξ CreditVol-Eco.Grow.) {∂YpC/∂CreditVol * (CreditVol/ YpC)}*
Log-lin	*Log YpCt = γ_0 +γ_1 VolCredit t + γ'_i Log Zt +ut*	*γ_1YpC**	*γ_1*	*γ_1VolCredit**
Z_t includes other explanatory variables, in this case Domestic Savings and Trade Openness as a proportion of GDP respectively.				
* It indicates the elasticity of economic growth as a function of credit volatility. In practice, when credit volatility values are not specified, it is very common to measure this elasticity with its average observed value.				
Model	Equation	Slope {∂ Inv./Y/∂CreditVol}	Semi-elasticity {∂ log Inv./Y/∂CreditVol t}	Elasticity (ξ Credit.Vo.-Inv.) {∂Inv./Y/∂CreditVol * (CreditVol/ Inv./Y)}

Log-lin	*Log (Inv./Y) = γ_0'+γ_1' VolCredit t + γ'_i Log Zt +ut*	*γ_1' Inv/Y**	*γ_1'*	*γ_1'VolCredit**
Z_t includes other explanatory variables, in this case Domestic Savings and Trade Openness as a proportion of GDP respectively.				
* It indicates the elasticity of investment as a function of credit volatility. In practice, when credit volatility values are not specified, it is very common to measure this elasticity with its average observed value.				

4. RESULTS

In this section, by applying a Vector Error Corrector Model (VECM), according to the methodology proposed by Johansen (1988; 1995), the long-run relationships between the variables considered are shown, with the respective calculation of elasticities, impulse-response functions (IRF), short-run causality and variance decomposition.

Long-Term Relationships

Consequently, two long-term relationships were determined (Annexes 3 and 4), where it was shown that credit volatility has a negative and statistically significant relationship with real per capita income (economic growth variable) and aggregate investment (Table 3).

Table 3. Long Run Relationships: Two cointegration equations

			Dependent variables	
			Log (Ingr. Per Cápita real)	*Log (Inv. Agre/ PIB)*
Constant	Coefficient	g_0	3.03***	-4.19***
	ee		1.01	1.10
	t		3.00	3.80
Credit Volatility	Coefficient	g_1	-0.05***	-0.06***
	ee		0.01	0.01
	t		-4.60	5.25
Log (Dom. Sav./Y)	Coefficient	g_2	-0.67***	-0.14
	ee		0.21	0.23
	t		-3.14	-0.60
Log (Trade Open./Y)	Coefficient	g_3	1.89***	0.76†
	ee		0.36	0.39
	t		5.24	1.62

Statistical significance level: at 1% ***; at 10% † of statistical significance.

Table 4. Long Run Elasticities resulting from Credit Volatility

		Dependent variable	
Explanatory Variable: *Credit Volatility*	Parameters	*Economic Growth*	*Aggreg. Invest/GDP*
Semi-elasticity	γ_1	-0.05***	-0.06***
Elasticity	ξ	-0.31***	-0.40***
Error Corrector (ST)	α	-0.08***	0.63***

ST: Short term. Significance level*** at 1%.

Consequently, according to Table 4, when estimating long-term elasticities for each positive or negative variability of 6.2%. This value corresponds to the historical average for the period 1965-2017, in financing to the private sector, economic growth contracts by 0.31% and aggregate investment is reduced by 0.4%, respectively. Other variables of interest reflect that in the long term, a higher level of

domestic savings would have different impacts on economic growth; for example, in the long term (there would be a decrease) as opposed to the short term (increase according to impulse-response functions); trade openness would have a positive and statistically significant effect on economic growth.

On the long run function side for aggregate investment/GDP, domestic savings would not influence the level of investment, according to Feldstein and Horioka (1980), therefore, international capital flows would play a relevant role; similarly, the level of trade openness presents a weakly significant impact on the level of investment (at 10% statistical significance). Similarly, in terms of the error correction mechanism, an increase in the term ratio with the related factors of economic growth would require an adjustment or reduction speed of 0.08% in the short term. As for aggregate investment, an increase in the long-run ratio would have an increase of 0.68% in the short run, thus diverging from its equilibrium value; both estimates at the 1% level of statistical significance.b0n the other hand, to evaluate the influence of long-term shocks and their incidence in the short term, the error correction mechanism is evaluated according to Table 5.

Table 5. Error-correcting mechanism in the short term - Weak exogeneity test

Ho: The dependent variable does not respond to Long-Term (LT) discrepancies, therefore, the variable is weakly exogenous.					
	Dependent variable				
	Economic Growth	*Var Inv % /Y*	*Credit Volatility*	*Var. Do. Sav.%/Y*	*Var. Trade Open. %/ Y*
Ho:	$\alpha_{11} = \alpha_{21} = 0$	$\alpha_{12} = \alpha_{22} = 0$	$\alpha_{13} = \alpha_{23} = 0$	$\alpha_{14} = \alpha_{24} = 0$	$\alpha_{15} = \alpha_{25} = 0$
$c^2(2)$	12.81***	15.02***	7.84**	1.63	0.40

Statistical significance level: *** at 1%; ** at 5%.

In this sense, and according to Table 5, domestic savings and trade openness are weakly exogenous in the short term; then, they do not respond to long-term dynamics and discrepancies. On the other hand, economic growth, aggregate investment and credit volatility show error correction mechanisms in the short term; therefore, long-term dynamics play an adjustment role in the short term. Finally, to provide methodological support for the estimates completed, various econometric specification tests were applied in the econometric modeling (Annexes 8-11). In this way, multivariate normal distribution test on the residuals, hypothesis of no autocorrelation, stability in the parameters and unit circle of inverse roots and hypothesis of no heteroscedasticity

Impulse-Response Functions (IRF)

In this section, the aim is to answer the factors that affect the variability of bank financing, as well as the implications of credit volatility shocks (quantifications) and their propagation mechanisms:

Credit volatility responses: Figure 4 shows that a positive shock of one standard deviation, equivalent to 1.16%, in aggregate investment, reduces credit volatility by up to 1. 5%, just as positive innovations in aggregate supply decrease around 1% respectively; on the other hand, while trade openness can reduce variability in credit supply in the short horizon; however, in the medium horizon, volatility increases close to 1% given the possible presence and amplification of external shocks (in five years ahead); likewise, a *positive shock* of one standard deviation, equivalent to 1. 21% in domestic savings can increase credit volatility by up to 0.5% over the medium horizon (dynamic and changing effects).

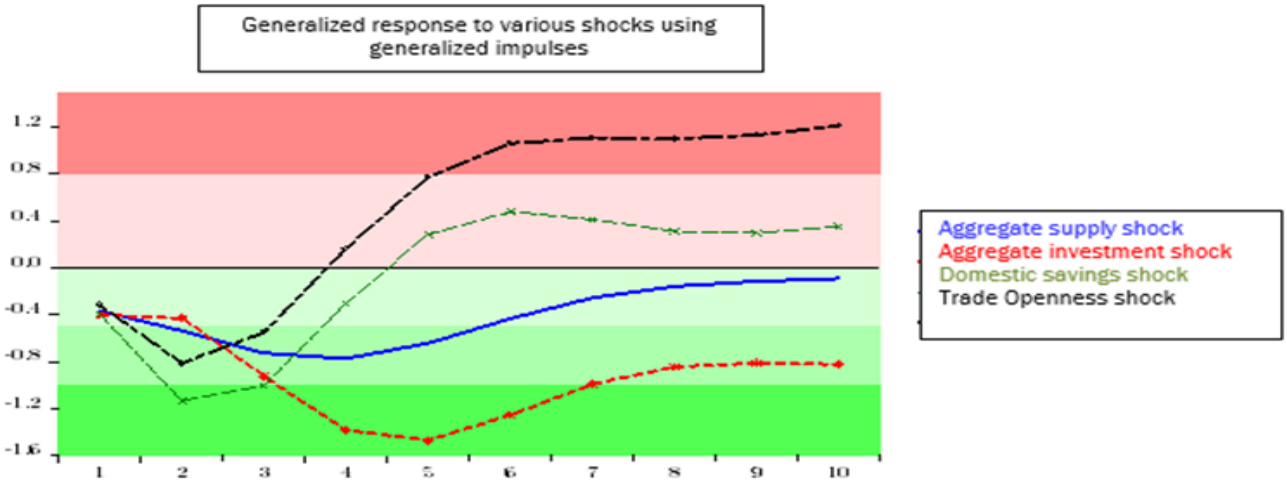

Figure 4. Responses to credit volatility (bank financing) - Impulse-Response Functions, in years forward

Below zero implies a reduction in volatility (green stripes); otherwise, an increase in volatility (pink stripes).

Source: Own estimates.

Propagation mechanisms: In a generalized manner, it is observed in accordance with the stated premise in the document that a *positive shock of one standard deviation, equivalent to 1% in credit volatility*, generates negative fluctuations in the macro-aggregates: -4% on domestic savings in the short term; contraction on aggregate investment between -3 and -5%, and trade openness (-2 and -3% respectively), with permanent effects according to Figure 5. Under the propagation interpretation, the most severe *shocks* are evidenced from the trade openness shock to domestic savings (positive response); from aggregate supply shocks to aggregate investment (investment accelerator role) and from the domestic savings shock (liquidity shock) to trade openness.

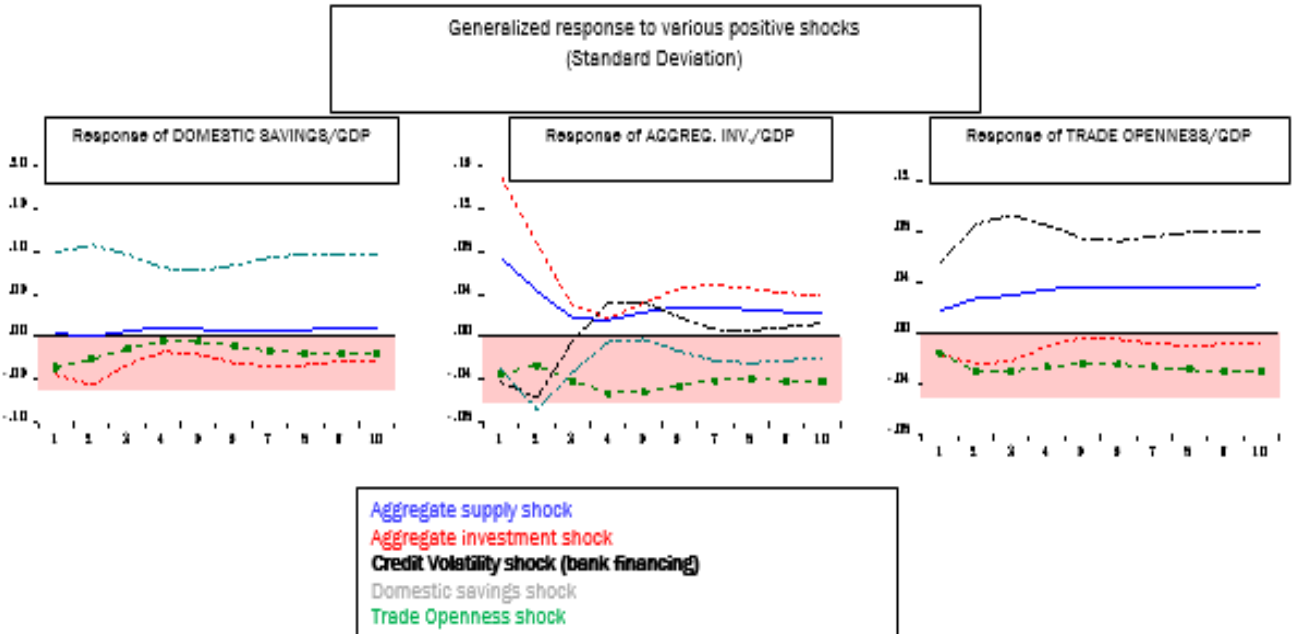

Figure 5. Propagation Mechanisms – Impulse - Response Functions, in years forward

Below zero implies negative responses (pink stripe).

Source: Own estimates

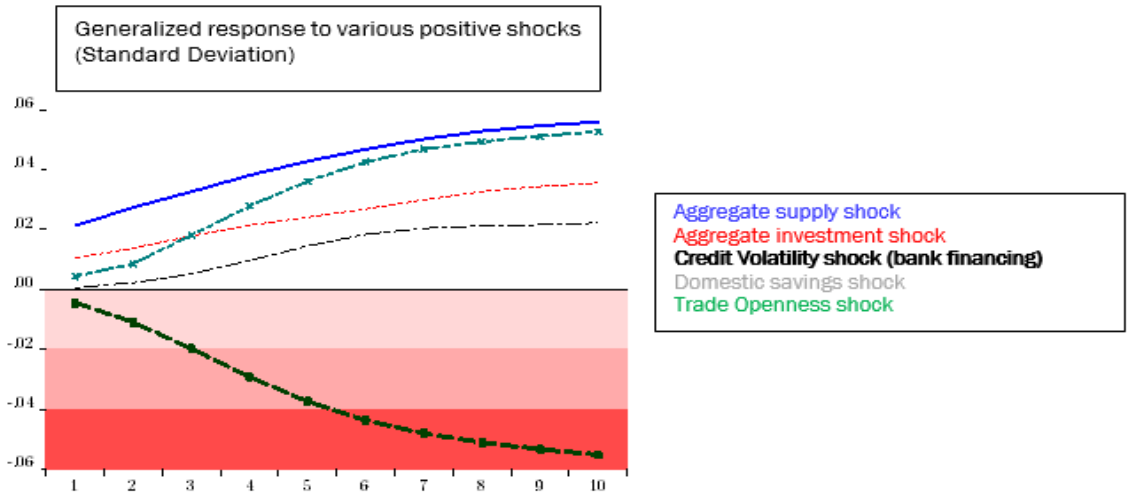

Figure 6. Economic growth responses- Impulse - Response Functions, in years forward

Below zero implies negative responses (pink stripe).

Responses of economic growth: According to Figure 6, economic growth responds positively to aggregate supply shocks, aggregate investment, domestic savings and trade openness, in a unidirectional manner, respectively.

On the other hand, credit volatility on the bank financing side is a decelerating factor of economic growth; therefore, a positive shock of one standard deviation, which is equivalent to 1%, in the volatility of bank financing affects negatively with greater emphasis from the second year onwards, in the order of -1 to -5% in the medium term.

Short-Term Causality and Variance Decomposition: In Granger's sense *(*Annex 5*):* there is empirical support that past dynamics of domestic savings and aggregate investment causes present credit volatility (at the 0.05 level of statistical significance); domestic savings cause aggregate investment (at the 0.05 level) and trade openness exerts short-run causality on economic growth (at the 0.01 level).

On the variance decomposition side (Annex 6), shocks to credit volatility, through bank financing, generate about 25% of the variance of economic growth over the medium horizon; in a similar magnitude, innovations in domestic savings generate variability on aggregate investment. Likewise, changes in investment and trade openness explain about 50% of the variance of credit volatility over the medium horizon; consequently, in the short term, from one to five years forward, the variance is explained by the same innovations in the variability of bank financing.

From a historical variance decomposition perspective (Annex 7), since the mid-1980s (reforms and structural adjustment measures), the stochastic component of Bolivia's economic growth was related to the dynamics of credit volatility and the role of aggregate investment; similarly, the historical variance in the random factor of credit volatility has been related to the dynamics of the role of investment. Finally, the trajectory of domestic savings has been synchronized, to a greater extent, with the dynamics of trade openness since the mid-1980s.

5. RESULTS DISCUSSION

As a schematization of the response of credit volatility, Figure 7 systematizes the sources of variation in bank financing due to different sources of fluctuations, in two-time horizons: 1) short, from 1 to 5 years, and 2) medium, greater than 5 years. When considering the approach that moves credit volatility, it is considered that fluctuations in savings and trade flows would be cyclical with effects in the medium horizon, in the interpretation of international contagion and would be transformed into sources of specu-

lative-*Ponzi* type financing, which would increase financial volatility in the medium horizon. For this type of analysis of the Bolivian economy, the adaptation of Minsky's approach allows to explain the increase in the volatility of bank financing as a complement to the empirical results obtained.

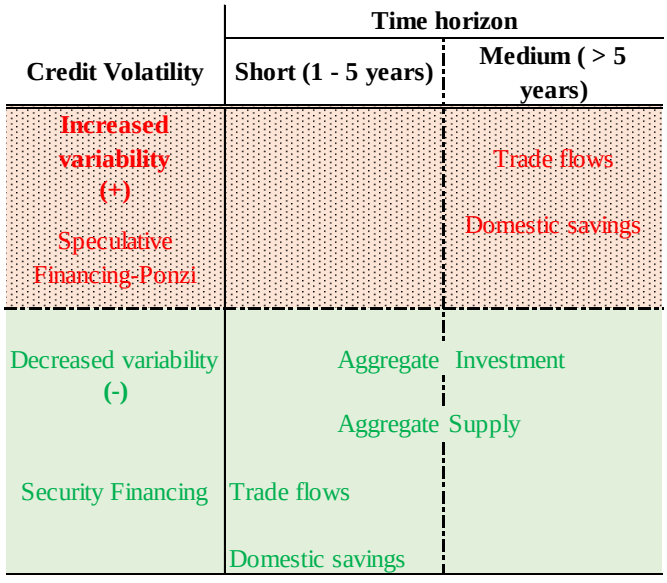

Figure 7. Response of credit volatility in Bolivia to various types of fluctuations

Source: Own elaboration.

As for the sources of fluctuations that reduce the variability of bank financing, it was found that Aggregate Investment and Aggregate Supply, both in the short and medium term and interpreted as fluctuations, generate security financing with a reduction in credit volatility: trade flows and domestic savings reduce volatility in the short term, but amplify it in the medium term.

On the other hand, for the effect of bank financing volatility shocks, there is empirical support for the negative effect of credit volatility on aggregate fluctuations -main emphasis on economic growth- which is consistent with previous studies.

This negative role is interpreted given that the financial system, especially the banking system, presents asymmetries in the knowledge of information and economic expectations, which generates variability in the financing mechanisms, producing misalignments in the real production levels of the economy, in such a way that it has a negative impact on economic growth based on information from 1965 to 2013 for Bolivia.

Bolivia's economic and financial history has been linked to the opening and closing of public and private banks, with credit extension facilities by state banks (Morales and Sachs, 1987), loss absorption, forced bankruptcies in the 90s and credit contraction during the 80s and 90s, which has caused volatility in financing and has spread throughout the productive sector. An example is the Bolivian Agricultural Bank, with loans to the productive sector between 1972 and 1975, which generated irrecoverable losses for the State.

On the other hand, banks act with information asymmetry mechanisms that are not foreseen by investors and economic agents, and therefore, there are agency costs that are passed on to the economy as a whole (Bernanke and Gertler 1989; Carlstrom and Fuerst, 1997; Bernanke et al., 1999) The found results are congruent with previous results, based on the negative effects of the financial sector under conditions of volatility; therefore, the effects of the 2007 international financial crisis have shown that a temporary shock in the supply of credit contracts investment and affects the gradual deterioration of

output (Khan and Thomas, 2013). In short, the greater the credit volatility→↓investment→↓trade openness→↓domestic savings→↓economic growth as a virtuous circle.

Public policy implications

By demonstrating that credit volatility has a negative impact, with a propagation mechanism on economic growth, it is pointed out that volatility is a measure of variability around an average, so, high or lower values in relation to a measure of central tendency; in this sense, the credit supply of the financial system should be focused on a sustained smoothing.

First, excess levels above their central tendency measure, may cause over levels of indebtedness and depending on the economic deterioration, systematic risks for the financial sector increase (asset quality risks), which could cause imbalances, financial fragility and generate negative forward fluctuations, with the need for macro-prudential countercyclical policies (Madeira, 2018; Agénor and da Silva, 2017). For Chile, it was found that in situations of economic recessions, the probability of credit default increases by 30%, therefore, the index in bank delinquency in times of crisis is 400 times to the index in times of boom respectively (Madeira, 2018).

Second, lower thresholds below their central tendency measure can cause falls in investment, consumption and production, even generating negative expectations about the future dynamics of the economy. Similarly, the implications for public policies are centered on the debate about the regulation of financial markets versus their liberalization; that is, considering that volatility in the credit supply generates contractionary implications on macroeconomic aggregates, *policy maker*s could direct the banking system to comply with specific goals of credit objectives and banking system participation or, alternatively, leave it to the market, under the motto "*laissez faire, laissez passer*" *(laissez faire, laissez passer)*.

In conditions of free supply and competition in financial markets or the presence of competitive banking systems, free discretion could be a tentative response (*financial deregulation*); however, the banking system (e.g. Bolivia) is more oriented towards imperfect oligopolistic markets, with characteristics of market power. Consequently, in imperfect markets and in the presence of externalities, regulation is more inclined since it is potential in the presence of the phenomenon of agents and principals, where banks (agents) establish their credit guidelines based on the asymmetry in the information on economic growth expectations, for the granting of credit to borrowers or borrowers of funds (principals).In the end, public policy can focus on reducing variability (positive or negative), since in the short term, the variance of credit volatility is explained by its own innovations, with the perspective of avoiding the channeling of volatility as a measure of uncertainty that dissipates dynamically (forward) in the main variables of the economy: savings, investment, trade openness and growth.

Nevertheless, it should be noted that the cost of inducing a stable and softened credit policy for bank credit could lead to the risk of financial fragility on the financing side, especially speculative or Ponzi schemes, depending on the internal and external economic environment (Minsky, 1996). These schemes could be reduced in function of the composition of reserves for future credit supply, constituted in boom periods to be used in periods of deceleration or fall of the product, under a countercyclical approach (Agénor and da Silva, 2017), in such a way that bank financing is softened in a sustainable way.

Limitations and research agenda

Based on the present results for the case of a small open economy, the *role of credit cycles* is suggested for future research, according to firms or lenders, characteristics of loan contracts, bank risks and their different financing products. The above, in order to measure the level of synchronization with aggregate fluctuations (*procyclical, countercyclical and acyclical),* as well as the role of consumer credit confidence, the bi-directionality hypothesis between the relationship between financial market performance and investors' expectations respectively, and the role of the financial market as a source of credit risk (Greenwood et al., 2019; Azariadis et al., 2015; Liberti, and Sturgess, 2018).
There are other aspects pending evaluation, in accordance with Minsky´s (1996) approach, which are considered as an explanatory agenda to explain the volatility of the banking system: profit rate, interest rate, exchange rate, as well as the level of public indebtedness of economic agents in Bolivia.

Finally, the question arises as to the interaction that would exist between the joint hypothesis of *double exchange-rate-credit volatility* and its implications in aggregate fluctuations since in Latin American countries, a strong relationship has been demonstrated between currency crises, costs of banking crises, productivity shocks and currency overvaluation as factors that explain losses in real output (Nakatani, 2019).

CONCLUSIONS

The decade of the 1960s is a period of openness to financial development in Bolivia; in this sense, two research questions were identified based on the period 1965-2017: the first one, related to the elements that determine credit volatility and the second one, related to the role of variability in bank financing and its dynamic effects.

First, it was found that the historical trend in aggregate investment and domestic savings exert causality on the variability in the supply of bank financing in the short term; aggregate investment evidence an explanation of close to 25% in the variance of credit volatility.

From an impulse-response approach, credit volatility is reduced in the face of positive dynamics in *aggregate supply* and *aggregate investment*; conversely, credit volatility increases in the face of positive shocks in trade openness, especially in the medium horizon (amplifications of external shocks). Therefore, changes in trade flows are the main source of credit volatility, followed by domestic savings, generating 1/3 of the increase in the variability of bank financing in the medium horizon.

To answer the second question of the document, the results indicate that a *positive shock* in credit volatility generates negative impacts on economic fluctuations such as domestic savings, up to -4% in the short term; negative and permanent implications on aggregate investment (-3.-5%) and trade openness (-2.-3%); therefore, the greatest impact is evidenced on economic growth, between -1 and -5%, from the second year onwards and after a credit volatility shock.

When estimating long-term elasticities, for every 6% increase in historical credit volatility, economic growth, it contracts by 0.3% and investment decreases by 0.4%, respectively.

Over the medium horizon, shocks in credit volatility, measured by bank financing, explain about 25% of the variance of economic growth, which is why financial system *shocks* are relevant.

As a discussion and suggestion for public policies, it is proposed the smoothing of credit supply around stable paths of bank financing, controlling high and low fluctuations, as *proxy* measurements in the economic-financial uncertainty to avoid the generation of negative expectations by consumers and investors, which is in the debate of financial regulation versus free discretion.

Similarly, the critical point in the softening of bank financing should be oriented towards a context of hedged and sustainable financing, avoiding fragility with speculative or Ponzi-type financing (Minsky's hypothesis).

Finally, the magnitude and severity of bank financing volatility shocks reflect the relevance of the financial sector, especially in a context that generates negative fluctuations in the real economy.

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ANNEXES

Annex 1. Unit root test

		At levels			*First difference*		
Variable	*Specification*	*t-statistics*	*Number of lags*	*Specification*	*t-statistics*	*Number of lags*	*Integration order*
Log (Y per capita)	With direction	0.622689	1	With no direction	-5.342086***	0	I(1)
Log (Aggreg. Inv./Y)	With direction	-2.856146*	0	With no direction	-8.4411***	0	I(1)
Log (Dom. Sav./Y)	With direction	-2.272173	1	With no direction	-5.794377***	0	I(1)
Credit Volatility	With direction	-2.886246*	0	With no direction	-4.720801***	0	I(1)
Log (Trade Open./Y)	With direction	-1.747794	0	With no direction	-6.898409***	0	I(1)

*** Statistical significance level at 1%.

Annex 2. Selection criteria VECM: $(p-1)$

Lag	LogL	LR	FPE	AIC	SC	HQ
1	103.13	NA	0.00	-3.19	-2.223889*	-2.822903*
2	132.61	46.92399*	2.43e-08*	-3.371875*	-1.44	-2.64
3	147.60	20.81	0.00	-2.96	-0.07	-1.86

* Indicates the order in which lags are selected
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Annex 3. Summary of cointegration specification, Johansen methodology (1988)

Selection at the 0.05 level, Number of cointegrating relationships per model*					
Data tendency	None	None	Lineal	Lineal	Quadratic
Type of test	No intercept	Intercept	Intercept	Intercept	Intercept
	No tendency	No tendency	No tendency	With tendency	With tendency
Trace	2	2	1	1	1
Max. eigenvalue	3	2	1	1	1
*Critical values based on MacKinnon-Haug-Michelis (1999)					
Information criteria by range and model					
Data tendency	None	None	Lineal	Lineal	Quadratic
Range o	No intercept	Intercept	Intercept	Intercept	Intercept
No. of Ces	No tendency	No tendency	No tendency	With tendency	With tendency
	Log of verosim. By Range (rows) and model (columns)				
0	140.03	140.03	148.85	148.85	149.94
1	157.54	164.62	172.25	172.83	173.88
2	173.55	180.76	185.61	187.86	188.91
3	183.34	190.75	191.59	196.49	196.65
4	185.63	193.07	193.07	198.24	198.25
5	185.66	193.48	193.48	198.85	198.85
	AKAIKE information criterion By Range (rows) and model (columns)				
0	-4.51	-4.51	-4.66	-4.66	-4.51
1	-4.81	-5.04	-5.19	-5.17	- 5.05
2	-5.04	-5.25	-5.32	-5.327714*	-5.25
3	-5.03	-5.21	-5.16	-5.23	-5.16
4	-4.73	-4.87	-4.83	-4.87	-4.83
5	-4.34	-4.45	-4.45	-4.46	-4.46
	SCHWARZ information criteria by Range (rows) and model (columns)				
0	-3.56	-3.56	-3.52	-3.52	-3.18
1	-3.48	-3.680372*	-3.67	-3.62	-3.35
2	-3.34	- 3.47	-3.42	-3.36	-3.17
3	-2.95	- 3.01	-2.89	-2.85	-2.70
4	-2.27	- 2.25	-2.17	-2.07	-1.99
5	-1.50	- 1.42	-1.42	-1.24	-1.24

Annex 4. Cointegration tests: Trace and Maximum Eigenvalue

Adjusted sample: 1967-2017					
Number of observations: 51 years					
Trend assumption: Non-deterministic trend (constrained constant)					
Lagging intervals (in first difference): 1 a 1					
Rank test in irreconstrained cointegration, The Trace					
			5%		
N° of Coint. Ecu.	*Eigenvalue*	*The Trace Stats.*	*Critical Value*	*Prob.***	
Ho: Existence of N° of long term relationships					
None *	0.62	106.90	76.97	0.00	
At most 1*	0.47	57.72	54.08	0.02	
At most 2	0.32	25.44	35.19	0.37	
At most 3	0.09	5.47	20.26	0.97	
At most 4	0.02	0.82	9.16	0.97	
The Trace test points out 2 Coint. equations at 5% of Stats Sign.					
*Denotes rejection of the null hypothesis at the 5% level.					
**Prob. according to values of MacKinnon-Haug-Michelis (1999)					
Rank test in irreconstrained cointegration, The Trace					
			5%		
N° of Coint. Ecu.	*Eigenvalue*	*Max. Stats. Eigenvalue*	*Critical Value*	*Prob.***	
Ho: Existence of N° of long term relationships					
None *	0.618737	49.17754	34.80587	0.0005	

At most 1*	0.469003	32.28293	28.58808	0.0161	
At most 2	0.324045	19.97304	22.29962	0.1023	
At most 3	0.087054	4.645005	15.8921	0.9169	
At most 4	0.015981	0.821621	9.164546	0.9718	
The Maximum Eigenvalue test points out 2 Coint. Equations at 5% of Stats. Sign.					
*Denotes rejection of the null hypothesis at the 5% level.					
**Prob. according to values of MacKinnon-Haug-Michelis (1999)					

Annex 5. Short-term Causality in the Granger´s sense
Ho: The variable Δxi does not cause Granger to variable Δyi
VECM, Granger Causality, Wald block exogeneity test

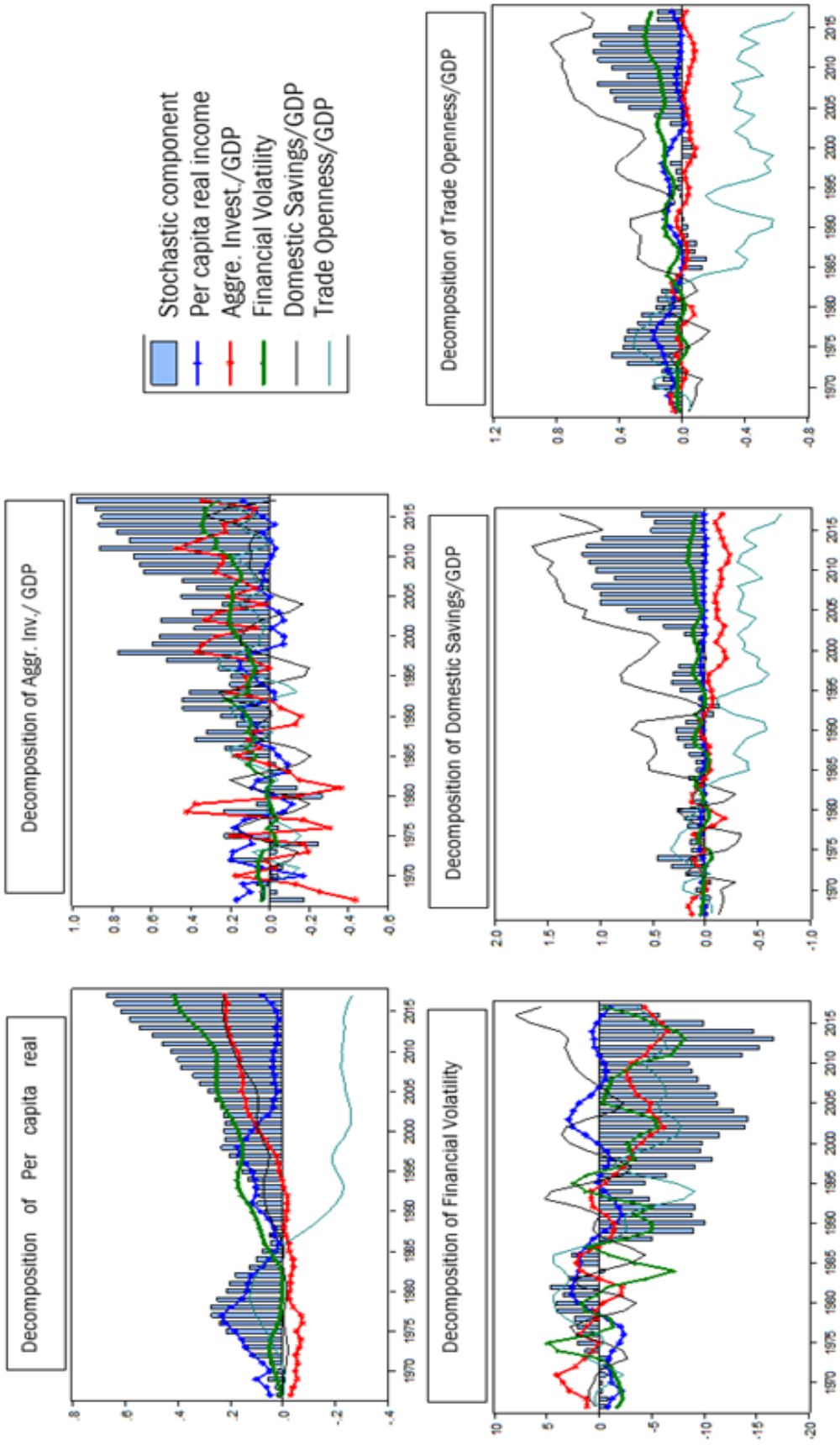
Sample: 1965-2017		
Included observations: 51 years		
Dependent variable: Economic Growth		
Excluded	c^2	G de L
Var % Inv/Y	1.21	1
Credit Volatility	0.07	1
Var. % Dom. Sav./Y	2.42	1
Var. % Tra. Open./ Y	5.61***	1
Combined	6.78	4
Dependent variable: Var.% Inv/Y		
Excluded	c^2	G de L
Economic Growth	0.67	1
Volatil. Crediticia	0.14	1
Var. % Dom. Sav./Y	4.46**	1
Var. % Tra. Open./ Y	0.11	1
Combined	7.33	4
Dependent variable: Credit Volatility		
Excluded	c^2	G de L
Economic Growth	0.03	1
Var % Inv/Y	4.71**	1
Var. % Dom. Sav./Y	5.24**	1
Var. % Tra. Open./ Y	0.38	1
Combined	12.71**	4
Dependent variable: Var. % of Dom. Sav./Y		
Excluded	c^2	G de L
Economic Growth	0.11	1
Var % Inv/Y	1.70	1
Credit Volatility	0.11	1
Var. % Tra. Open./ Y	0.94	1
Combined	2.57	4
Variable dependiente: Var. % of Tra. Open./Y		
Excluida	c^2	G de L
Economic Growth	2.62	1
Var % Inv/Y	0.30	1
Credit Volatility	0.92	1
Var. % Tra. Open./ Y	3.44†	1
Combined	9.47†	4

Annex 6. Variance Decomposition

Variance decomposition of Economic Growth					
Period	Economic Growth	Var % Inv/Y	Credit Volatil.	Var. % Dom. Sav./Y	Var. % Tra. Open./ Y
1	100	0	0	0	0
5	65	0	19	1	16
10	48	1	27	2	22
Variance decomposition in the Var % of Ad. Inv. /Y					
Period	Economic Growth	Var % Inv/Y	Credit Volatil.	Var. % Dom. Sav./Y	Var. % Tra. Open./ Y
1	25	75	0	0	0
5	18	50	8	6	17
10	16	43	10	5	26
Variance decomposition in Credit Volatility					
Period	Economic Growth	Var % Inv/Y	Credit Volatil.	Var. % Dom. Sav./Y	Var. % Tra. Open./ Y
1	5	2	93	0	0
5	11	17	62	6	4
10	7	23	39	4	26
Variance decomposition in the Var. % of Dom. Savings/Y					
Period	Economic Growth	Var % Inv/Y	Credit Volatil.	Var. % Dom. Sav./Y	Var. % Tra. Open./ Y
1	0	12	8	80	0
5	1	7	4	88	0
10	1	6	5	87	1
Variance decomposition in the Var. % of Trade Openness/Y					
Period	Economic Growth	Var % Inv/Y	Credit Volatil.	Var. % Dom. Sav./Y	Var. % Tra. Open./ Y
1	4	12	4	26	54
5	9	9	9	37	35
10	12	6	12	34	36

Annex 7. Historic Variance decomposition

VECM model for the Bolivian economy, 1965-2017



Annex 8. Residuals with multivariate normal distribution

Multivariate normality residuals test VECM					
Orthogonalization: Cholesky (Lutkepohl)					
Null hypothesis: Residuals have a multivariate normal distribution.					
Sample: 1965-2017					
Included observations: 51 years					
Component	*Asymmetry*	*c2*	*G d L*	*Prob.*	
1	-0.289901	0.714362	1	0.398	
2	0.061587	0.03224	1	0.8575	
3	0.00599	0.000305	1	0.9861	
4	-0.559285	2.658799	1	0.103	
5	0.188116	0.300795	1	0.5834	
Combined		3.7065	5	0.5924	
Component	Kurtosis	c2	G d L	Prob.	
1	3.226333	0.108857	1	0.7414	
2	3.593272	0.74794	1	0.3871	
3	3.338382	0.243318	1	0.6218	
4	3.225999	0.108536	1	0.7418	
5	2.575804	0.382378	1	0.5363	
Combined		1.59103	5	0.9023	
Component	Jarque-Bera	G d L	Prob.		
1	0.823219	2	0.6626		
2	0.78018	2	0.677		
3	0.243623	2	0.8853		
4	2.767335	2	0.2507		
5	0.683173	2	0.7106		
Combined	5.29753	10	0.8704		

Annex 9. Stability and roots outside the unit circle

Characteristics of polynomial roots	
N° of endogenous variables: 5	
Maximum N° of allowed roots: 4	
Roots	*Module*
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.755396	0.755396
0.356627 - 0.561089i	0.664834
0.356627 + 0.561089i	0.664834
0.288973	0.288973
0.062725 - 0.281196i	0.288107
0.062725 + 0.281196i	0.288107
-0.014814	0.014814
The VECM model establishes three roots outside the unit circle, which is less than the maximum number of allowed roots (4). The model meets the stability condition.	

Annex 10. VECM, White's Heteroscedasticity Test

(Levels and squares)

Null hypothesis: Residuals are homoscedastic (constant variance).					
Sample: 1965-2017					
Included observations: 51 years					
Combined					
c2	G d L	Prob.			
221.4718	255	0.9364			

Annex 11. VECM, Lm serial non-correlation test

VEC Residual Serial Correlation LM Tests						
Prueba de No correlación serial LM						
Null hypothesis: There is no serial correlation in the residuals *h*						
Sample: 1965-2017						
Included observations: 51 years						
Null hypothesis: No serial correlation at lag *h*						
Lag	LRE* stat	G d L	Prob.	Rao F-stat	G d L	Prob.
1	32.07893	25	0.1557	1.326006	(25, 120.4)	0.1588
2	21.94114	25	0.6391	0.871611	(25, 120.4)	0.6426