

Financial Portfolio And Economic Growth In Colombia. An Error Correction Model Summary

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Abstract

The purpose of this paper is to analyze the relationship between economic growth and Colombian financial portfolio quality institutions during the second decade of the 21st century for forecasting purposes, by means of an econometric error correction model using quarterly information for the period between 2011-I and 2020-III, both of gross domestic product and of the gross and past-due portfolio of financial institutions. The estimation of the model was executed using the econometric program Eviews 10 with the intervention of two variables. The first one consists of the seasonally natural logarithm adjusted gross domestic product [LPIBD] and the second corresponds to the portfolio quality indicator defined as the ratio of the past-due portfolio to the gross portfolio [INCALID]. The results reveal that the variables are integrated of order 1 and are co-integrated, making it possible to estimate the model with three lags, which added to the unidirectional causality in the Granger sense, allowed predicting the portfolio quality of financial institutions for the fourth quarter of 2020 and establishing the short- and long-term dynamics.

Keywords: Production, economic growth, portfolio quality, error correction model.

1. Introduction

Numerous research studies have shown that the bank system or financial inclusion is directly related to a country's economic growth, as well as to an increase in the population's well-being. One example is the work done by Tafur Saiden (2013), who established in his study that the banking system plays an important role in poverty reduction.

However, in the specific case of bank indebtedness, the credit cycle behavior is not necessarily fulfilled, since in many opportunities debtor defaults affect the portfolio quality therefore banks must resort to restrictive measures that slow down placements so that in the

long-term their end up being major repercussions at the macroeconomic level on the country's growth that can negatively impact the welfare and life quality of its inhabitants.

According to the World Bank (2021), Colombia had in the last decade before the pandemic, a balanced fiscal and macroeconomic management, based on inflation targets, a flexible exchange rate, and a regulated fiscal framework, which allowed the economy to grow uninterruptedly since 2000 and approximately 3.3% in 2019. However, the pandemic onslaught slowed down both the country's economy and that of the entire world further narrowing the relationship, explained by Clavijo & Vera (2012), between the banks' portfolio and production [GDP]. For that reason, according to Banco de la República (2021), the economic leverage shifted to private investments and other non-banks.

The objective of this paper is to analyze the relationship between economic growth [GDP variation] and the quality of the portfolio of Colombian financial institutions in the second decade of the 21st century for forecasting purposes, by estimating an econometric error correction model using quarterly information from the period between 2011-I and 2020-III, both Gross Domestic Product [GDP] and of the gross and past-due portfolio of financial institutions.

The model estimation with two variables was executed using the econometric program Eviews 10. These variables correspond, on the one hand, to the natural logarithm of the seasonally adjusted gross domestic product [LPIBD] and, on the other hand, to the portfolio quality indicator defined as the ratio of non-performing loans to gross loans [INCALID]. The results confirm that the variables are integrated of order 1 and are co-integrated, making it possible to estimate the model with three lags, which added to the finding of unidirectional causality in the Granger sense, made it possible to predict the portfolio quality of financial institutions for the fourth quarter of 2020 and to establish the short- and long-term dynamics.

To achieve the proposed objectives, this work begins with a first part that corresponds to the review of the scientific literature related to the subject, the second part to the methodology used, the third part to the results, and finally a fourth part dedicated to the conclusions.

2. Literature review

The history of Latin American countries, most of them considered emerging countries, is covered with events that allow discerning about the relationship between the private banking behavior, particularly the portfolio, and macroeconomic indicators fluctuations that determine the economy, such as the Gross Domestic Product - GDP, both at the international and national level. Authors such as (Gómez-González et al., 2012) state that the existing literature refers to two apparently contradictory currents: that of Levine(2003) who advocates a positive effect on financial intermediation [as greater availability of domestic credit, for example] on the growth of the Gross Domestic Product (GDP), i.e., financial development

precedes GDP growth (Blasco-martel et al., 2018); and that of Schneider and Tornell (2004) who defended the existence of destabilizing effects of financial liberalization, which can lead to an excessive expansion of credit, an approach reaffirmed by (Ibáñez Hernández et al., 2009) in their research, where they proposed that events such as a slowdown in economic growth or adverse variations in the real interest rate, inflation or the exchange rate, will cause an immediate deterioration in credit risk indicators, resulting in portfolio delinquency.

However, it is considered that there are theories where both currents converge in financial crisis situations where random events and information asymmetries are the order of the day. It is in this context that portfolio quality indicators are influenced by general credit conditions, risk preferences, and macroeconomic shocks (Romero, 2015). These factors in the credit market imply that credit policies in the financial system are less restrictive, which translates into lower levels of credit quality in the future.

Among financial crises' antecedents and the GDP/portfolio ratio behavior, perhaps the most studied case at the international level has been that of Argentina, where it could be demonstrated that macroeconomic instability has a direct impact on the financial development of private financial institutions. It has adverse effects on the real performance of economic growth (Burdisso et al., 2016). In particular, the author found that high inflation affects the domestic currency as a value store, which leads to a decrease in contractual terms and a contraction process of financial transactions, especially credit transactions, giving this phenomenon the name "A perverse Tobin effect".

On the other hand, Bolivia presented in the last decade significant improvements in its GDP per capita levels, but although the financial system has been consolidating in the country, the author (López Justiniano, 2016) concludes that it has not been the main source of GDP per capita growth in Bolivia, but because the financial crises of the 1980s have annulled the positive impact found both theoretically and empirically between financial development and long-term economic growth. But contrastingly, more currently, the legislation could be generating 'liar prices' with respect to the interest rates offered to the productive sector, preventing the banking system from correctly allocating resources.

In Venezuela, before the political crisis, (Urrutia Claudia & Alberto, 1998) showed that the financial system is a good reflection of what is happening in the rest of the economy because factors such as growth, translated into the gross domestic product, inflation rate, unemployment rate, and savings. They are variables that show some relationship with the financial intermediation development in Venezuela. And in Ecuador, (Cuascota Méndez, 2018) through the econometric model's application, using the Least Squares method, found that macroeconomic aggregates such as GDP, trade balance, money supply, and liquidity have a direct impact on private banking behavior, especially financial indicators such as liquidity and credit portfolio of these institutions.

Particularly in Colombia, the intensity with which portfolio quality indicators have deteriorated has varied over time. Before the pandemic caused by Covid 19, there were two recessionary periods [the turn-of-the-century crisis and the international financial crisis] in which a significant deterioration was observed, but of different intensity in the credit quality indicator due to regulatory modifications such as the countercyclical provisions established in 2007, the financial system greater soundness and the capacity to carry out countercyclical policies (Romero, 2015). Among the studies found in the country, the one by (Gómez-González et al., 2012) stands out. It uses a VAR model for the total portfolio quality indicator to find a significant impact of GDP on credit quality, confirming the hypothesis put forward in this research.

3. Methodology

This paper's objective was to examine the relationship between the macroeconomic variable production and the quality of financial institutions' portfolios in the period 2011-2020, using GDP and the traditional portfolio quality indicator. It is defined as the proportion of non-performing loans in the gross portfolio, respectively. The above, to be able to make predictions using an Error Correction Econometric Model [ECM] that shows the long and short-term dynamic relationships between these two variables, so this work is clearly framed in time series econometrics. The data to be used corresponds to quarterly statistical information on the two variables for the period between January 1, 2011, and September 30, 2020, which will be processed with the Eviews 10 program.

Firstly, since this is longitudinal information, the observations data show a natural ordering with respect to time, and therefore it is very likely that there are inter-correlations between successive observations. It causes the so-called autocorrelation between residuals, violating one of the Classical Linear Regression Model assumptions [CLRM]; secondly, for this time series information type, it is essential to determine whether they are stationary, because if the series is not stationary, autocorrelation problems may arise (Gujarati & Porter, 2010).

In addition to the above, it is necessary to avoid spurious regressions that are identified by presenting good fits represented by very high R² and with a non-significant relationship between the variables involved. Where the errors are non-stationary for this reason, it is recommended to first investigate whether the variables involved are compatible with each other in a linear relationship (Montenegro García, 2007). This requires that, before starting the model estimation with time series information, tests about the stationarity of the variables should be executed to determine the integration order (Gujarati & Porter, 2010). Thus, when the series in levels are non-stationary but are stationary in their first differences, they are said to be integrated of order 1 or simply I (1), which can be generalized to order N [N > 1] if N-fold differencing is required to achieve stationarity.

For the specific case of the I (1) series, Engle & Granger (1991) showed that the linear combination of this series type can be stationary I (0). According to Montenegro García (2007), this means that when there is a long-run equilibrium mechanism, the linear combination of two or more non-stationary variables can produce a stationary one if they have the same order of integration. When this happens, it is said that the variables are co-integrated and, in this case, there must be an Error Correction Mechanism, a kind of automatic stabilizer that preserves the long-run equilibrium between them (Granger, 1984).

3.1 The VAR model

The Vector Autoregressive model, called VAR, together with the Autoregressive Integrated Moving Averages model called ARIMA, also known as Box-Jenkins, is considered one of the most popular methods at present for forecasting economic variables. Since the predictions are very good and, in many cases, exceed those of more complex simultaneous equation models (Gujarati & Porter, 2010). Assuming that there are M variables and that Y_t is the vector that groups them, the set of M equations given in [1] is called VAR(p) Autoregressive Vector:

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-1} + \dots + \Phi_p Y_{t-p} + \epsilon_t \quad [1].$$

Where Φ_0 is a vector $M \times 1$ of constants $\Phi_1, \Phi_2, \dots, \Phi_p$ are coefficient matrices of order $M \times M$ and where the M elements of the vector ϵ_t are individually white noise (Montenegro García, 2007). These models are considered atheoretical since in these simultaneous equations system all variables are considered endogenous, that is, they depend on each other. It is an advantage over other models where the correct theory must be considered to know which variables are endogenous and which are exogenous (Gujarati & Porter, 2010). However, Montenegro García (2007) argues that theory is not entirely absent, as it is required for the choice of the M variables to be used.

3.2 The Error Correction Model - ECM

An Error Correction Model [also called VEC] is a restricted VAR [Vector Autoregressive Model], where the restriction refers to the requirement that the variables considered must be non-stationary and present co-integration (Córdova Olivera, 2014). For his part, Montenegro García (2007) states that an MCE model entails the same philosophy as a VAR. It consists of allowing the data, rather than the theory, to suggest the relationships between the variables. As it is, an SCM is also an equations system, which considers the same M variables, with Y_t the vector that groups them, can be written, according to Montenegro García, 2007, as shown in equation [2]:

$$Y_t = \alpha_0 + \delta_1 \Delta Y_{t-2} + \dots + \delta_p \Delta Y_{t-p+1} + Bz_{t-1} + \epsilon_t \quad [2].$$

Where each element of the vector Bz_{t-1} introduces the correction needed to move the variable Y_t through ΔY_t in the direction that guarantees the maintenance of equilibrium.

3.3 Data and variables

As stated before, the information for this article corresponds to the quarterly time series from the period 2011-I to 2020-III of the variables INCALID and LPIBD, defined as the ratio of the past-due portfolio over the gross portfolio taking the value of the first-day index of the following quarter reported by the Financial Superintendence of Colombia [Superfinanciera] and the Natural Logarithm of the Gross Domestic Product reported by DANE (2021) at constant prices seasonally adjusted, respectively.

4. Results and discussion

In this section, an Error Correction Model is determined. It allows a single equation to observe the long and short-term dynamics between the variables under analysis. The statistical information used in this work, as mentioned above, corresponds to time series, so it is required to establish, following Gujarati & Porter (2010), whether the relationship that exists between the variables is spurious or true.

To this end, we will initially investigate, applying Dickey & Fuller's (1979) unit root test [hereinafter ADF], whether the series is stationary and, if not, specify their integration level. If it is confirmed that they are integrated of the first order $I(1)$, which is very frequent in this information type, it is verified if there is co-integration. It uses the method proposed by Engle & Granger (1991) on the regression residuals with the variables in levels; that is, it is corroborated that the variables converge towards a stationary and stable relationship in the long term, to then estimate the SCM (Gujarati & Porter, 2010) and (Loría, 2007).

4.1 Unit root tests

To determine the stationarity of the series considered, the ADF test was applied to them and their first differences, with the results shown in Table 1, in which the INCALID and LPIBD variables in levels are not stationary, since the null hypothesis that the series has a unit root cannot be rejected at 5% significance; that is: (Prob: 0.9047 and 0.2613 are greater than 0.05). On the other hand, the series in their first differences are stationary, since the null hypothesis is rejected with the same significance, given that the values [Prob: 0.0002 and 0.0000] are less than 0.05, therefore they are integrated of order 1: $I(1)$.

Table 1. Tests of unit roots applying Augmented Dickey-Fuller

Variables	Adj. t-Stat	Prob.*
INCALID	-0,367594	0,9047
LPIB	-2,059998	0,2613
Δ INCALID=D(INCALID)	-5,071254	0,0002
Δ LPIB=D(LPIB)	-5,894071	0,0000

*MacKinnon (1996) one-sided p-values. Δ : Primera diferencia de la serie
Ho: Variables (INCALID, LPIB, Δ INCALID, Δ LPIB) tienen raíz unitaria

Source: Own elaboration with the results of Eviews 10 (2021).

4.2 Co-integration

Since the series in levels are not stationary, it is necessary to determine using the Engle-Granger test if they are co-integrated, for which initially the linear model of equation [3] must be adjusted by means of Ordinary Least Squares - OLS.

$$LPIB=c_0+c_1INCALID+u \quad [3].$$

The estimation results of the equation model (9) are shown in Table 2, which also reveals that the partial regression coefficients are statistically significant at 95% confidence since the probabilities of the t-statistics are less than 5% (0.05) and the goodness of fit measured by the adjusted R² of 55.3%.

Table 2. OLS fit results of the $LPIB=c_0+c_1INCALID+u$ model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11,91588	0,040881	291,4783	0,0000
INCALID	0,075614	0,010910	6,930629	0,0000
R-squared	0,564878	Adjusted R-squared		0,553118

Source: Own elaboration with the results of Eviews 10 (2021).

The residuals of this RESID1 regression are now examined again, for which the Augmented Dickey-Fuller unit root test is applied again. The results are shown in Table 3, which allows rejecting the null hypothesis of unit root given that the probability associated with the t-statistic is less than 5% (0.05) and indicating stationarity in the residuals.

Table 3. Results of ADF unit root test on RESID1

Null Hypothesis: RESID1 has a unit root	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3,104601	0,0346

*MacKinnon (1996) one-sided p-values.

Source: Own elaboration with the results of Eviews 10 (2021).

In addition to the above, the null hypothesis of residual normality can be accepted according to the Jarque-Bera test. It shows a probability of 0.392445, which far exceeds the significance level of 0.05 [see Figure 1].

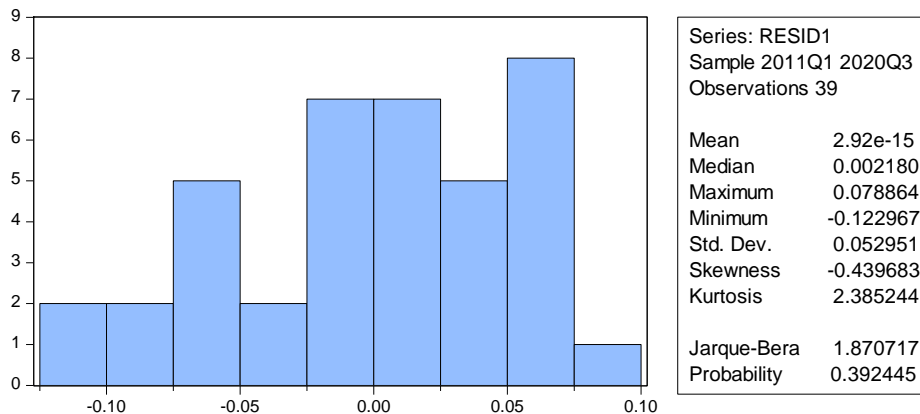


Figure 1. Normality test on RESID1. Source: Own elaboration with the results of Eviews 10 (2021)

4.3 SCM estimation

The above results confirm that co-integration between the variables under analysis does exist and, therefore, the SCM model can be estimated, for which we begin by determining the lags number to be incorporated.

4.3.1 Number of lags

Table 4 shows the results of the five criteria application (LR, FPE, Akaike, Schwarz, and Hannan-Quinn respectively) to choose the lags number that the SCM model should contain. All criteria indicate that three lags should be selected, so we proceed to estimate the SCM with the same number of lags.

Table 4. Results of lags according to criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	17,76532	NA	0,001428	-0,875851	-0,787878	-0,845146
1	71,15995	97,89015	9,19e-05	-3,619997	-3,356077	-3,527882
2	76,36665	8,967104	8,62e-05	-3,687036	-3,247170	-3,533511
3	90,79062	23,23861*	4,86e-05*	-4,266146*	-3,650333*	-4,051210*

* Indicates lag order selected by the criterion

Source: Own elaboration with the results of Eviews 10 (2021),

4.3.2 Estimation of the SCM

The MCE is estimated without restrictions, including three lags and constants, both in the VAR and in the co-integration vector. Table 5 shows the value of the co-integration equation coefficient (1 0.177277 -12.85641), statistically significant at 90% confidence, given the calculated value of t [in absolute terms greater than 2] associated with the coefficient, so the estimated co-integration equation under study is the one shown in [4]:

$$LPIBD = 12.85641 - 0.177277INCALID \quad [4].$$

Likewise, Table 5 shows the error correction term [CointEq1] for the equation (of interest in this work) in differences D(LPIBD), which is -0.070719. It is also negative, with a statistical significance of 95% confidence. This means that 7.07% of the discrepancies between the short- and long-term LPIBD are corrected in one quarter.

Considering the value of the t-statistic, which is less than 2 [in absolute terms], the coefficient of D(INCALID) is not statistically significant at 95% confidence. However, it should be noted that according to Montenegro García (2007), the significance of some coefficients should be viewed with certain flexibility or tolerance, given the frequent multicollinearity among the explanatory variables.

Table 5. ECM estimation results

Cointegrating Eq:	LPIBD(-1)	INCALID (-1)	C
CointEq1	1,000000	0,177277 (0,08854) [2,00231]	-12,85641
Error Correction:		D(LPIBD)	D(INCALID)
CointEq1		-0,070719 (0,03027) [-2,33663]	-0,220073 (0,12496) [-1,76113]

Errores estándar en () y estadísticos t en []. Source: Own elaboration with the results of Eviews 10 (2021).

In addition, tests were applied to detect possible problems of residual non-normality, autocorrelation, and heteroscedasticity. It reveals that the null hypotheses of residual normality, serial non-correlation, and non-heteroscedasticity can be accepted in the MCE model.

Finally, the Granger causality test is applied, the results of which are shown in Table 6. It indicates that the null hypothesis that INCALID does not cause LPIBD in the Granger sense cannot be rejected, while the opposite non-causality can be rejected, and therefore it is

accepted that LPIBD causes INCALID in the Granger sense, thus validating the prediction of INCALID using LPIBD.

Table 6. Granger causality test results

Null Hypothesis:	Obs	F-Statistic	Prob.
INCALID does not Granger Cause LPIBD	37	0,54919	0,5828
LPIBD does not Granger Cause INCALID		4,53878	0,0184

Source: Own elaboration with the results of Eviews 10 (2021).

4.4 Predictions

For the fourth quarter of 2020, the estimated MCE model predicts the following values for each of the variables, as follows: INCALID = 2.762117 and LPIBD = 12.296093 [GDPD = 218,839.5 and GDP = 235,489.1].

5. Conclusions and Recommendations

The financial portfolio quality is related to economic performance and particularly to the behavior of Colombian production in the second decade of the 21st century.

According to the literature consulted and referenced in previous works, it can be concluded that financial development encompasses not only the fulfillment of the financial system's functions but also penetrates the country's economic development. This paper confirms this by demonstrating that the natural logarithm of the seasonally adjusted gross domestic product [LPIBD] adequately explains the behavior of the portfolio quality indicator [INCALID].

The series used in this work for the period 2011-I to 2020-III, which correspond to the natural logarithm of the seasonally adjusted gross domestic product [LPIBD] and the portfolio quality indicator [INCALID], turned out to be non-stationary in levels but integrated order one I (1). It was demonstrated with the repeated application of Augmented Dickey-Fuller unit root tests. This made it possible, by means of the Engle-Granger method, to determine that the series in this work are co-integrated. In turn, this co-integration allowed the estimation of an Econometric Error Correction Model (ECM) that reveals the short and long-term dynamics between the variables.

Finally, tests were applied to detect possible problems of the MCE model on residual non-normality, autocorrelation, and heteroscedasticity. It yielded results indicating that the estimated MCE model could be adequately used to make predictions on the INCALID portfolio quality variable, considering the results of the Granger causality test, which is useful information for economic agents.

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