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Non-Performing Loans in Latin America: determinants and macroeconomic effects

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Abstract

The paper investigates the determinants of non-performing loans in 13 Latin American countries using a panel data approach from 2005 to 2017. The study demonstrates that macroeconomic and bank variables are statistically significant through the estimation. Further, in order to determine the feedback effects of NPLs and economic activity, the Vector Autoregressive (VAR) model is employed with Impulse Response Functions (IRFs). The results suggest that exist strong interactions between the real economy and banking system.

Keywords: Non-Performing Loans; Determinants; Feedback effects; Latin America

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1. Introduction

Over the past two decades, specially after the 2008 crisis, policy makers, economists and financial institutions have faced a growing issue concern about the high level reached of non-performing loans. In fact, several financial crisis are related to these loans, in which understanding the causes of NPLs can be crucial to improve banking performance and economic growth around developed and emerging markets. For many analysts, these loans are a measure of credit risk, and a great amount of the bad loans can result in bank failure and economic stagnation. According to European Central Bank (2017), NPLs have impacted negatively on banks profitability, balance sheets and capital constraints, hampering their lending operations and capabilities. Over past years, the current crisis emphasizes the importance of correlating macroeconomic conditions to the health of banking system and loan quality. With this rising concern, several studies with different estimation models have tried to identify the factors that contribute to the expansion of bad loans.

In general, non-performing loans have different definitions across countries, however it can be evaluated as when interest or principal payments are overdue by 90 days or more or when payments are less than 90 days overdue, but the debtors have cast doubt the ability the other counterpart will not pay off completely in full (IMF, 2005). In this case, borrowers have failed to carry out the contractual deal under the law for a pre-determined period. On the other hand, NPLs has been difficult to interpret since there is no universal standard definition among the economies. According to

Moreover, the deterioration of credit quality of the loan portfolios has been important to bank in order to develop strategies to prevent fluctuations in NPLs levels, in which can reduce the profitability, liquidity and solvency of banking industry in a country. Regarding the latter, these loans also can affect negatively private investment and private consumption that could mitigate into an economic slowdown. Additionally, globalization interconnectedness, trade blocks and integrated financial markets can expand the economic crisis and financial shocks into several economies. In fact, the financial integration across economies has evolved rapidly, in which this global financial interconnectedness can amplify the increase the propagation of shocks, jeopardizing the financial stability. Therefore, it is important that policy makers manage quick responses in the post-crisis period in order to stabilize the deterioration of asset quality among

micro and macro variables determinants. Hence, among the studies it exits a common finding a relationship between economic growth and asset quality is positive, (Beck et. al 2013).

The research focuses on Latin American region, which used a panel data sample of 13 countries from 2005 to 2017. The first purpose of this thesis is to investigate the major determinants of non-performing loans at macroeconomic and bank-specific levels. The second is to analyze the interactions between the macroeconomic performance and non-performing loans. In fact, several studies have investigated the determinants of NPLs in different areas such as: Baltic States, Advanced economies, Central and European, Sub-Saharan Africa, Guld Cooperation Council, Asia, Eurozone and Middle East and North Africa region etc. Nevertheless, this is one of the first empirical studies to cover macroeconomic and bank factors in Latam region in past years.

This study is structured in the following manner: Section II demonstrates the literature findings over different workings papers and the empirical results on both macroeconomic and bank-level determinants of NPLs over the real economy. Section III discusses briefly the banking industry overview and its interactions. Section IV presents the data, the different methodologies Fixed Effects and Generalized Methods of Moments (GMM) to estimate the econometric outputs through the balanced panel data discussion of the results. Section V demonstrates the relationship between NPLs and macro-linkages of the real economy. Section VI describes the concluding remarks and policy implications.

2. Literature Review

First of all, there are plenty of articles and working papers worldwide in past few years, attempting to identify the macroeconomic determinants and bank variables that affects the non-performing loans. The relationship between the major quality of the loans and macroeconomic indicators has been studied in the literature since past few years more data is available at bank, country and aggregate banking system level. Therefore, the association of the credit risk, bank crises and non-performing loans led to vast number of papers and model techniques aiming to detect the variables that have impact on these NPLs.

Espinoza (2010) conducted a study analyzing 80 banks at GCC (Gulf Cooperation Council) over 1995-2008. Firstly, they found out that NPL ratio expand when non-oil GDP growth reduces, or the interest rate increases. In addition, as for bank-specific factors the credit growth, size of capital

and efficiency play an important role determining the effect on non-performing loans. Secondly, using a VAR (vector autoregression) model, he investigated a feedback from the banking system to the real economy.

Furthermore, Nkusu (2011) divided his research into two parts: Firstly, examined the determinants of NPL using panel regressions in 26 advanced economies from 1998 to 2009. The study states that the deterioration of unemployment and GDP growth has a negative impact in banking system and credit quality. Secondly, he investigated through a VAR model the relationship between macro-financial factors and NPL claiming that credit to private sector, financial shocks to asset prices and macroeconomic performance undermine and trigger bad loan quality among developing countries.

According to Lee and Rosenkranz (2019), the studies employed a data sample covering data of 165 commercial banks in 17 emerging Asian markets from 1995 to 2014. Firstly, they applied the fixed effects model to analyze bank heterogeneity and therefore the GMM (generalized method moments) to use lagged level of regressors and level differences as factors. Their estimations point out that inflation rate, GDP growth, unemployment rate, a measure of global risk aversion VIX, considered the ticker symbol of the Chicago Board Options Exchange Volatility Index, and currency exchange are significant macroeconomic variables among all estimations employed. Additionally, banks with low capital and less profit were considered to have greater NPLs Asian economies. The results shows that profitable banks have almost no incentives to commit into high credit risk behavior preventing the rise of NPLs ratio in the following years.

Similarly, Kjosevski and Petkovski (2017) performed a research over 27 banks from the Baltics states from 2005 to 2014 in order to determine macroeconomic and bank determinants of NPLs using a GMM difference estimation. They considered that domestic credit to private sector, inflation, GDP, unemployment, ratio of net income to total equity (ROE), ratio of equity to total assets (ETA), growth of gross loans and ratio of net income to total assets (ROE) as major determinants of non-performing loans in that region. Indeed, a dummy variable for global economic crisis demonstrated to have the greatest impact on the deterioration of loans in Baltic states, hampering the improvement of some economic indicators.

What is more, Louzis, Vouldis and Metaxas (2010) analyzed the determinants of NPL for different types of loans such as: mortgages, consumer loans and business loans into the Greek banking industry from 2003 to 2009. They used a panel data analysis for the 9 largest Greek banks to identify the macroeconomic and bank factors that impact the loans. Their study shows that interest rate unemployment, GDP, public debt, and management quality are the main determinants that have effect on Greek loans. In addition, they claim that to prevent crisis cycles the regulators must emphasize their efforts on risk management systems and procedures in order to improve the stability of financial system.

Skarica (2013) conducted a study to evaluate the determinants of NPL for 7 Central and Eastern European (CEE) economies over 2007-2012. After 2008 crisis, the economic slowdown hit in a unprecedent way the CEE region suffering a negative annual GDP growth in 2009, contributing to increase the NPLs and deteriorate the economy recovery in the following years. The results reveal that the economic downturn is the major determinant to increase the NPLs level, in which the GDP growth had been the main factor to contribute to this NPL process. Also, the inflation rate was found to play a significant role to expand non-performing loans. Skarica (2013) asserts that banks in these markets face an ambiguous result when they tried to recover the economic development through expansionary monetary policy. Firstly, this move would increase the aggregate demand and GDP, on the other hand it would increase the inflation and NPLs.

Fofack (2005) investigated the macroeconomic and microeconomic determinants of NPL in Sub-Saharan Africa countries from 1993 to 2002. His research included a panel data analysis of 16 countries applying Granger causality and correlation analysis, between economic variables and non- performing loans. Indeed, the results reveal that GDP per capita growth, real exchange rate, interest rate and broad money are the main drivers to determine non-performing loans. Additionally, the author points out that high NPLs can deteriorate capital and significant assets of banks in Sub-Saharan Africa region.

Makri and Tsagkanos (2014) attempted to measure the factors that influence the NPL into Eurozone banking system over 2000-2008. They selected 14 economies with 120 observations and examined the determinants of NPL at pre-crisis period, applying GMM (generalized method of moments). Hence, the findings of macroeconomic variables are that GDP, public debt and unemployment plays a significant role affecting the non-performing loans. At bank-specific factors perspective,

the ROE (return on equity), non-performing loans of previous year and capital ratio (bank capital divided to reserves to total assets) have influence on NPLs. They claimed that these outputs emphasize some fiscal problems those countries might have had, which deteriorates the loan efficiency.

In another study, Klein (2013) investigated 16 countries from Central, Eastern, and South-Eastern Europe (CESEE) in the period of 1998-2011. First of all, the results suggests that high inflation, unemployment, global risk aversion (VIX) and exchange rate indicates a positive relationship with NPLs, however GDP growth has a negative impact on them in this analysis. Besides, among bank variables, the return on equity (ROE), the loan-to-asset ratio are significantly associated to level of NPLs. In addition, a second analysis using VAR performed implying that high credit and GDP contribute to low levels of NPLs while a positive inflation shock result in higher NPLs.

3. Banking System Overview

In fact, the six largest banks in Latin America accounts for three quarters of total banking system assets. Brazil represents the largest banking system economy as share of GDP, followed by Chile and Uruguay in the second and third position respectively. The Banco Itaú (Brazil) led the rank with US$ 378 billion value of assets representing nearly the whole Mexican and Colombian banking system (Statista, 2019), in which past few years has expanded its operations among Latam markets. For instance, Latin America banking sector is greatly concentrated, with Chile, Mexico, Brazil, and Colombia holding half of the banking assets by the three largest banks in those countries, in which may contribute to have impact on the spread and loan rates affecting negatively the consumers lending (Enoch et al. 2016). As a result, the elevated concentration is constituted as potential barriers to regional bank entry and as a high risk of financial distress, mainly because of the size of the market. Despite that, since the liberalization period in 1990s that resulted in the openness to foreign bank, the Latam markets have been regognized as more financial integrated until the global financial crisis (GFC) in 2008. However, after the subprime mortgage crisis in 2008, several global banks, such as HSBC, Canadian Imperial Bank, Deutsche Bank, JP Morgan, Credit Agricole started withdrawing and downsizing their operations from Latin American countries increasing the consolidation of local banks mainly through Mergers and Acquisitions process (Enoch et al. 2016). Furthermore, some Latam economies still hold a significant level of

macroeconomic instability and inflation that affect straightly the credit cycle, increasing the consequences of final distress and loss of purchasing power of bank deposits (Suarez e Amado, 2014). Banking crises are a constant phenomenon cycles that needs further explanation nowadays. In addition, Latam banking crises have been analyzed from macroeconomic outlook, currency cycles, foreign capital inflows, sovereign debt crises and regulatory institutions. In addition, the increase value of private debt has contributed to banking crisis, (Esquivel et al. 2019). Moreover, in past recent years with the end of commodity cycle and economic slowdown in China, the high concentration of banking system plays an important role in the improvement of GDP.

4. Determinants of Non-Performing Loans

Description of variables and Expected sign

Macroeconomic Variables

Empirical studies have commonly used country-specific macroeconomic indicators to address the level of loans in the banking sector. Therefore, the macroeconomic variables selected broadly support the literature and are structured as follows: GDP growth, unemployment rate, exchange rate, real interest rate, inflation, public debt to GDP ratio and corruption index.

GDP (***gdp***) – Previous studies have claimed that a growing economy increase the income and enhance the ability of borrowers to repay their debts improving financial stability. For instance, Saurina and Salas (2002) showed that at Spanish banking industry exist a strong negative correlation between GDP growth and NPL, in which credit tend to expand faster during expansion cycles. Furthermore, Nkusu (2012) and Messai and Jouini (2010) illustrated that GDP is one of the key macroeconomic factors that can have significant impact in banking financial distress.

Unemployment (***unem***) – The unemployment rate during economic recession tend to increase the NPLs level, because more citizens have fewer resources to pay their debts. For instance, the unemployment rate contributes significantly to greater NPLs among banks in emerging Asia in pre and post global financial crisis (Lee and Rosenkranz,2019). In addition, Louzis and Metaxas (2010) stated that the unemployment rate has a strong effect on the level of NPL in the Greek banking sector. During economic deterioration and financial distress macroeconomic measures to reduce

the impact of unemployment rate can play an important role to attenuate the negative impact on financial system.

Exchange Rate (***exr***) – The exchange rate is expected to be negatively associated to NPLs level, mainly in countries that have a significant amount of their debts foreign currency. In this case, an increase in exchange rate represents a depreciation of local currency against U$ dollar. For instance, Klein (2013) demonstrated that the exchange rate depreciation against euro had a significant negative impact on asset quality in Central and Eastern and South Eastern (CESEE) countries. Furthermore, Lee and Rosenkranz (2019) asserted that exchange rate has played an important role attempting to explain the rise of NPLs level in emerging Asia. Hence, an increase in the exchange rate (local currency depreciation against US dollar) is expected to impact on greater NPLs levels in Latin American countries.

Real Interest Rate (***rit***) – In general, higher interest rates is expected to weaken the capacity of borrowers to pay off their debt. Fofack (2005) claimed that the real interest rate is important determinant to increase the deterioration of loans in sub-Saharan African countries. Additionally, Louzis (2012) stated that in equilibrium state, the interest rate impact on the capacity in serving debt, when it exits loan floating rate, which should lead to higher NPLs level in Greece. On the other hand, Malvar and Pascual (2020) analyzed a negative relationship between NPL and real interest rate in Latin American countries. They explained that Latin American banks functionate better with higher interest rates where they usually allocate better their assets contrary to European economies.

Inflation (***inf***) – Through previous studies inflation rate has been pointed out determinant of NPL level, however the findings denote an ambiguous effect that diverge through scholars. For instance, Lee (2012) asserted that inflation can reduce the real value of outstanding loan, nevertheless, on the other hand can deteriorate the real income reducing the debt capacity of borrowers. Furthermore, Petkovski and Kjosevski (2017) found out the same results with ambiguous effects, which have impacted on both economic activity and real interest rate in Baltic States.

Public Debt ratio (***debt***) – The public debt as percentage of GDP can be addressed positively related to NPLs. In fact, the high public debt deteriorates the government's fiscal budget and loan quality

of the economy. For instance, the Makri, Tsagkanos and Bellas (2014) showed that the public debt ratio worsens the loan portfolio capacity in the Eurozone for the period 2000-2008.

Corruption Index (***corrupt***) - Over the years, substantial amount of corruption has been under investigation in Latin American countries. According to Transparency International Organization (2019), huge scandals have been released at media such as: Lava Jato in Brazil, La Estafa Maestra in Mexico, Notebooks in Argentina etc, which increases the probability of banking financial distress. Following this purpose, the score for the Freedom of corruption index (***corrup***) is originated from the Transparency International company in order to determine the level of corruption. For instance, Son (2019) found significant results that the corruption has deteriorated the quality of banking system in 120 countries from 2004 to 2017.

Bank-Specific Variables

The determinants of NPLs must not be analyzed only macroeconomic factors perspective, since they are presented as exogenous forces impacting on banking industry. Berger and DeYoung (1997) investigated as a pioneer how the non-performing loans are linked to inefficiency in banking sector employing a data sample of U.S commercial banks from 1985 to 1994. In fact, they applied the Granger-causality analysis in order to establish the four main hypotheses that report the relationship among financial capital, problem loans and cost efficiency.

1. ***Moral Hazard*** hypothesis refers to banks with significant low capital tend to increase the riskiness of their loan's portfolios, which implies in enlarging the volume of non-performing loans.
2. ***Bad Management*** hypothesis identifies the poor management practices, related to a bad day-to-day operation to be associated with a high proportion of non-performing loans. In fact, poor managers skills in monitoring borrowers, credit scoring, and evaluating the value of collateral against loan would contribute to a low cost of efficiency.
3. ***Bad Luck*** hypothesis is considered as exogenous force, conducted mainly by external events and deterioration of macroeconomic condition result. Following this purpose, the external forces result in bank extra operating costs weakening the cost of efficiency and expanding the level of non-performing loans.

4. ***Skimping*** hypothesis states that high cost of efficiency can increase the NPLs due to few resources allocated to monitor and underwrite lending risks. According to this view, there is a trade-off between banks that may seem cost efficient in the short run devoting less effort to control and monitor borrowers but, at the same time, they can face the consequences in the long run with higher NPLs

Across literature several academics have employed the CAMEL (Capital, Asset Quality, Management, Earnings, and Liquidity) rating system that attempts to set up five variables that explain bank-risk variables that have influence on non-performing loans. At this paper, five variables are chosen following the CAMEL technique:

1. Capital (Adequacy) - The Capital Adequacy Ratio (***car***) denotes the amount of capital available associated as a percentage of bank's risk weighted assets as credit exposure of the financial institution such as operational risk, credit risk and market risk. Tsagkanos, Makri and Bellas (2013) showed that capital adequacy ratio is related to risk operational activities and therefore tend to increase the level of NPLs. The CAR is related to 'moral hazard' and its calculation consists by dividing the bank's capital by its total weighted assets.
2. Asset (Quality) - Banks with poor asset quality must be concerned with the negative effects on their balance sheets. In the literature, different measures of asset quality have been analyzed over the years such as: the loan provision ratio to total average loans, the non-performing loan as percentage of total gross loan and the sectoral distribution of total of loans to total loans, (Betz et al. 2013). However, due to limited amount of data in Latin America countries, this paper does not consider as a proxy to set as a determinant of NPLs.
3. Management Quality - The management measures the performance of the senior managers in scenarios over financial distress. It is the capability of the board of directors to control and identify risk activities in order to adopt safe operations. Moreover, the Cost to Income (***costin***) is able to measure the management efficiency and its ratio is the operating expenses as percentage of operating income. Malvar and Pascual (2020) showed that exist a positive relationship between NPL and Cost to Income in Latin American markets. Thus, it is expected to have a positive sign.
4. Earnings (Profitability) - Earnings and Profitability indicators are employed to assess the financial health and evaluate how efficient the banks are using their assets to generate

earnings over the years. Subsequently, it can infer that more profitable banks may be less prospect to undertake risk operations over time. The Return on Equity (***roe***) and Return on Asset (***roa***) are selected to be part of the econometric analysis, which point out how much of profits the banks can generate from shareholders investment and available assets respectively. Across several researchers the ROE and ROA indicators have been correlated negatively with NPLs. Klein (2013) asserted that ROE contributes to lower NPLs in Central, Eastern, and South-Eastern Europe over 1998-2011 period. Additionally, Fofack (2005) indicated that ROA is one of the bank determinants of NPL in Sub-Saharan Africa region from 1993 to 2002. Hence, ROA and ROE are expected to have a negative impact on NPL.

5. Liquidity -The liquidity ratio demonstrates the degree of a bank to meet its financial obligations. In this case, the Loan to Deposit ratio (***credtdep***) measure the ability of a bank to convert funds from deposits into loans. For instance, high levels of Loan to Deposit demonstrates that banks have less resources to lend, which would deteriorate their profit margins and increase debt. According to previous studies such as Tsagkanos et. Al. and Louzis et. al (2010) the loan to deposit ratio is expected to have a positive sign.

Table 1. Variables

Symbol	Macroecomic variables	Expected Sign
GDP	GDP	(-)
UNEM	Unemployment	(+)
INF	Inflation	(-) (+)
RIT	Real Interest Rate	(-) (+)
EXR	Exchange Rate	(-)
DEBT	Public Debt	(+)
CORRUP	Corruption	(+)
	Bank-Specific variables	
ROA	Return on Asset	(-)
ROE	Return on Equity	(-)
CREDTDEP	Credit to Deposit	(+)
COSTIN	Cost to Income	(+)
CAR	Capital Adequacy	(+)

Source: Author´s own

Data

In this study, panel data techniques are employed to analyze the effects of macroeconomic and bank factors on the quality of bank loans in 13 countries from Latin American region over 2005-2017. The countries selected have 169 observations in total and the data was extracted from The Global Economy, Federal Reserve Economic Data and World Bank Data. According to the literature review, disaggregate (individual bank) data and aggregate have been used over last years with both providing similar results. In this thesis, the aggregate level of banking system is used in order to reduce bias related to some missing values for some countries. For this purpose, Venezuela, Puerto Rico, Cuba, Haiti, and El Salvador were excluded in this analysis due to a vast of the missing data of banking variables. Boudriga, Taktak and Jellouli (2009) investigated a sample of 59 countries using aggregate data to reduce the representativeness bias in the country level. Moreover, Tsagkanos (2013) used aggregate data in his research to identify the determinants of 14 countries on the pre-crisis from 2000 to 2008.

Table 2. Distribution of observations

Country	Number of observations
Argentina	13
Bolivia	13
Brazil	13
Chile	13
Colombia	13
Costa Rica	13
Dominican Republic	13
Ecuador	13
Guatemala	13
Mexico	13
Panama	13
Paraguay	13
Peru	13
Total	169

Source: Author´s own. Data Source from The Global Economy

The research describes both bank-specific determinants and macroeconomic characteristics. The following data is used:

Macroeconomic variables: include NPL ratio, GDP growth rate (***gdp***), unemployment rate (***unem***), inflation rate (***inf***), real interest rate (***rit***), exchange rate (value of local currency per US dollar, (***exr***), public debt ratio (ratio of debt to gdp, denoted as **debt**) and corruption Index (***corrupt***).

Bank specific factors: contain Return on Asset (***roa***), Return on Equity (***roe***), credit to deposits ratio (***credtdep***), capital adequacy (***costin***), capital adequacy (**car**), and corruption index (***corrupt***).

Table 3. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
NPL	2,35	1,44	0,70	11,30
GDP	4,26	2,99	-5,92	11,98
UNEM	4,86	2,66	2,01	12,82
INF	4,20	4,75	0,10	41,00
RIT	7,61	9,97	-11,60	44,64
EXR	8,07	1406,91	1,00	6177,94
DEBT	36,37	16,16	3,90	82,16
CORRUP	-0,40	0,62	-1,32	1,58
ROA	2,07	1,01	-4,75	5,24
ROE	22,17	7,61	4,67	44,93
CREDTDEP	98,77	40,92	47,09	220,94
COSTIN	61,51	8,49	43,67	82,19
CAR	15,90	2,01	11,70	20,40

Source: Author's estimation

As a result, the data collected presents some outputs in Latam region. For instance, the NPL highest value is observed from Bolivia with 11,30% in 2015 and the lowest value from Panama with 0,7% level in 2012. Additionally, the exchange rate standard deviation of 1406,91 is a high value mainly because of the strong depreciation of national currency against US dollar from Colombia, Costa Rica and Paraguay. The inflation variable displays high disparity from 0,1% to 41% mainly when compared to developed economies, which demonstrates that excessive inflation continues to influence the financial leverage and the quality of banking sector in Latin American countries. With Brazil and Argentina as the main players of an elevated Debt by a mean of 36,37%, the high public debt has increased substantially after 2007-2008 crisis specially because governments have deteriorated their budgets with expansionist fiscal policies, attempting to improve the economy.

In fact, there are several unit roots and stationarity tests applied in panel data analysis in the literature. The author performed a unit root analysis where the null hypothesis is that each time series is a unit root verified against an alternative hypothesis, that all of them are stationary variables. Thereby, the Fisher test for unit root is applied, using Augmented Dickey Fuller (ADF)

and Phillips Perron (PP) at 5% significance level, (Breitung and Pesaran, 2005). Thus, the Fisher test demonstrates that except for unemployment (***unem***), exchange rate (***exr***) and corruption index (***corrupt***) all the other variables are stationarity for the panel data, in which the null hypothesis of a unit root is rejected. However, those three (***unem, exr and corrupt***) variables are stationarity after the first difference application.

Table 4. Stationarity Test - Fisher

	Fisher ADF	Fisher-PP
NPL	89,9	118,63
GDP	79,69	78,89
UNEM	73,33	79,37
INF	56,74	57,41
RIT	75,71	66,28
EXR	50,01	51,46
DEBT	99,52	83,85
CORRUP	87,9	104,41
ROA	77,55	101,79
ROE	50,47	63,44
CREDTDEP	63,84	45,52
COSTIN	73,97	94,84
CAR	68,6	59,14

Source: Author's calculation via Eviews11

Methodology

As mentioned previously, this research aims to determine the factors that have impact on non-performing loans in 13 Latam countries and the feedback effect of NPLs into real economy from 2005 to 2017. Indeed, the model includes seven macroeconomic variables and five bank specific factors regarding the effects on the loan quality. Thereby, we consider three alternative econometric estimation techniques. To begin with, to determine which model is best fit: fixed effects or random effect model, the Hausman test is applied. Secondly, the Generalized Method of Moments (GMM) difference is employed to reduce the potential dynamic panel bias. Lastly, the Vector Autoregression model is used to analyze the feedback from the banking system to the real economy

Panel Data Method

Over the years panel data have been used in applied economic research to quantify the effects in the real world with econometric techniques. To define he determinants that have influence on the

NPLs in the Latin American region, the panel data analysis is selected to that function. Implementing panel data approach can reduce the biases generated by potential heterogeneity and omitted variables problems across data. Indeed, panel data has several benefits compared to other types of data such as: cross sectional and time series data. Hsiao (1986) showed that panel data has many advantages: firstly, this method presents more information, simpler computation, a greater degree of freedom, more viability, more efficiency, and less collinearity among other variables. Secondly, he asserted that panel data demonstrates that individual countries are heterogenous. Additionally, panel data can measure statistical analysis and effects that in time series and cross-sectional are not detectable. As a consequence, panel data can yield more accurate predictions for individual outcomes.

The correlation matrix is applied to the regression model in order to verify the multicollinearity level of variables. When the correlations are very elevated, it can easily lose the true statistical significance of a variable. The correlation analysis between NPL and the explanatory variables is broadly following the economic theory, supporting the expected signs previously stated. In general, the magnitude of correlation among different variables is not considered high in the model, since most of the results are less than 0.5, except between ROA and ROE which is 0,798 and. In fact, Kennedy (2008) asserts that multicollinearity is a problem to the method when the correlation is above 0.8.

Table 5. Correlation Matrix

	NPL	GDP	UNEM	INF	RIT	EXR	DEBT	CORRUP	ROA	ROE	CREDTDEP	COSTIN	CAR
NPL	1,00												
GDP	-0,09	1,00											
UNEM	0,05	-0,18	1,00										
INF	-0,04	-0,14	0,14	1,00									
RIT	0,17	-0,07	0,20	-0,20	1,00								
EXR	0,00	0,00	0,15	-0,02	0,18	1,00							
DEBT	0,26	-0,03	0,35	0,22	0,19	-0,33	1,00						
CORRUP	-0,25	-0,03	0,43	-0,06	-0,06	-0,17	-0,08	1,00					
ROA	-0,14	-0,01	0,07	0,41	0,00	0,21	-0,14	-0,18	1,00				
ROE	-0,11	0,05	0,02	0,38	0,02	0,14	-0,26	-0,18	0,80	1,00			
CREDTDEP	-0,14	-0,02	0,46	-0,19	0,06	0,43	-0,01	0,50	-0,15	-0,24	1,00		
COSTIN	0,24	0,08	-0,05	0,02	0,00	0,14	0,24	-0,39	-0,22	-0,25	0,05	1,00	
CAR	0,17	-0,26	0,29	0,03	0,13	0,22	0,26	-0,22	-0,06	-0,21	0,13	0,28	1,00

Source: Author's estimation

However, to provide further explanations, a multicollinearity test, the Variance Inflation Vector (VIF), is utilized to this empirical analysis. The test quantifies the severity of correlation among independent variables. Following this reasoning, all variables presented Centered VIF are lower than 10 (Table 1A), setting up no multicollinearity problem in the model.

Econometric Models

Fixed Effects x Random Effects

Across literature the Fixed Effect and Random Effect models have been applied to analyze panel data problems. According to Wooldridge (2001), these models are also known Unobserved Effect Models (UEM) and its basic form can be written as:

$$y_{i,\,t} = x_{i,t}\beta + \alpha_i + \varepsilon_{i,t} \qquad t = 1,2...,T.$$

where β is the K x 1 matrix of parameters and $x_{i,t}$ is the vector of observable variables with i indicating cross-section dimension whereas, t demonstrates the time-series dimension. Besides that, α_i is considered as the unobserved effect or unobserved heterogeneity and $\varepsilon_{i,t}$ are the idiosyncratic errors or idiosyncratic disturbances that varies across t and i. The previous papers broadly focus on analyzing whether α_i should be treated as a parameter to be estimated, in this case fixed effect or viewed as random effect. Both FE and RE model assumes that:

$$E(\varepsilon_{i,t} | x_{i,t}, \alpha_i) = 0 \qquad t = 1,2...T.$$

As a starting point, the fixed effects or Least-Squares Dummy Variable (LSDV) model grants heterogeneity or individuality among the individual subjects by allowing that each entity has its own intercept value. In addition, the further fixed effects assumptions are that: it suffers from a great loss degree of freedom and cannot estimate the effects of any time-invariant variable in the panel data analysis (Baltagi,2008). Also, the second assumption is that the model explicitly assumes that the error term and entity´s error are strict correlated among themselves. Originally, fixed effect is used to the causes of changes over entities, however a time-invariant feature cannot provide such change, because it is constant for each entity. Thus, FE assumes that the time invariant characteristics is unique to each individual and can not be correlated with another individuality's characteristics.

Moreover, the random effects model implies zero correlation between the unobserved effect and observed explanatory variables $Cov(x_{it},\alpha_i) = 0$. Besides, the differences across entities are considered as random and the variance of the unobserved effect given all explanatory variables is constant over time (Wooldridge, 2001). To prevent from losing degrees of freedom at the several

parameters of the fixed effect model, the error is assumed as random. Also, the RE outweigh the FE, because time invariant variables can be added into RE such as race and gender, in which the estimators absorb the impact on the time invariant variable.

To continue with, as mentioned previously in order to determine which model is appropriate Fixed Effects or Random Effects, the Hausman Test is implemented to the data. According to Wooldridge (2015), the FE is valid when α_i is correlated to x_{it} however the RE is inconsistent in this case. As a result, the null hypothesis of the test is that the Random Effects is the model selected, with an alternative hypothesis that states the Fixed Effects should be ran into EViews11. The Hausman Test indicates whether unique errors are correlated with regressors of the econometric estimation. The p-value of 0,31%, the null-hypothesis is rejected, and therefore the FE should be performed in the regression estimation.

$$H_0: E(\alpha_i|x_{it}) = 0 \qquad H_1: E(\alpha_i|x_{it}) \neq 0$$

Table 6. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	P-value
Period Random	29,66	12	0,0031

Source: Author's calculation via Eviews11

Furthermore, the appropriate model to be estimated through fixed effects is:

$$NPL_{i,t} = \beta_0 + \beta_1 GDP_{i,t} + \beta_2 UNEM_{i,t} + \beta_3 INF_{i,t} + \beta_4 RIT_{i,t} + \beta_5 EXR_{i,t} + \beta_6 DEBT_{i,t} + \beta_7 CORRUP_{i,t} + \beta_8 ROA_{i,t} + \beta_9 ROE_{i,t} + \beta_{10} CREDTDEP_{i,t} + \beta_{11} COSTIN_{i,t} + \beta_{12} CAR_{i,t} + \alpha_{i,t} + \varepsilon_{i,t}$$

Where: β_0 (i = 1,...169) is the individual time-invariant intercept, β_1 - β_{12} represent the coefficients of independent variables which displays their impact on non-performing loans (dependent variable), $\alpha_{i,t}$ is the unobserved effect, and $\varepsilon_{i,t}$ is the idiosyncratic errors of the model

Table 7. Fixed Effects Model

Variable	Coefficient	Std.Error	P-Value
C	3,636	1,443	0,013
GDP	-0,114	0,047	0,017
UNEM	0,066	0,059	0,027
INF	-0,025	0,030	0,409
RIT	0,009	0,012	0,046
EXR	0,000	0,000	0,675
DEBT	0,011	0,011	0,287
CORRUP	-0,961	0,330	0,004
ROA	-0,095	0,176	0,589
ROE	-0,019	0,026	0,038
CREDTDEP	0,002	0,005	0,610
COSTIN	-0,005	0,016	0,742
CAR	-0,048	0,065	0,162
R-Squared	0,5659		
Ajusted R-Squared	0,4936		
Observations	169		
Periods Included	13		

Source: Author's calculation via Eviews11

Discussion of the results

To begin with, the results of fixed effects model reveal that at a level of 5% significance the GDP, UNEM, RIT, CORRUP and ROE are considered statistically significant reflecting in the NPL level over Latin American countries. At bank-level indicators, ROE indicates that the profitability in banking system plays an important role in problem loans, which is negatively related to NPL level. By magnitude one unit point increase in ROE level would lead to 0,019 percentage points decline in non-performing loans. Additionally, the macroeconomic variables implies that one percentage point increase in GDP, UNEM, RIT and CORRUP indicates 0,114 contraction, 0,066 increase, 0,009 increase and -0,961 increase percentage points in NPL level respectively. Thus, the justification of this macroeconomic relationship is that: the improvement of GDP denotes rising incomes enhancing the debt servicing capacity of borrowers, reducing the potential financial distress. Second, the higher is the unemployment rate, the greater is the deterioration in economic labor activity, reducing the capacity of borrowers to pay off their financial obligations. Additionally, the real interest rate was previously stated to have an expected ambiguous sign. Nevertheless, the loan rate in most cases is attached to the real interest rate, consequently affecting the ability to service the debt. Lastly, the corruption index results confirmed that the corruption deteriorates the bank's asset quality and hampers the economic growth.

Generalized Method of Moments

Arellano and Bond (1991) proposed GMM difference, known as one-step estimator, uses past lagged levels as instruments in the model. Afterwards, Arellano and Bover (1995) and Blundell and Bond (1998) elaborated GMM system, two-step estimator. Under both GMM estimations the lagged dependent variable is included, assuming that the number of instruments does not surpass the number of cross-sectional units in the panel data sample. At this study, the equation is analyzed using the first difference of Generalized Method of Moments developed by Arellano and Bond (1991). The difference GMM implements Hence, this technique is based on the first difference transformation of equation in order to remove the unbiased results from fixed effects model and to implement the lagged levels of the regressors as instruments variables (IVs). Thus, the bank-specific variables are treated as endogenous variables and the macroeconomic variables as exogenous variables.

The selection of this method follows previous empirical studies such as: Tsagkanos et al. (2013), Petkvoski et al. (2016), and Nkusu (2011). According to Owen and Judson (1999), Monte Carlo studies have demonstrated that the GMM difference model outperforms the GMM system model (two-step estimator), which in small samples tend to generate results with smaller standard deviation and bias. In addition, the Sargan test proposed by Arellano and Bond (1991), aims to identify the validity of the instruments in the model. Hence, the null hypothesis is that all the instruments are valid when the p-value is greater than 5%. The equation is structured as follow:

$$NPL_{i,t} = NPL_{i,t-1} + lB_{i,t-1} + dM_{i,t-1} + u_{i,t-1}$$

$$u_{i,t-1} = \alpha_{i,t-1} + \varepsilon_{i,t-1}$$

Where $NPL_{i,t-1}$ indicates the lagged dependent variable, $B_{i,t-1}$ the lagged vector of bank-specific variables, $M_{i,t-1}$ the lagged vector of macroeconomic specific variables, and u_{i-t-1} denotes $\varepsilon_{i,t-1}$ the idiosyncratic errors and $\alpha_{i,t-1}$ the unobserved effects.

Table 8. GMM Difference Model

Variable	Coefficient	Std. Error	P-Value
NPL (-1)	0,704	0,034	0,001
GDP	-0,031	0,065	0,006
UNEM	0,061	0,042	0,143
INF	0,079	0,044	0,073
RIT	0,248	0,009	0,001
EXR	0,035	0,071	0,023
DEBT	0,030	0,010	0,017
CORRUP	0,073	0,241	0,003
ROA	-0,184	0,457	0,688
ROE	-0,008	0,427	0,848
CREDTDEP	0,114	0,003	0,002
COSTIN	0,020	0,014	0,162
CAR	0,069	0,040	0,048

Source: Author's calculation via Eviews11

Discussion of the results

The GMM difference results identified 6 macroeconomic, 2 bank-specific variables and NPL first lag statistically significant: NPL (-1), GDP, RIT, EXR, DEBT, CORRUP, CREDTDEP, and CAR. In fact, the analysis proposed highlights the positive effects of the lagged dependent variable on non-performing loans. On the macroeconomic level, the estimation demonstrates that an increase in inflation contributes to greater NPL, proving that higher inflation can reduce the real income when wares are depreciated. Additionally, an increase in one percentage point in DEBT and EXR leads to an expansion of 0,03 and of 0,035 in NPLs level, respectively in LATAM region.

The increase exchange rate (depreciation of local currency against dollar) can be related mainly to external debt of Latin American countries is issued predominantly in foreign currency (dollar), which contributes the deterioration of bank portfolios and the rise of NPLs. Besides, the public debt as percentage of GDP points out that, the reduction in public finance quality represents a rise of NPLs. Therefore, one unit increase in public debts represents an increase of 0,03 units points in NPLs. Additionally, the credit to deposit ratio (***credtdep***) and capital adequacy ratio (***car***) shows a positive relationship. Accordingly, to Table 8, the rise of one percentage point in CREDTDEP and CAR will lead to ascending level of NPLs of 0,114 and 0,069 percentage points respectively. As a result, a high CREDTDEP implies a reduction of liquidity of banks, which increases the probability of default causing a financial disruption. Moreover, the CAR represents the risk that banks can

undertake, and captures the inefficiency of banking system. Hence, the model estimated that high CAR is related to high-risk activities, which increases the loan portfolio risk and elevates NPL levels.

Furthermore, the lagged dependent variable NPL (-1) is statistically significant in this model, suggesting that a shock to past NPLs periods will last on the banking system. Compared to the fixed effect models the GDP, RIT and CORRUP are also considered significant to have influence on NPLs. However, the UNEM variable has not been statistically significant at 5% level. In addition, the COSTIN and ROA were not considered as valid variables in both models. Besides. The author performed Sargan test to check the valid of the instruments, and therefore with p-value of 32,57% all the chosen instruments analyzed are valid.

5. The macroeconomic effects of NPLs on the economy

As indicated previously, this section aims to explore the feedback effects of non-performing loans to the real economy in Latin American region. Following this purpose, the Vector Auto Regression (VAR) methodology is applied and rely on impulse response functions (IRFs), which provides a useful method to evaluate the duration of shocks and magnitude of effects using a panel data approach. A VAR technique includes n-variables and n-equations model, which represents each variable as a linear function of its own past values with the past values of all other variables considered in the estimation. In fact, this method treats all variables in the equation as endogenous, and there are no exogenous variables. In particular, the author is interested in the linkages and interactions among NPLs, GDP growth, unemployment rate, inflation, exchange rate, public debt ratio, real interest rate to determine how the effects are on the economic activity. Hence, the Vector Autoregressive model helps to point out how variables in the system respond to shocks to other variables

$$Y_{i,t} = \delta_0 + \sum_{z=1}^{n} \delta_z Y_{i,t-z} + u_i \quad ,$$

$$u_{i,t} = \alpha_{i,t} + \varepsilon_{i,t} \qquad i,t$$

$$Y_{i,t} = [\boldsymbol{NPL}_{i,t}, \boldsymbol{gdp}_{i,t}, \boldsymbol{unem}_{i,t}, \boldsymbol{inf}_{i,t}, \boldsymbol{exr}_{i,t}, \boldsymbol{rit}_{i,t}, \boldsymbol{debt}_{i,t}, \boldsymbol{corrupt}_{i,t}]$$

In fact, $Y_{i,t}$ consists of the vector of eight macroeconomic endogenous variables, u_i indicates the $\varepsilon_{i,t-1}$ the idiosyncratic errors and $\alpha_{i,t-1}$ the unobserved effects, where i and t indicates the country i and year t, respectively. The variable NPL is the ratio of non-performing loans to total loans of the banking industry, ***gdp***$_{i,t}$ is the gross domestic product rate, ***unem***$_{i,t}$ is the unemployment rate, ***inf*** $_{i,t}$ is the inflation rate, ***exr*** $_{i,t}$ is the exchange rate, ***rit*** $_{i,t}$ is the real interest rate, ***debt*** $_{i,t}$ is the ratio of public debt to GDP and ***corrupt*** $_{i,t}$ is the index of corruption in Latam countries. Following the literature Andrews and Lu (2001) addressed that the optimal and most efficient lag order is 1, and as a consequence the author applied the first lag of each of the eight endogenous variables into this methodology.

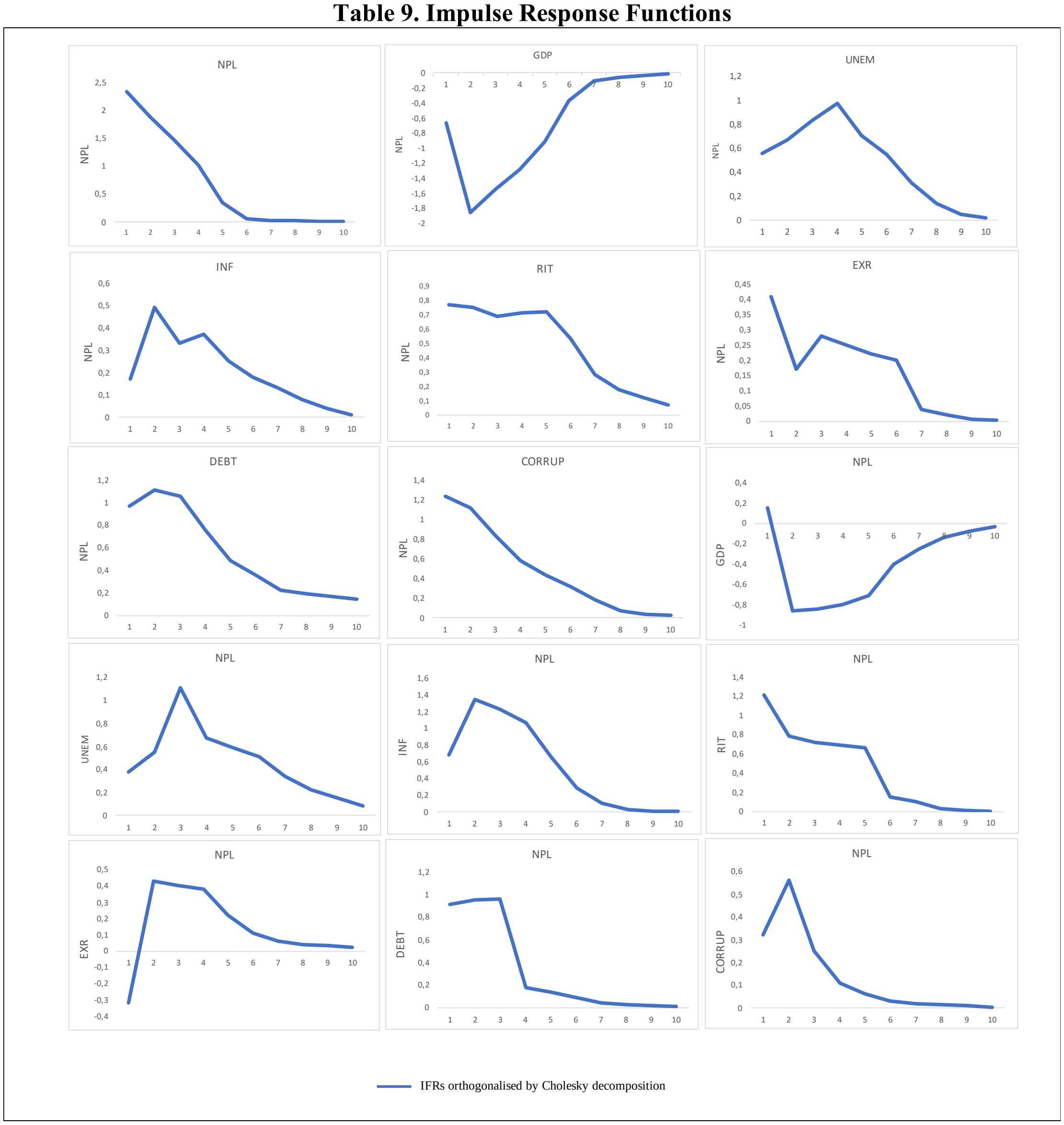
As stated previously, to investigate the interactions among variables the impulse response functions (IRFs) were used in VAR model. In addition, the shocks in VAR methodology were applied implementing an orthogonalization technique by Cholesky decomposition. In this specification, the author followed Petkvoski (2016) and Klein (2013), that used the orthogonalized Cholesky decomposition. The examination aims to analyze the response of NPL in the system to a macroeconomic shock on the real economy, and vice-versa, while the other variables are treated as fixed. Hence, the presented IRFs points out the response of NPLs for one standard deviation shock to selected macroeconomic variables (GDP, UNEM, INF, EXR, RIT, DEBT and CORRUP) and the influence of a shock of NPLs on economic activity. Furthermore, the lag selection criteria is applied based on lowest value between Akaike (AIC) and Schwartz (SC) criteria (Table 2A). In this analysis 2 lags are used and considered the optimal length in this VAR model.

Discussion of the results

Response of NPLs to shocks in other macroeconomic variables: The impulse response function evaluate the effect of economic activity on NPLs level. In particular, the change in public debt ratio by one standard deviation increase, amounting to 16,16 percentage points, NPL increases 0,97 points percentage in the first year. Similarly, an increase in GDP and unemployment resulted in a decline of 0,67 and an increase of 0,56 percentage points in NPLs level respectively, by the first year. In this regard, a one percentage point increase in inflation represents an increase in NPL by 0,17 percentage points in the first year and by 0,49 by the second year.

Impact of a macroeconomic shock to NPLs: an increase in NPLs results in prolonged reduction in GDP over 10 years, deteriorating the economic activity. Additionally, the GDP increases by 0,15 by the first year, and therefore started to decline in the following years, reaching -0,71 in the fifth year. Also, the unemployment increases significantly over 3 years reaching a 1,11 points percentage by the third year. Besides, such a shock resulted in an increase of about 0,43 percentage points in the exchange rate over 2 years and 0,24 percentage points in corruption index over 5 years. Thus, the results implies that a one percentage point increase in NPL expand inflation by 0,68 and debt by 0,96 percentage points by the first and third year respectively. NPL itself increase by 2,33 and 1,88 by the year one and year two respectively.

Table 9. Impulse Response Functions



Source: Author's calculation via Eviews11

6. Conclusion

In recent years, the rise of non-performing loans across banking system loans have increased the vulnerabilities of several economies worldwide. In this study, the econometric analysis is applied in order to identify the macroeconomic and bank-specific determinants of non-performing loans of 13 Latin American countries from 2005 to 2007. This paper is conducted through different panel data estimation techniques in order to provide a broader group of results. In particular, the empirical results are consistent in line with the literature. The investigation found that macroeconomic variables, specially when the GDP decreases, real interest rate is high, the exchange rate depreciates, the public debt and level of corruption increases tend to expand the NPLs.

Furthermore, the findings demonstrates that banks must be concern to many variables when they offer different types of loans that can expand the level of non-performing loans. Following this context, an increase in capital adequacy ratio and loans to deposit ratio leads to a positive relationship to NPLs. Particularly, banks with high proportion of capital adequacy ratio and credit to deposit, which includes the capital used to support risk operations and the evaluation of liquidity activities respectively, can undermine significantly the efficiency of banking system and contributes to financial stability in Latam markets.

The research also attempted to evaluate the feedback effects between NPLs to economic activity applying the Vector Autoregressive (VAR) model. In fact, the model indicates that exists a macro-financial linkage in Latam region. More specifically, the results point out that NPL has impact on GDP, unemployment, inflation and real interest rate. In addition, the strongest results suggest that NPL respond significantly to macroeconomic conditions such as: GDP growth, unemployment rate, public debt and levels of corruption in Latin American countries. Thus, the different responses of NPLs to macroeconomic shocks indicates a high risky level of deterioration of economic activity, validating that sustainable growth will not be achieved without an efficient and solid banking industry.

Lastly, the findings present some implications to policymakers and regulatory authorities of the financial system in Latin American. Hence, it highlights the need to address rapidly and efficiently the rising of NPL that can contribute to economic downturn. Banking instability can undermine the allocation of capital, the quality of loans and the function of financial markets. Therefore,

regulators should emphasize their efforts to promote the reduction of non-performing loans in order to mitigate the risk of banking crisis and therefore financial recession.

This study has some limitations and could be extended in several ways in the future. Firstly, the study did not include recent data from 2018 and 2019 years, because most of data of Latam countries selected were not available yet. In addition, Puerto Rico, El Salvador, Venezuela, Cuba, and Haiti were excluded from the sample due to the lack of information in different years. To solve this limitation, future researchers can extend the data and the countries in Latin American region.

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Appendix

Table 1A. Variance Inflation Factor

Variable	fficient Varia	Centered VIF	ncentered VI
GDP	0,001	1,578	3,497
UNEM	0,004	4,290	13,539
INF	0,001	2,337	4,150
RIT	0,000	0,590	2,314
EXR	0,000	1,256	3,272
DEBT	0,001	3,677	15,486
CORRUP	0,092	0,878	4,031
ROA	0,033	2,321	17,654
ROE	0,001	2,588	28,369
CREDTDEP	0,002	1,879	23,946
COSTIN	0,000	6,893	58,894
CAR	0,002	5,888	56,424

Source: Author's calculation via Eviews11

Table 2A. Vector Autoregression, Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3868,21	NA	2,47E+16	74,83848	74,96903	74,7724
1	-2534,29	2308,68	4711133	52,23647	56,86415*	54,11128
2	-2336,24	293,26	3089553*	51,44471*	60,60266	54,02457*
3	-2155,12	222,92	3592636	51,67784	64,66666	56,80131
4	-1948,56	202,58*	3982898	52,65787	68,24155	57,81996

Source: Author's calculation via Eviews11

*indicates lag order selected by criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hanna-Quinn information criterion

Table 3A - NPLs by country