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BANK RISK DETERMINATS IN LATIN AMERICA: A HOLISTIC VIEW

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Preliminary version

Abstract

This paper examines Latin American banks' risk determinants during timespan 1999 to 2013, including crisis from Argentina (2001-2003) and Uruguay (2002-2005). We apply a data-driven comparable procedure to select commercial banks from the sample. We study bank risk proxied by Z-score. We use bank specific (CAMEL), macroeconomic and regulatory variables. We use GMM-System as our main empirical analysis method. Our results show a negative relationship between banks' good management, profitability, liquidity and its risk. We also find a positive relationship between bank asset quality and its risks. We undertake robustness tests and the results remain similar to our original model.

1. *Introduction*

In this paper, we study bank risk determinats in Latin America. Our results show a negative relationship between good management, profitability and the liquidity of a bank and its risk. Additionally, we find a positive relationship between bank asset quality and its risks. As Laeven and Valencia (2012) distinguish between how banking crisis resolution are treated in advanced and emerging economies; while in the first case they find a tencendy to use macroeconomic policies in the second case the bank restructuring approach gains more relevance. Thus we think our results are of interest for Regulators and Policy makers as we determine the main areas of the bank associated with an increase bank' risk. At the same time we are also contributing to explain and predict bank crisis (Sherbo and Smith, 2013).

Banking crises and banking regulation continue being a relevant topic in the economic policy debate. Since 1972 the succession of banking crises has not stopped, and nothing indicates this will change in the future. In fact, in the world there have been thouands episodes of systemic banking crises occurred in 93 countries since the late 1970s and 51 borderline crises were recorded in 46 countries. These crises have been observed in developing and transition countries as in the industrial world (Caprio, and Klingebiel, 1997).

There is a lack of understanding of the factors that generate banking crises; regulators have more propensities to assist than to resolve the effect of insolvent institutions as it is mentioned by E.J. Kane (2016). As well regulators lately have been defining rules that control the risk taken by banks in order to limit the impact futures crises will have. Prudential regulation has been considered as an approach to protect society from the consequences of excessive risk-taking, capital shortages and loss concealment at individual banks (E. J. Kane, 2016). Unfortunately these controls arrive too late, as in a crisis which are already spreading, timing is a relevant factor as an early intervention could be helpful in further reducing risk, mainly when regulator's powers enable authorities to address situations of distress before these spread to the wider financial system (Schich and Byoung-Hwan, 2010).

Systemic banking crises are relevant as they affect the economy as a whole, principally to the region in Latin America due to the characteristics of their market; Firstly, the markets are highly concentrated and with significant entry barriers (Enoch et al., 2016) which might increase the risk of financial distress. Secondly the institutions are categorized as, too big to fail, their collapse would cause a distress in the economy or in the sector tearing down the entire financial system of the region as mentioned by Martin Summer (2003). Thirdly inflation and hipper-inflation have been a distinctive of Latin America economies. This conditions the way the banking sector works, the financial leverage and the sources of financing. This last reason

has gained some relevance due to the current chaging global political and economic scenario: the interest rates back in a rising trend in the developed economies, and Latin America (LATAM) has a special pressure due to financial risks and market volatility (Enoch et al. 2016). Also protectionist movements as the ones we are seeing in US or an inverse in the risk aversion of the investors, consequence of the tightening of financial conditions on international markets (Banco de España, 2017).

2. Literature review and research hypotheses

Across the literature there are differing methodologies to study the determinants and leading indicators of banking crises;

Firstly, there are authors who more closely analyze the real sector and macroeconomic shocks. For instance, Eichengreen and Rose (1998) highlight that the examples of banking crises in emerging markets are related to four factors: Macroeconomic volatility (e.g.: large relative price changes, trade fluctuations, interest rate and capitals flows changes), connected lending, government involvement and the failure of prudential regulation. Kaminsky et al. (1999) focus on the links of banking crisis examining variables which affect negatively the bank risk as; currency crashes (measured by an aggravated in the interest rate), balance-of-payment crises (analyzed by the slow down in economic growth) and weak and deteriorating economic fundamentals

Secondly, some other authors also look into banking sector variables as Elsinger, Lehar, and Summer (2006) who develop a framework based in aggregated variables of the banking system and macroeconomic risk factors on banks. In fact for these authors the sources of systemic risk within the banking sector are positively connected to: the level of correlation of the bank´s portfolio exposures, the high bankruptcy costs and the ineffective crisis resolution strategies. On the contrary they also show how a lender of last resort can reduce the risk stopping the contagious defaults. Additionally Altunbas et al., (2007) show that the level of capital of the banks seems to be positively correlated with the bank´s risk level. Other authors as Demirgüç-Kunt et al. (2018) verify that a weak institutional environment is not the unique justification behind banking sector problems. In fact, these authors find evidence that the bank capital is associated with a reduction in the systemic risk being able to overcome the negative effects of a weak institutional environment. Along with this way of thinking currently different early warning systems are combining variables at a macro and micro (individual institution) level. Indeed Lang and Schmidt (2016) find pertinent to include in their system bank´s assets and demand deposits as banking risk vulnerability indicators. Similarly Oet et al. (2011) include variables at bank and macro level with the objective to identify imbalances that can be associated with bubbles which explain financial stress (e.g.:

Securitzation, Fx concentration, bank capital at risk, Economic value of loan portfolio, Leverage, GDP, Property, investments, Leverage, Interest rate, Credit to GDP, Solvency and Credit). This holistic approach is observed in the latest publications of several central banks about their early warning systems (e.g. Borio et al. 2018; Ito et al. 2013; Nyman et al. 2018). In our study we follow this approach in the variable selection and we focus in the categories: Regulatory, Macroeconomic and Banking level.

In the 80´s USA supervisors introduced the CAMEL rating for on-site examinations of banking institution. This system allows the supervisors to gather information in a systematic way that will result in the evaluation of bank financial conditions (Federal Reserve, 1999). CAMEL rating is a uniform rating system, which covers five categories of the bank general conditions to be examined (Capital, Asset Quality, Management, Earnings and Liquidity) (Federal Reserve, 2013; Stackhouse, 2018). Within each category or component there is a rating system from 1 to 5 to measure the level of impact this risk component can have in the bank: 1 represents the highest rating and the lowest level of supervisor concerns, while 5 represents most critically deficient level of performance and therefore the highest degree of supervisory concern.

This rating, known by the acronym CAMEL, has been extensively used in the literature (e.g.: Chiaramonte et al., 2015; Stiroh and Rumble, 2006; Mäkinen and Solanko, 2017). Moreover, several Early-Warning Systems developed by intenational banking supervisors are using this system to classify the variables in the model (e.g. Lang et al. 2018 and Nyman et al. 2018).

2.1 Capital (adequacy):

Capital determines the robustness of financial institutions to withstand shocks to their balance sheet sandhow leverage emphasized the propagating distress across financial institutions (Gelos, 2015). In particular, Klomp et al. (2014) and Karels (1989) find a negative significant correlation between capital adequacy ratio and risk. Usually capital is measured through leverage proxies (e.g. Lopez, 1999; Stackhouse 2018; Bornemann et al, 2017).

Hypothesis 1: There is a negative relationship between the capital adequacy of a bank and its risk.

2.2 Asset (Quality):

According to the Federal Deposit Insurance Corporation, asset quality measures “the quantity of existing and potential credit risk associated with the loan portfolio, other real estate own and other assets, as well as off-balance sheet transactions.” (Federal Deposit Insurance Corporation, 2019). This category can also be affected by the market value of the assets and other risks as reputational, compliance or strategic

risk, which could affect the assets valuation as mentioned by Rono and Traore (2018). There is a broad consensus concerning the existence of an inverse relationship between asset quality and bank risk (Agrestietal, 2008). In the literature we can find different measures of asset quality as for example: non-performing loans to total gross loans, sectoral distribution of loans to total loans, the higher share of non-performing assets to total assets and the share of loan loss provisions to total average loans (Betz et al., 2013).

Hypothesis 2: There is a negative relationship between the asset quality of a banks and its risk.

2.3 Management (quality/capability):

Management measures the performance of individuals in leadership roles at a bank. Regulators expect a bank to operate in a safe and sound manner promoting a culture of compliance (Stackhouse, 2018). Management is proxied in the literature by the cost to income ratio, earnings, interest margin, the natural logarithm of total assets and efficiency among others (Petropoulos et al., 2017, Demsetz and Strahan, 1997, and Stiroh and Rumble, 2006).

Hypothesis 3: There is a negative relationship between good management and bank risk.

2.4 Earnings:

Earnings and profitability indicators are used to assess the financial health and monitor the efficiency of bank resources (Agresti et al., 2008). Banks that lose money over significant periods of time will not remain in business and banks, like other firms, will not stay in business if they are not profitable (Stackhouse, 2018). The common metrics to monitor this category are the return on asset, the return on equity (e.g. Altunbas, et al. 2007; C-C Lee et al., 2013) and the income generated measured by the ratiosnet interest margin, the interest margin to gross income, and non-interest expenses to gross income (e.g. Agresti et al., 2008; Petropoulos et al., 2017).

Hypothesis 4: There is a negative relationship between bank profitability and its risk.

2.5 Liquidity:

Liquidity is related to the fundamental mission of a bank, to redistribute deposits and other liabilities into loans. As the maturity of deposits and loans can differ, the bank need to manage its liquidity by being able to meet deposits outflows at the same time satisfy the loans demand (Stackhouse, 2018). Different authors measure the liquidity through by comparing the loans to the different type asets as for example: loans to customer deposit, loans to total assets, volatile liabilities (Petropoulos et al., 2017; Köhler, 2012). Furthermore, Vazquez and Federico (2012) look at liquidity coverage

ratio to show the relationship between bank´s dependence on short-term funding to finance the expansion of their balance sheet and their risk. Additionally, V Greuning et al. (2009) determine the liquidity risk of a bank is related to the bank´s dependence to a limited sources funding source.

Hypothesis 5: There is a negative relationship between the liquidity of a bank and its risk.

3.7 Data and methodological aspects

3.1. Sample:

We chose banks based on the availability of data from the Bankscope database maintained by Bureau Van Dijk. To minimize any incoherence and possible bias related to the bank business idiosyncrasies, we have selected only commercial banks in our sample. Moreover, to limit selection bias we have included in the sample banks that ceased their activities and others that might have changed the name due to acquisition and further structural changes.

The period range we cover is from 1999 to 2013. Including crisis of Argentina from 2001 to 2003 and Uruguay from 2002 to 2005. The countries selected are the sovereign states categorized as Latin America (see Tabla 1). Nevertheless, four countries cannot be included as there was no information about their banks (Cuba, El Salvador, Haiti and Nicaragua).

Entities with abnormal ratios or extreme values are eliminated from the sample as outliers. The criteria used to the lower limit is to remove observations which are below Q[1]1 – 1,5* IQD[2]. To calculate the upper bound the formula followed is Q3 + 1,5* IQD.

INSERT TABLE 1 ABOUT HERE

[1] Quartile

[2] Inter Quartile Distance Q1- Q3

3.2. Business model classification:

We use the BIS Bank business models classification (Roengpitya et al., 2014) to select only retail- commercial banks. The Classification and selection of retail-commercial banks is based in the following variables:

i.Growth of Gross Loans to growth of total assets, ii. Deposits to total assets, iii. Interbank Assets/ Interbank liabilities to total assets, iv. Stable funding to total assets vs. Trading to total assets vi. Wholesale debt to total assets

All banks from the sample need to fulfill specific conditions to be classified as “commercial”. The prerequisites of commercial banks are from business models profiles presented by Roengpitya R, et al. (2014); To start with, the ratio of Growth of Gross Loans to growth of total assets has to be larger than the Gross loans of the Trading Banks equals to 26%. Secondly we look at the ratio deposits to total assets, which need to be larger than the ratio Deposits to total assets of the Trading Banks (38%). The third requirement covers the proportion of Interbank Assets to total assets divided by Interbank liabilities to total assets of the banks which has to be lower to Interbank lending to total assets divided by interbank borrowing to total assets of Trading banks (equals 14 %.) The forth condition is that the Stable funding to total assets ratio for commercial banks needs to be higher than the Stable funding ratio of Trading banks in equal to 48 % as in Roengpitya R, et al. (2014). The last condition is that the relationship between Trading to total assets for the commercial banks has to be lower than for the Trading banks at an 18%.

3.3. Variables

Dependent variables:

The Z-score is our primary measurement for levels of individual´s banks risk taking. Our risk proxy the Z-Score ratio (*Z-score*) measures the distance to default of a bank from an accounting point of view, as the inputs to the calculation are the return on assets and the volatility of the return. The higher the Z-score ratio, the more distance to default and consequently the less risk; whereasthe closer to zero, the more risk and more probability of default. Z-score is indirectly proportional to the risk taken by the banks.

It is common practice in the literature to use Z-score as a financial tool to measure risk (Maudos, 2017; Uhde and Heimeshoff 2009; Kumar and Ravi, 2007). Recently Sherbo and Smith (2013) analyse the Z-score on the financial crisis period (from December 2007 to June 2009) proving confidence of the risk measurement with a 99% of confidence

We calculate the Z-score as follows:

$$\boldsymbol{Z-score\ i,t=\frac{ROAA\ i,t+ETA\ i,t}{\sigma(ROAA)i,t}}$$

Where ROAAi,t represents the return on average assets of a bank I in year t, ETAi,t denotes the ratio of equity to total assets and σ(ROAA) it is the standard deviation of the return on total average assets.

Since the Z-score is highly skewed, we use the natural logarithm of the Z-score, following Laeven and Levine (2009) and Liu, Molyneux&Wilson, (2013). Schaeck and Cihk (2007) prove that the frame to calculate the Z-score in their sample do not affect the results and Yi (2012) computes a Z-score with two consecutive periods. Thus we adjusted the Z-score calculation to two consecutive years rolling window in order to increase the number of observations.

To control for the robustness of the results in our study we use an alternative proxy for risk taking: Loan loss reserves to gross loans (*LLR/GL*), which measures the credit risk one of the main variables that affect the bank performance (e.g. Specific Credit Risk Adjustments of EBA, 2016). The propensity to increase the loan loss reserves indicates a deteriorating of the balance sheet asset as it means the banks expect loses in the loans portfolio (MacDonald et al., 2014). The ratio *LLR/GL* is used in the literature as a proxy of credit risk. The authors Bikker, Metzemakers, (2005) and Borio et al. (2002) describe how risk is build up during economic booms. In contrast, provisioning can be seen as a countercyclical outcome of the earnings effect. C. -C. Lee et al. (2013) in their analysis of the risk in the Asian banking system use this variable as a proxy for risk.

Demirguç-Kunt and Detragiache (1998) study how shocks that affect negatively the economic performance of banks' borrowers are correlated with systemic banking crises. In fact, an increase in non-performing loans could deterioriate the banks' balance if the rate of return on banks assets falls short of the rate that must be paid to the liabilities, indirectly related to the economy interest rate.

3.4. Explanatory variables

In Table 2 we can observe the different proxies within each category of variables. We use as proxy for Capital adequacy the ratio Equity to total assets ratio (*E/TA*). Following a diminution in equity, with constant total assets, the proportion of debt of a bank will increase causing higher leverage and increasing the risk-taking as described by Vazquez and Federico (2012). Similarly Uhde and Heimeshoff (2009) and Chortareas et al. (2011) use *E/TA* as a proxy for credit risk.

Net loan to total assets (*NL/TA*) is the proxy for asset quality. This ratio is used in the literature to analyze the negative relationship between risk and the asset efficiency allocation (Altunbas et al., 2007). Similarly, from a regulatory point of view the Federal Deposit Insurance Corporation in the definition of Asset Quality states how Loans typically comprise a majority of a bank's assets and carry the greatest amount of risk to their capital in the same way (Petropoulos et al., 2017).

We proxy management quality by the ratios; Cost to income (*CostI*), Growth of gross loans (*GroTL*) and Total Assets (*TA*). Betz et al.(2013) use the first proxy in their analysis to predict banking distress, also Baselga-Pascual et al. (2015) show that less efficient banks may be tempted to take on higher risks to compensate for the lost returns. Additionally, countries with high *CostI* ratios are less efficient and the level of risk is related to the level of efficiency or capital Chortareas et al. (2011). Furthermore, Petropoulos et al. (2017) consider the *CostI* ratio represents Management quality as this ratio is expected to reduce the probability of bank failure. Regarding *GroTL*, the authors Altunbas, et al. (2007) analyze how a rapid *GroTL* may increase risk and impact adversely on capital and bank efficiency. *TA* are considered as the literature states that larger Banks are associated with less risk as they have more potential to diversify the sources of income Demsetz and Strahan (1997) and Stiroh and Rumble, (2006).

To measure the category Earnings we consider the variables Return on Equity (*ROAE*) and return on assets (*ROAA*). These ratios measure the profitability of the bank through the cost of capital. An increase in competition could drive to a more expansive cost of capital that could encourage risk taking Altunbas et al. (2007) and C-C Lee et al. (2013). Also ROAA is an indicator of a bank's competitive position in banking markets, which is related to the bank risk profile and the ability to have cash or highly liquid assets against short-term problems. Banks need stable and increasing profits, which force them to manage risk, capital and profitability to develop a business that augment capital resources over time Greuning et al. (2009).

In regards to liquidity we observer different variables that are used in the literature as a measure of the liquidity; Authors as Bogdan et al. (2015) or Vazquez and Federico (2012) use the ratio Loans to customer deposits (*L/CD*) to measure the bank liquidity and prove the dependence of banks on short-term funding to finance the expansion of their balance sheets in the run-up to the crisis. Another methodology to measure liquidity is the ratio Liquid Assets to Deposits and short-term Funding (*LA/STF*) (e,g. Köhler,2012; Greuning et al. 2009) and the Net Loans to Deposit & Short-Term Funding.

3.5. Control variables

The differences between the countries in their economic, political and regulatory framework justify controlling the macroeconomic and regulatory variables in this analysis.

At first to consider the Macroeconomic variables will help to measure the business cycles and the economic breaks as they differ across the countries in the sample. This approach to the investigation tries to capture an holistic view of the banking crises considering macro and bank specific variables in line with the research by Lund-Jensen (2012) who found that the level of systemic risk depends on several risk factors: credit-to-GDP growth, changes in bank lending premium, equity price growth, increasing interconnectedness in the financial

sector and real effective exchange rate appreciation. Comparably Demirgüc-Kunt and Detragiache (1998) in their analysis of the early warning signs of banking crisis found the impact that macroeconomic factors have and that crisis tend to emerge in a scenario of weak macroeconomic conditions; low growth, high inflation, high real interest rates, a vulnerable balance of payments, explicit deposit insurance and weak law enforcement.
Table 2

Moreover Reinhart and Rogoff (2013) conclude that the there is a correlation between peaks in the current account balance and new defaults on sovereign debt, this is the reason why we control for Current account (*CurrAcc*). Similarly, Laeven and Valencia (2008) proved most banking crises occur in countries with large current account deficits, while Kauko (2012) found out that credit growth when combined with current account deficits contributed to vulnerabilities in the banking system.

Domestic credit to private sector (*DCPS*) plays an economically and statistically significant role in predicting subsequent crises. Obstfeld (2012), Gourinchas and Obstfeld (2012) conclude that across all types of crisis, the domestic credit to output was identified as one variable with an important role.

GDP growth % (*GDPgrowth*) is a variable considered for most model specifications, irrespective of the geographic location of the banking crisis. Davis, Karim and Liadze (2011) indicate that crisis occur in period where the GDP growth rate is low, the interest rates, inflation and fiscal deficits high. This idea is reinforced by Demirgüc-Kunt and Detragiache (2005) who prove that economic growth can be used as a predictor for crises, as in most cases the GDP growth rate has slows down immediately before a crises.

Dooley (1997) analyses how crises in Latin America were generally preceded by a foreign large speculative capital inflow, which do not necessarily follow interest rate differentials across currencies. The fiscal shocks can create destabilizing increases in domestic interest rates; these will translate to the inflation

expectations and distort the deposit domestic demand (Gavin and Hausmann, 1998). Additionally, in a context use to high interest rate, a reduction of them could induce the banks to lower their lending standards in a search of better yield (European Systemic Risk Board, 2016a). Therefore we control if the interest rate (*Int*) in the period studied across the different countries seem to have an explanatory power to explain the risk assumed by the banks.

The authors Demirgüç-Kunt and Detragiache (1998) in their conclusions of how weak macroeconomic conditions affect the systemic banking crises also state that high inflation can be found as one of the main justifications to have systemic banking problems. In the same way, Davis, Karim and Liadze (2011) examine how in the case of Latin America excessive inflation (above 30%) doubles the chances of a systemic banking crisis as opposition to other regions in the world. Finally, Lo Duca and Peltonen (2013) consider the inflation as one of the relevant variables to address country-specific macro financial indicators in the case of emerging economies. We, therefore control for Inflation % (*Infl*) in our multivariate analysis.

We further control for Unemployment rate % (*Unemp*), which is related to bank asset quality in previous literature (Bofondi and Ropele, 2011). Higher unemployment rate may affect the bank risk associated to lending (Hancock and Wilcox, 1994).

Finally, we have selected four indicators from the World Bank database on Bank Regulation and Supervision developed by Barth, Caprio, and Levine (2004) to control for Regulation differences across Latin American countries in our empirical specification, as the literature suggests that these indicators may affect banks' risk.

The Activity restriction index (*Ares*) includes restrictions on securities, insurance, and real estate activities plus restrictions on the banks owning and controlling nonfinancial firms." (Barth, Caprio and Levine, 2004).

Capital Stringecy (*CStr*) (Barth, Caprio and Levine, 2004) captures whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined

Official supervisory power (*OSP*) understood as Barth, Caprio and Levine (2004) is connected to whether the supervisors have the authority to take specific actions to prevent and correct problems and circumstances that can help to prevent banks from engaging in excessive risk-taking behavior and thus improve bank development, performance and stability

Private Monitoring (*PriM*) show the degree to which banks are forced by the supervisor authorities to disclose accurate information to the public and whether there are incentives to increase market discipline (Barth, Caprio and Levine 2004). The regulations, which promote and facilitate private monitoring of banks, are associated with better banking-sector outcomes.

Following Uhde and Heimeshoff (2009), we control for Industry concentration by the Herfindahl-Hirschman Index (*HHI*). In their investigation Uhde and Heimeshoff (2009), show a negative relationship between market concentration and European banks' financial robustness.

INSERT TABLE 2 ABOUT HERE

Methodology

Following the authors who study macro and microanalysis of the banking risk we include different variables at the bank, macroeconomic and regulatory level.

The first analysis we undertake is a univariate analysis through the t-test, this test allows to compare the differences in averages between the banks groups (group above and below the Z-score average) and allowing to compare if the to samples sets are different across the variables.

Secondly as the bank-specific factors of bank risk can be endogenous and some other unobserved characteristics could cause correlations between the coefficients of the explanatory variables. We have chosen the GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998), also referred to as the system-GMM estimator which we apply in two-step estimation procedure with finite-sample corrected standard errors, as proposed by Windmeijer (2005) and L. Baselga-Pascual et al. (2015).

The system-GMM estimator addresses endogeneity by means of suitable instruments. We consider the bank-specific variables as endogenous covariates by employing lagged first differences of the bank-specific explanatory variables as instruments for the equation in levels and the lagged values of the explanatory variables in levels as instruments for the equation in differences (in line with Arellano and Bover, 1995, and Blundell and Bond, 1998). Industry concentration and macroeconomic variables are treated as strictly exogenous following the authors Delis and Staikouras (2011) and L. Baselga-Pascual et al (2015). Our baseline equation is as follows:

$$(1)\ \mathrm{Z-Score} = c + \beta.\mathrm{ROAE} - \phi.\mathrm{CostI} - \varphi.\frac{\mathrm{NL}}{\mathrm{TA}} - \rho.\mathrm{HHI} - \upsilon.\mathrm{CurrAcc} + \partial.\ \mathrm{DCPS} + \zeta.\ \mathrm{GDPgrow} + \sigma.\ \mathrm{Int} - \alpha.\ \mathrm{Infl} - \Theta.\ \mathrm{Unpl}$$

Additionally and similar to earlier studies on bank risk (e.g. Baselga-Pascual et al. 2015; Foos et al. 2009) with the objective to add some robustness to our model we apply a different technique: ordinary least squares (OLS) regression to the Z-

score and OLS and Regression with fixed year and country to Loan loss reserves. However due to the nature and capabilities of the GMM (able to use lagged values of the dependent variable and capable to treat endogenous, bank-specific variables instrumented by their own lagged values) we will prioritize the results of this modeling above OLS.

4 Results

4.1 Univariate test

In the analysis t-test (see Table 3) all variables present differences between the means of the banks above and below the Z-score average. Of the differences there are the majority with statistically significance. As E/TA seems not to have statistically significance and thus we cannot confirm our hypothesis 1. Regarding asset quality the NL/TA banks with Z-score above the average hold a larger proportion of this ratio. From a Management perspective the statistically significant results are in line with our premises as Banks with Z-score above the average have lower *CostI* and GroTL and higher TA. Also in line with our hypothesis are the Earnings variables as Banks with less risk have higher ROAA and ROAE. Finally from a liquidity point of view the Banks with lower risk (and higher Z-score) seem to be holding in average a lower liquidity levels in the ratios *L/CD* and NL/STF.

Looking at the control variables most seem to have significance differences between them except for the Int.

INSERT TABLE 3 ABOUT HERE

4.2 Multivariate results

At Table 4 we can look at the results of the GMM and OLS to the variable Z-score.

First of all looking at the E/TA, proxy we used to measure the Capital, we observe a positive sing, which could indicate banks with less risk hold higher ratio of *E/TA*

as we state in hypothesis 1. However we cannot confirm our first hypothesis, as this variable does not show statistically significance.

Consecutively looking at the relationship between Net loans to *TA* with the Z-score we can see a negative correlation, which reject the hypothesis that assets quality is positively related to a lower level of risk in the banks.

We can confirm our third hypothesis, as both *CostI* and *GroTL* are positive and significantly related to the risk intake of the bank. Notwithstanding *TA* proxy states larger banks tend to hold lower risk but this result is not statistically significant.

Observing the return variables (ROAA and ROAE) as proxies of the earnings we can confirm our hypothesis 4 as the relationship between bank profitability measured by its ROAA of a banks and its risk is negative.

Finally the liquidity seems to be positively correlated to the bank risk (negatively to the Z-score value). Thus we can confirm our fifth hypothesis, as the proxy L/CD is statistically significant and positively related to the banks risk in GMM.

INSERT TABLE 4 ABOUT HERE

4.3 Robustness

4.3.1 Alternative model (OLS) to measure bank risk:

Examining the results of the OLS we find a consistency with the results of the GMM. Nevertheless there are two main differences; the first one is that there are more variables with statistically significant results and the second one is the fact that the control variables gain notoriety. In particular most of significant variables have a coefficient' sign in coherence with the literature regulatory variables, PriM, Infl, CurrAcc and Unemp (with the exception of CStr). In particular the concentration is positive related to the risk. Equally *Unemp* presents significant positive relationship with the level of risk assumed by the banks in the OLS applied to the Z-score, this result is covered in the literature per Bofondi and Ropele (2011) who find a positive correlation between unemployment 'rate as a

predictors of bank asset quality. The authors Hancock and Wilcox (1994) mention that higher unemployment rate affect the bank risk associated to lending.

The second comment is the contradiction in the ROAA sings which seems positively correlated to the level of risk of the bank.

4.3.2 Alternative proxies of bank risk:

The empirical results of the proxy LLR/GL confirm the robustness of our results as the previously discussion of the hypothesis prevails. The only notably relevance is the level of significance which seems in the case of the LLR/GL higher in the case of ROAA (99%) and *CostI* (95%). In this way the *E/TA* seems to have a negative relationship to the bank level of risk, as it was presented in the OLS calculated for the Z-score.

In models applied to *LLR/GL* (fixing year and country effects and OLS) as in the OLS applied to the Z-score, we find significance in the regulatory variables (Ares and PriM), *Infl*, *CurrAcc* and Unpl. For all mentioned variables except for the CStr the sign of the coefficient is coherent between the different models and the literature. In particular the concentration is positive related to the risk.

INSERT TABLE 5 ABOUT HERE

5. Conclusions

Financial institutions in Latin America continue to be confronted with significant challenges, related to a weak economic environment, currency devaluation and interest rate volatility that has reduced profitability and increased risk. This article empirically analyzes the factors influencing commercial bank risks in Latin America from the period 1999 to 2013 using a panel data set of 13,365 observations.

We apply the system-GMM estimator developed for dynamic panel models by Arellano and Bover (1995) and Blundell and Bond(1998), which has only recently been used in a few studies on the determinants of bank risk (e.g., Delis and Staikouras, 2011; Haq & Heaney, 2012; Louzis, Vouldis, & Metaxas, 2012). We examine the bank-specific, regulatory and macroeconomic determinants of bank risk and how they affect to the risk measured by the Z-score (Maudos, 2017; Uhde and Heimeshoff, 2009; Kumar and Ravi, 2007 and Smith 2013).

We find a negative relationship between good management, profitability and the liquidity of a bank and its risk. Notwithstanding bank's asset quality is positively related to bank risk. Our results indicate the consistency across different models.

Despite the macroeconomic effect is not statistically significant in the GMM, the effect in the OLS and Fixed effects models are in line with the literature. Nevertheless remains interesting to study in more detail the macroeconomic effects into banks' risk as Davis et all (2011) establishes that in American debt crisis of 1982 fiscal deficits, inflation and external imbalances are not captured consistently due to the pooling assumptions.

Tabla 1 Distribution observations across country

Country	Observations	% Observations per country
Argentina	1500	11,2%
Bolivia	255	1,9%
Brasil	3165	23,7%
Chile	780	5,8%
Colombia	1185	8,9%
Costa Rica	690	5,2%
Ecuador	420	3,1%
Guatemala	615	4,6%
Honduras	390	2,9%
México	885	6,6%
Panama	1590	11,9%
Peru	540	4,0%
Uruguay	510	3,8%
Venezuela	840	6,3%

Table 2 Variables description

Classification	Variable	Notation	References
RISK	Z-SCORE	**Z-SCORE**	Lapteacru,(2017) Mercieca et al. (2007), J. Maudos (2017), Sherbo and Smith (2013), Kumar and Ravi (2007), Laeven & Levine (2009), Liu, Molyneux&Wilson (2013)
	Loan Loss Reserves to Gross Loans	**LLR/GL %**	Arena (2007) Bikker, Metzemakers (2005), Borio et al. (2002) Demirguç-Kunt and Detragiache (1998) and C.-C. Lee et al. (2013)
Capital	Equity to Total Assets	**E/TA %**	Vazquez and Federico (2012). Uhde and Heimeshoff (2009) ;Chortareas et al. (2011)
Asset Quality	Net Loans to Total Assets	**NL/TA %**	Altunbas et al. (2007); Petropoulos et al. (2017); Betz et al. (2013)
Management	Cost To Income Ratio	**CostI %**	Betz et al.(2013), Baselga-Pascual, Trujillo-Ponce, Cardone-Riportella (2015) ; Chortareas et al. (2011)
	Growth of Gross Loans	**GroTL%**	Altunbas, et al. (2007)
	Total Assets (in Eur)	**TA**	Demsetz and Strahan (1997), Stiroh and Rumble (2006)
Earnings	Return On Avg Assets	**ROAA %**	Altunbas, Carbo, Gardener and Molyneux (2007); Greuning et al. (2009).
	Return On Avg Equity	**ROAE %**	Altunbas et al. (2007); C-C Lee et al. (2013)
Liquidity	Loans to Customer Deposits	**L/CD %**	Bogdan et al. (2015); Vazquez and Federico (2012) Köhler(2012) Vab Greuning and Brajovic Bratanovic (2009);
	Net Loans to Deposit & Short-Term Funding	**NL/STF %**	Kleinow, Horsch2 and Garcia-Molina (2015)
BANK CONCENTRATION	Herfindahl-Hirschman Index	**HHI**	A. Uhde, U. Heimeshoff (2009)
REGULATION	Activity restriction index	**Ares**	Barth, Caprio, Levine (2002)
	Capital stringency	**CStr**	Barth, Caprio, Levine (2002)
	Official supervisory power	**OSP**	Barth, Caprio, Levine (2002)
	Private Monitoring	**PriM**	Barth, Caprio, Levine (2002)
MACROECONOMIC	Domestic credit to private sector (as % of GDP)	**DCPS**	Demirguç-Kunt and Detragiache (1998) kaminsky and reinhart (1999)
	Real interest rate	**Int**	Demirguç-Kunt and Detragiache, (1998) A. Uhde, U. Heimeshoff (2009)
	Inflation %	**Infl %**	Demirguç-Kunt and Detragiache (1998) Kaminsky and Reinhart (2008b) Davis et all (2011)
	Current Account	**CurrAcc %**	M. Gertleretal et al. (2012)
	Real GDP growth (Annual percent change)	**GDPgrow**	World DevelopmentIndicators (WDI) Demirguç-Kunt and Detragiache (1998)
	Unemployment rate	**Unpl %**	Bofondi and Ropele (2011) A. Uhde, U. Uhde and Heimeshoff (2009)

Table 3 T-test Z-score

	Observations below the average	Observations above the average	Diff means
	Mean	Mean	
E/TA %	16,39	**16,27**	0,12
NL/TA %	43,00	53,94	-10,94***
CostI %	77,91	63,50	14,40***
GroTL%	31,91	23,33	8,58**
TA	6,01	6,02	-0,01
ROAA %	11,33	13,64	-2,31**
ROAE %	1,29	1,97	-0,67***
L/CD %	116,11	127,75	-11,64**
NL/STF %	43,00	81,66	-38,67***
HHI	0,19	0,17	0,02***
Ares	10,33	10,92	-0,60***
CStr	5,80	5,62	0,18**
OSP	10,90	10,83	0,069
PriM	0,04	0,05	-0,01***
DCPS	0,53	0,42	0,11***
Int	0,52	0,40	0,12
Infl	0,25	0,18	0,08***
CurrAcc	0,52	0,50	0,02**
GDPgrow	0,17	0,13	0,04***
Unpl	0,15	0,11	0,03***

Table 4 GMM Z-score

	ZSCORE_1	Z-SCORE
	GMM	Ordinary least squares (OLS) regression
cons	42,88	86,31
	240	102,39
ETA	2,78	2,51***
	(-2,06)	(0,71)
NLTA	1,54**	0,41**
	(0,77)	(0,51)
CostI	-0,22*	-0,42**
	(-0,13)	(0,19)
GroTL	-0,31***	-0,15**
	(0,11)	(0,1)
TA	8,55	10,85**
	(-14,12)	(4,21)
ROAA	1,30*	-0,64**
	(-0,69)	(0,59)
ROAE	-2,94	1,47
	(-3,03)	(-2,89)
LCD	(-0,39)*	-0,14**
	-0,27	(0,08)
NLSTF	0,00	0,15**
	-0,27	(0,21)
HHI	-33,12	-63,36**
	(-175,05)	(88,94)
Ares	4,88	68,08**
	(-7,22)	(3,75)
CStr	11,28	6,81
	(-10,45)	(5,02)**
OSP	-2,54	-1,17
	(-6,86)	(-3,97)
PriM	-5,54	-6,98**
	(-9,05)	(6,06)
DCPS	0,42	0,19
	(-0,76)	(-0,53)
Int	1,77	0,80**
	(-1,42)	(0,66)
Infl	-1,74	-1,28**
	(-1,83)	(1,42)
CurrAcc	0,23	0,56**
	(-0,84)	(0,58)
GDPgrow	-0,08	-0,47
	(-1,79)	(-1,61)
Unemp	-6,69**	-6,06***
	(2,9)	(2,18)
AR_1	-2.57	
AR_2	-0.87	
Sargan	885.22(673)	
Hansen	306.53 (673)	
R^2		0,0342
F	4,61***	3,35***
Number of observations	1,564	2,007

Table 5 Fixed effect and OLS results to Loan Loss reserves

	Loan Loss reserves	
	Regression fixed year and country	Ordinary least squares (OLS) regression
Cons	-3,51	0,93
	4.62	2,78
ETA	0,02**	0,02**
	(0,01)	(0,01)
NLTA	-0,01**	-0,01**
	(0,00)	(0,01)
CostI	0,00	0,00**
	(0,00)	(0,00)
GroTL	-0,01	0,00
	(0,00)***	(0,00)***
TA	-0,04	0,06
	(-0,073)	(0,07)
ROAA	-0,03***	-0,03***
	(0,01)	(0,01)
ROAE	0,04	0,07
	(-0,05)	(0,05)
NLSTF	0,00	0,00
	(-0,003)	(0,00)
LSTF	-0,01***	-0,01***
	(0,003)	(0,00)
LCD	0,00	0,00
	(-0,001)	(0,001)
HHI	6,30*	7,04***
	(3,64)	(2,57)
Ares	0,09	-0,15
	(-0,15)	(0,10)
CStr	0,12	0,16**
	(-0,17)	(0,08)
OSP	0,01	0,03
	(-0,38)	(0,10)
PriM	-0,01	0,02**
	(-0,44)	(0,14)
DCPS	0,06	0,00
	(-0,03)	(0,01)
Int	0,01	-0,01
	(-0,02)	(0,01)
Infl	0,07**	0,02**
	(0,06)	(0,02)
CurrAcc	0,02**	-0,01**
	(0,02)	(0,01)
GDPgrow	0,03	-0,02
	(-0,04)	(0,02)
Unemp	0,23**	0,25***
	(0,14)	(0,04)
Year and Country F.I.	yes	
R^2	0.3361	0.3161
F	9,30***	17,01***
Number of observations	573	795

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