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The relationship between banking market competition and risk-taking: Do size and capitalization matter?

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Abstract

This paper aims to study the effect of banking competition on Latin American banks' risk-taking and whether capitalization and size changes this relationship. We conclude that: (1) competition affects risk in a non-linear manner: high/low (average) competition are related to more (less) stability; (2) bank's size explains the advantage from competition, while capitalization is only positive for larger banks in this case; (3) capital ratio explains the advantage from lower competition. These results are of uttermost importance for bank regulation, specially due to the recent turmoil in worldwide financial markets.

Key Words: bank competition, emerging market, financial stability, bank regulation

JEL Classification: D40, G21, G28

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1 Introduction

The analysis of banking competition has been of great concern in the literature, specially due to its effects on the financial stability (Beck et al., 2006; Schaeck et al., 2009; Wagner, 2010). A competitive banking market may result in more benefits to the society as a whole, such as lower prices and higher quality of financial products (Boyd and Nicoló, 2005), but on the other hand its influence on financial stability is not conclusive according to the literature. There are two main rival theories on this matter. Some papers find that competition, in fact, enhances bank risk-taking behavior, since it pressures banks to operate with a minimum capital "buffer" (Hellman et al., 2000; Allen and Gale, 2004). Others defend the contrary by stating that crises are less likely to happen in competitive banking systems (Beck et al., 2006; Boyd and Nicoló, 2005). Motivated by the process of deregulation and consolidation that financial sectors around the world have been facing lately, specially on the developing world, our paper proposes to analyze whether competition has any effect on Latin American financial stability and if this relationship changes with other factors, such as size and capitalization. Our interest is to determine whether one of these theories better explain the case of Latin American banks or even if they are both simultaneously valid.

The studies that support the concentration-stability (or competition-fragility) view state that banks may have a higher profit premium in collusive markets, creating a buffer from crises and therefore, reducing their incentives to take risks (Hellman et al., 2000). In fact, in a competitive market, managers may be forced to take more risks on behalf of the shareholders, since competition reduces the profits of managers and shareholders, as well (Keeley, 1990). Allen and Gale (2004) also affirm that this increased risk may be due to a higher bank exposure to contagion in competitive markets. An adverse shock can cause a bank to go bankrupt and, thus, it may trigger a chain reaction where all banks that were exposed to the first bank also go bankrupt and so forth. Since under perfect competition these banks are price-takers, and therefore small compared to the whole market, no bank will have an incentive to provide liquidity to the troubled bank, causing the contagion to spread. In addition, there is the matter of adverse selection is worsened in a competitive market, i.e. in the presence of many banks in the market (Broecker, 1990; Nakamura, 1993; Shaffer, 1998). The chance of a poor quality borrower to apply for a loan at any bank is an increasing function of the number of banks, decreasing the quality of loan portfolio of the entire banking market.

A rival view, the "concentration-fragility" (or competition-stability), states that a more collusive banking market increases the financial fragility. Boyd and Nicoló (2005) show that the higher interest rates charged by banks in a less competitive market may enhance the risk-taking behavior of borrowers and, therefore, increase the probability of a systemic risk[1]. The trade-off between competition and risk ceases to exist in this analysis by assuming that banks are solving an *optimal contracting problem*. In other words, banks are supposed to be agents in relation to their depositors, but they are also principal in relation to the borrowers. According to the authors, the literature ignores the bank-borrower relationship and for that reason it does not see competition as the social optimum.

Since competition cannot directly be measured, the literature has used several different methods to estimate competitive levels of a specific sector. This paper, in particular, employs an innovative method to measure competition, known as the Boone indicator, which was introduced by the work of Boone (2008). This indicator measures the impact of efficiency on performance. The stronger this impact is, the higher the degree of competition a bank is facing. A few works in fact have already used this measure for the banking sector. For example, Schaeck and Cihák (2010) and Leuvensteijin et al. (2007) employs the Boone indicator for banks from the US and Europe. After that, in order to assess for whether the competition-stability or competition-fragility relationship holds for 10 Latin American countries between 2001 and 2008, we regress the Boone indicator on the banks' risk taking for these countries. This risk-taking measure is the "stability inefficiency" from Fang et al. (2011), whose estimation approach is a Stochastic Frontier Analysis (SFA).

Additionally, we are also interested to test how size and capitalization changes the relationship between competition and stability. In fact, as noted above, the proponents of the concentration-stability view, state that larger banks tend to operate better in collusive markets, even they have not provided an empirical proof of this. Shaffer and DiSalvo (1994) demonstrate that the presence of large banks in relation to the market is not a sufficient condition to reflect collusion [2]. Thus, we would like to test if this assump-

[1]See Wagner (2010) for a extension of this analysis, where the author contradicts the conclusions of Boyd and Nicoló (2005). If one assumes that banks can choose between different types of borrowers, competition can pressure these banks to finance riskier projects so as to maintain their optimal risk-taking level.

[2]This matter has been thoroughly discussed in the literature. Claessens and Laeven (2004), for example, that find a positive relation between concentration and competition; Shaffer and DiSalvo (1994) that find a high degree of banking competition in a small Pennsylvania county, even though the market structure was a duopoly; Maudos and Guevara (2007) that suggest that the effect of market concentration and competition on banks' efficiency is different. On the other hand, Bikker and Haaf (2002), Deltuvaite et al. (2007), Chan et al. (2007), Turk-Ariss (2009) regress competition indicators on market concen-

tion indeed holds by interacting the competition measure with a proxy of size. We also include an interaction between competition and equity ratio (capitalization) to test if a bank may be pressured to take more risks when they have an higher participation of sharholders' capital in relation to their assets given the competitive degree. There are two opposed effects in this case. Capital ratio can discipline banks due to the capital at risk effect, or decrease stability through a franchise value effect (Keeley, 1990; Hellman et al., 2000). The overall effect is, then, ambiguous.

The recent world financial crisis has made bank regulators utterly interested in determining how risk-taking depends on variables of market structure, bank size and leverage (Basel Committee on Banking Supervision, 2010). Through the implementation of the Basel III accord, they would like to impose restrictions for banks to utilize a larger fraction of their own capital in their operations. The objective is to reduce both the exposure to contagion and the risk-taking behavior. In fact, the main concern of these regulators regards the too big to fail (TBTF) banks. Because of their systemic importance, these banks are likely to incur in risks, believing that the authorities will assist them if any problem should occur (basically, a moral hazard problem). Not only this creates instability in the banking market, but also TBTF banks are too costly to save (Demirguc-Kunt and Huizinga, 2010b). The literature, therefore, must have a vanguard role in investigating this field so as to bring forth effective solutions for policy makers, specially on the eve of the implementation of this accord. As already stated before, this is our main motivation and, in the end, we intend to contribute relevantly to this topic.

This paper is structured as follows: in Section 2, we describe our methodology, defining the variables of interest and the regression approaches taken; in Section 3, we present and summarize the data sources; we demonstrate and discuss the empirical results in Section 4, and finally in Section 5 we make our the final remarks regarding the outcome of this paper.

2 Methodology

2.1 The estimation of a competition measure: the Boone indicator

The fact that the competition level is not observable has resulted in many different methods of measuring and estimating it. First, we may highlight the

tration and found a negative relationship, supporting the structure-conduct-performance (SCP) paradigm.

SCP paradigm, which have used concentration measures as proxy of competition (e.g. Lloyd-Williams et al., 1994; Berger and Hannan, 1998). The idea of this theory is that structure reflects conduct and, thus, market concentration means collusion. Latter on, the New Economic Industrial Organization (NEIO) paradigm emerged with the idea of estimating parameters that reflects the competition level of a market. The two most used are the models of Bresnahan (1982), and Panzar and Rosse (1987). The first calculates competition by estimating simultaneously the supply and demand function of a given market, thus employing industry-aggregate data. Table 1 provides a brief review of the literature about the Bresnahan approach. The second is widely utilized in studies about this matter, since it only requires easily available data. This model use a reduced form revenue equation to construct the H-statistic, which is calculated as the sum of the elasticities of total revenues in respect to factor input prices, i.e. it measures market power by the extent to which a change in factor input prices influences the equilibrium revenues of a bank. Table 2 also presents a literature review on the papers that have utilized this method.

Place Tables 1 and 2 About Here

In addition to these already popular measures, Boone (2008) has recently developed a new method of estimating competition. The Boone indicator (β), as it is called, considers that competition improves the performance of efficient firms and weaken the performance of inefficient ones. The idea of this indicator is clearly based on the efficiency structure hypothesis by Demsetz (1973). Thus, it measures the impact of efficiency on performance, in terms of profits and market shares. The stronger this effect is, the larger in absolute values β will be. The simplest equation to identify the Boone Indicator for bank i is defined as follows:

$$ln\,(MS_{ki}) = \alpha + \beta\ ln\,(MC_{ki}), \tag{1}$$

where MS_{ki} stands for the market share of bank i in the output k, MC is the marginal cost, and β denotes the Boone Indicator. In this paper, we are going to focus on the analysis of competition in the loans market, so $k =$ loans.

As an assumption of Boone (2008), competition means that the banks' products are close substitutes and/or entry costs are low. This itself is an advantage of the his indicator over the concentration measures and some other competition proxies. Suppose, for example, that bank product substitution increases. Then, efficient banks gain market share and, as the efficiency structure hypothesis proposes, there is more competition in the market. If these "efficient banks" are those which already have a dominant position in relation to the others, the HHI would increase, instead of decreasing. Also, measures that imply that competition is inversely proportional to the magnitude of the price margin over marginal costs would not capture this effect as well. Efficient banks may charge higher prices because of their efficient lead, which can make them reduce marginal costs quicker than prices.

Among other advantages of the Boone indicator, we highlight the possibility of measuring competition for several specific product markets and also different categories of banks. This positive characteristic may have many interesting implications for future research on the competition issue. Not only it is possible to know which bank output is subject to more or less competitive pressures, but also we can compare different types of banks in terms of competition. As an example, Leuvensteijin et al. (2007) use the Boone indicator and, among other results, they find that commercial banks appear to face more competition than cooperative and saving banks, specially in Germany and the US.

On the other hand, there is also some disadvantages. For instance, because of a efficiency improvement (i.e. a decrease in marginal costs), banks may choose to decrease the price it charges in order to gain market share or even to increase its profits and maintain the same share as before. We, therefore, have to suppose that banks pass at least part of its efficiency gains to consumers. In addition, since we have to estimate this indicator, it is constrained to the problem of idiosyncratic variation, i.e. uncertainty, as any other estimated parameter.

Because one cannot observe marginal costs directly, Schaeck and Cihák (2010) approximate a firm's marginal costs by the ratio of average variable costs to total income, while Leuvensteijin et al. (2007) calculate the marginal costs from a translog cost function for each country considered in their data. Our approach is similar to this last one, which is an improvement with respect to the former. Besides being more closely in line with the theory, the use of a translog function offers the possibility of calculating the marginal costs of any one of the outputs in the specification, such the loan market, whereas their costs are also not directly available (Leuvensteijin et al., 2007). We assume a translog cost function for bank i, and year t and estimate it for each country in the sample separately. We then derive the marginal costs from its estimation and then we use this variable as the independent regressor of market share as in equation (1). Then, our cost translog specification has the following form:

$$
\begin{aligned}
\ln\left(\frac{C}{w_2}\right)_{it} &= \delta_0 + \sum_j \delta_j \ln y_{jit} + \frac{1}{2}\sum_j\sum_k \delta_{jk}\ln y_{jit}\ln y_{kit} + \beta_1 \ln\left(\frac{w_1}{w_2}\right)_{it} \\
&+ \frac{1}{2}\beta_{11}\ln\left(\frac{w_1}{w_2}\right)_{it}\ln\left(\frac{w_1}{w_2}\right)_{it} + \sum_j \theta_j \ln y_{jit}\ln\left(\frac{w_1}{w_2}\right)_{it} \\
&+ Dummies_t + \varepsilon_{it}, \qquad (2)
\end{aligned}
$$

where C stands for the bank's total cost; y represents four outputs: total loans, total deposits, other earning assets, and non-interest income, this last being a measure of bank non-traditional activity[3]; w consists in two input prices: interest expenses to total deposits (price of funds), non-interest expenses to total assets (price of capital)[4]. The objective of normalizing the dependent variable and one input price (w_1) by another input price (w_2) is to ensure linear homogeneity.

Thus, we can obtain the marginal costs of loans (l) if we take the first derivative of the dependent variable in equation 2 in relation to the output y_{ilt} (loans): $MC_{ilt} = \frac{\partial(C_{it}/w_2)}{\partial y_{ilt}} = \left(\frac{C_{it}/w_2}{y_{ilt}}\right)\frac{\partial(lnC_{it}/w_2)}{\partial ln\, y_{ilt}}$, or more detailed:

$$MC_{ilt} = \left(\frac{C_{it}/w_2}{y_{ilt}}\right)(\delta_{j=l} + 2\gamma_{llh}\ln y_{ilt} + \sum_{k=1,\ldots,K;k\neq l}\gamma_{lkh}\ln y_{ikt}) \qquad (3)$$

Having calculated the marginal costs for loans, we can proceed to estimating the Boone indicator as in equation (1), but with small changes. In this study, we will calculate the Boone Indicator in two different specifications. First, we evaluate the competitive conditions for each Latin American banking market in the whole period; second, we assess for the changes in competition through the years in these same countries. The estimation of the following equation for each country separately gives us the competitive conditions in the loans market for the full sample period:

$$ln\,(MS_{ilt}) = \alpha + \beta\; ln\,(MC_{ilt}) + Dummies_t + e_{ilt}. \qquad (4)$$

[3]There is a growing acceptance in the incorporation of variables of bank non-traditional activities (such as off-balance sheet and non-interest income) in the banking analysis (Lozano-Vivas and Pasiouras, 2010). Ignoring these measures can be misleading, since it does not take into account the bank's balance sheet as a whole. Due to a high number of missing values on Latin American banks' off-balance sheet, we only employ the non-interest income as a non-traditional output.

[4]Total assets is employed instead of fixed assets due to several missing data of the latter.

The equation above represents the relationship between individual market costs (MC_{ilt}) and market shares (MS_{ilt}) in the loans market of bank i at time t. We also add time dummies to control for timely evolution of the market share within a country. We expect that banks with low marginal costs gain market share, i.e. $\beta < 0$. Competition tends to increase this effect, since more efficient banks outperform less efficient ones. The more negative is β, the higher is the competition level in a banking market. However, positive values for β are also possible as we can see in Leuvensteijin et al. (2007). This means that the more marginal costs a bank has, the more market share it will earn. We can think of two reasons to explain this phenomena: (i) the market has an extreme level of collusion or (ii) the banks are competing on quality. This last reason may reflect strong collusion, as well. Banks may increase their costs in order to capture additional demand by the quality channel as the market as a whole grows, which is a clear obstruction of the entry of competitors in this same market (Dick, 2007).

However, it is not enough to observe how strong competition for the period as a whole. We are also interested to observe the time evolution of the degree of competition. In order to assess this time development, we consider the following equation, where we interact the Boone Indicator with time dummies, making it time dependent:

$$ln\,(MS_{ilt}) = \alpha + \sum_{t=2001,\ldots,2008} \beta_t \; Dummies_t \; ln\,(MC_{ilT}) + Dummies_T + e_{ilt}. \tag{5}$$

The estimation of the Boone indicator for each year t is a result of this specification. We can, therefore, analyze how competition has changed over time by considering the intensity banks with low marginal costs in loans gains market share in this market by year.

As in Leuvensteijin et al. (2007) and Schaeck and Cihák (2010), we are also aware of a possible endogeneity problem in the estimation of equations (4) and (5). Both papers point out that the determination of performance and cost are determined simultaneously. Our approach is first to test whether endogeneity is indeed present in our specifications. This tests consists in the difference of two Sargan-Hansen statistics: one for the equation where we treat MC as endogenous, and one for the equation where we treat MC as as exogenous. Under conditional homoskedasticity, this endogeneity test statistic is numerically equal to a Hausman test statistic (see Hayashi, 2000, for more information). Consequently, if we confirm this problem, we utilize a two-step GMM estimator where we use one lag of MC_{ilt} as instrument. Otherwise we use a fixed-effects OLS method, more specifically the within estimator, to regress the models. In both cases we perform the kernel-based heteroscedasticity and autocorrelation consistent (HAC) variance estimation by Newey and West (1987), in order to control for both of these problems.

2.2 Evaluating the impact of competition on risk-taking

In this subsection, we present the empirical analysis of the relationship between competition and risk-taking. For this purpose, we employ a measure that reflects banks' risk-taking behavior, the Z-score. Many other studies evaluating bank risk-taking behavior also use this measure, which confirms its acceptance in the literature (Mercieca et al., 2007; Laeven and Levine, 2009; Houston et al., 2010; Demirguc-Kunt and Huizinga, 2010a). The Z-score measures the number of ROA standard deviations that a bank's ROA plus its leverage have to decrease in order for the bank to become insolvent (or $Z - score = (\overline{ROA} + \overline{Capital\ Ratio})/\sigma_{ROA}$). In other words, the Z-score is inversely proportional to the bank's probability of default.

This measure has been often employed in cross-section OLS models, where one can calculate the mean and standard deviation of ROA for the whole period. We, however, propose to calculate this measure for each three years (present year and the two precedents) so as to maintain the Z-score as an panel variable. Instead of eliminating the time dimension of the analysis, this approach only reduces the time period we consider by two-years.

In addition, we follow the model that Fang et al. (2011) introduce, to estimate the impact of competition, size and capital on bank's risk taking. This method consists in estimating a stochastic frontier (Aigner et al., 1977; Meeusen and van den Broeck, 1977) with the Z-score as the dependent variable of the translog specification, so as to provide a measure of bank's "stability inefficiency". The main idea of these authors is that the Z-score does not necessarily reflect the potential stability each bank can achieve. One has also to consider the deviation from banks' current stability and the maximum stability given the economic and regulatory conditions, which they denominate as the "stability efficiency" analysis. At the same time, we employ the inefficiency explanatory variables in the specification through the method of Battese and Coelli (1995). Thus, we use the maximum likelihood to estimate the Z-score translog specification and the inefficiency correlates simultaneously.

The equation we consider for estimating this frontier is very similar of equation (2), but instead of C (costs) we employ the Z-score and the error term ε_{it} equals $\nu_{it} - \upsilon_{it}$. The first term (ν_{it}) captures the random disturbances, assumed to be normally distributed, and representing measurement errors and other uncontrollable factors, i.e., $\nu_{it} \overset{iid}{\sim} N(0, \sigma_\nu^2)$. The second ($\upsilon_{it}$) captures technical and allocative inefficiency, both under managerial control, and it is assumed to be half-normally distributed, i.e., $\upsilon_{it} \sim N^+(\mu_{it}, \sigma_\upsilon^2)$. The degree of "stability efficiency", in this case, represents how close a bank is to the maximum Z-score, i.e. the stochastic frontier. The model to estimate the frontier is as follows:

$$\begin{aligned} \ln\left(\frac{\text{Z-score}}{w_2}\right)_{it} &= \delta_0 + \sum_j \delta_j \ln y_{jit} + \frac{1}{2}\sum_j\sum_k \delta_{jk}\ln y_{jit}\ln y_{kit} + \beta_1 \ln\left(\frac{w_1}{w_2}\right)_{it} \\ &+ \frac{1}{2}\beta_{11}\ln\left(\frac{w_1}{w_2}\right)_{it}\ln\left(\frac{w_1}{w_2}\right)_{it} + \sum_j \theta_j \ln y_{jit}\ln\left(\frac{w_1}{w_2}\right)_{it} + \ln NPI \\ &+ \alpha_1 T + \alpha_2 T^2 + \text{Macroeconomic Variables} + \nu_{it} - \upsilon_{it}, \end{aligned} \tag{6}$$

where the output and input variables are the same from equation (2). We employ country environment variables in order to control for cross-country heterogeneity of banking markets. The use of macroeconomic variables in the translog functions has been considered very important by the literature in the correct estimation of cross-country efficiency scores (Dietsch and Lozano-Vivas, 2000; Fries and Taci, 2005). These variables reflect specific characteristics, such as geography, economic condition and financial dynamism, and we detail them next. First, we employ the density of population, measured by the ratio of inhabitants per square kilometers, because we believe that banks operating in a region with a high density of population might have lower expenses. We use the density of demand, i.e. the ratio of total deposits to square kilometers, so as control for the possible higher bank expenses when the density of demand is low. We employ the GDP per capita to assess for the general development of the economy. The purpose of also employing the ratio of equity to assets is to control for the regulatory conditions. In addition, we use the ratio of loans to deposits that consists on the rate in which deposits are converted into loans, i.e. the size of intermediation. Finally, we also use the real GDP growth, as a proxy of economic dynamics.

There is, however, a problem in applying the natural logarithm of the Z-score in equation (6), since this variable can take negative values as well. In order to solve this problem we follow Bos and Koetter (2009) who employs an additional independent variable - the Negative Performance Indicator (NPI) - that takes the value of 1 when Z-score ≥ 0 and it is equal to the absolute value of Z-score, when Z-score < 0. We also change the dependent variable to take the value of 1, when it is negative.

As we have already stated, parallel to the estimation of this stability frontier we also introduce the inefficiency correlates in the model. In other words, we define the mean value of the inefficiency term μ_{it} for the Z-score function as follows:

$$\mu_{it} = \delta_0 + \sum_n \delta_{nit} z_{nit} \tag{7}$$

where z is a vector of n bank-specific variables that explains efficiency of bank i at time t. In our case, this vector of variables comprises the following variables: (1) the opposite of Boone indicator (i.e. $-\beta_t$) that we estimate from equation (5) and its square value, as well; (2) the equity to assets ratio (*Capital Ratio*), as a measure of capitalization; (3) liquid assets to total assets ratio (*Liquidity*), as a measure of liquidity; (4) the natural logarithm of assets ($SIZE$); (5) and the loan loss reserves to gross loans (LLR, in %) to control for bank's loan portfolio risk. Finally, we also add ownership dummies to assess for differences of stability inefficiency across different bank ownership type.

The idea of employing the opposite of the Boone indicator is to make it directly proportional to competition. Moreover, we also add a quadratic term of this measure to capture a possible non-linearity of the competition-risk relationship. Although this non-linear analysis can have a crucial implication to the financial stability debate, it has been largely overlooked by the literature. Finally, with the purpose of making the results clearer, and also robust, we also add specifications in which we employ competition dummies instead of the Boone indicator. These dummies are for High ($\geq \overline{Boone} + 0.5\sigma_{Boone}$), Average ($< \overline{Boone} + 0.5\sigma_{Boone}$ and $> \overline{Boone} - 0.5\sigma_{Boone}$) and Low ($\leq \overline{Boone} - 0.5\sigma_{Boone}$) competition. The division of competition into three different categories has the purpose of identifying possible non-linearities in the model, as well.

As an additional test, we are also interest to analyze whether the competition-risk relationship changes among different bank size and capitalization. We test if larger banks outperform others in collusive markets due to higher profits, and/or if the magnitude of shareholders' capital can in fact force banks to take on more risks. In this regard, Carletti (2010) affirms that funding and regulation have the same importance as market structure for explaining how the recent crisis has affected different banking sectors. To achieve this result, we add the following specifications to equation (6) by interacting the Boone indicator and its square term with: (i) SIZE; (ii) Capital Ratio; (iii) both Capital Ratio and SIZE. We also estimate these specifications again interacting all three dummies of competition with SIZE and Capital Ratio.

3 Data

Initially, our data consisted in the population of four bank specializations - commercial, cooperative, real-state and specialized government institutions - that had been operating in 10 Latin American countries from 2001 to 2008. We have taken the relevant data from from the BankScope, a financial database distributed by BVD-IBCA and converted to US dollars, which guarantees accounting uniformity between different countries. We also check carefully these data in the respective countries' central banks. After excluding banks/periods with missing, negative or zero values for inputs and outputs and other relevant data, our resulting sample for estimating the Boone indicator is an unbalanced panel data of 376 banks, totalizing 2243 observations. Additionally, since we have used two time lags in order to calculate the Z-score our database to estimate the risk-taking correlates reduced to 1491 observations from 2003 to 2008. Table 3 shows the names and descriptions of the variables we use in the models of last section.

Place Table 3 About Here

First of all, Table 4 shows the summary statistics of the bank-level variables used in the translog specifications by country. From this Table, one may identify that the banks from some of the main economies in the region, such as Mexico, Chile and Brazil, have on average the largest loan and deposit portfolios. On the other hand, the smallest banking systems in terms of loans and deposits, for example are those from Costa Rica and Dominican Republic. Nevertheless, the size of the banking market does not seem to reflect overall stability. In terms of the Z-score, the banking markets of Costa Rica, Panama and Chile are the most stable, while those of Argentina and Brazil are the least stable.

Place Table 4 About Here

Second, the summary of the variables we use in the risk-taking model is available in Table 5. This Table also includes the percentiles to better understand how distributed are these variables. As one can observe from the Z-score and LLR variables, our data encompasses banks that are practically bankrupt (low Z-score and high LLR), and extremely stable banks (high Z-score and low LLR). Furthermore, the bank's size variable (SIZE) ranges from 8.941 (bank assets equal to U$ 7.639 millions) to 19.36 (bank assets equal to U$ 255.823 billions) that reflects a widely dispersed distribution of this variable.

Place Table 5 About Here

Additionally, in Table 6, we show the cross-correlation between our main independent variables of the model. An interesting thing to note is that size appear to be negatively correlated with the capital ratio, which means that large banks have a higher propensity to use capital from other entities, i.e. to acquire liabilities. This fact will be important in the following sections, since our goal is to determine whether size and capital ratio changes the relation between competition and risk. Greater capital ratio also seems to reflect higher stability, because of the positive correlations with Z-score and ROA. We will confirm this last result latter.

Place Table 6 About Here

Finally, Table 7 presents the means and standard deviations of the country-environment variables that we employ in the Z-score translog specification. They consist in economic and financial sector development indicators in order to access for cross-country differences in economic and financial conditions. These macroeconomic data were taken from the IMF's World Economic Outlook, World Bank's database, and BankScope[5]. In fact, in Latin America, there are some essential economic differences between countries. While there are some with a dynamic economy and satisfactory social conditions, other countries are more vulnerable and present poor social indicators. These variables may have direct influence on the profitability and stability of the corresponding banking systems.

Place Table 7 About Here

[5]Bank's deposits, loans, assets and equity by country have been aggregated using the original database from the central banks to proxy for total financial sector's deposits, loans, assets and equity.

4 Empirical Results

4.1 Boone coefficient scores

In this section, we present the results from the Boone indicator estimation. In order to obtain the marginal costs, we estimate a translog cost functions for each country considered. Then, we regress these marginal costs on the market share in the loans market. The coefficient of this last variable (β) is considered to be the Boone indicator. The more negative, this indicator is, the more competitive is a specific banking market.

Place Table 8 About Here

The results of the Boone indicator by country for the whole period considered are presented in Table 8. The endogeneity test has pointed out that only for Peru has marginal costs been considered endogenous (at 5% significance level) in the estimation of equation (4). Thus, we employ a GMM estimator for this country and we use an OLS for all the others. The overall result suggests that Latin American banks are operating in a less competitive market than in Europe and in the US, if we compare with the results from Leuvensteijin et al. (2007). However, we also acknowledge that this sort of comparison should be made carefully, since the estimation of the Boone indicator, depends on how it was modeled. For example, Schaeck and Cihák (2010) have employed in the Boone estimation ROA instead of market share as the dependent variable and average costs instead of marginal costs as the independent variable. They found that the Boone indicator for the US and Europe was concentrated between 0 and -0.15. The model of Leuvensteijin et al. (2007), on the other hand, is closer to ours despite some differences being apparent.

Another conclusion is that competition seems to be very heterogeneous across Latin American countries, with Peru and Colombia being, respectively, the most competitive banking markets, and Chile and Costa Rica being the most collusive ones. In fact, the Boone indicator for Chile is not significantly different from 0 (monopoly) at 10% significance level. Other large economies of Latin America, like Brazil, Argentina, Mexico and Venezuela, show a moderate level of banking competition in this period. These results shed some light in the development level of institutional framework of Latin American countries.

Place Table 9 About Here

We can also estimate the Boone indicator by year in order to consider the time evolution of competition. Table 9 shows these Boone indicators for Latin American countries. Through this analysis, we can observe that competition has evolved differently across Latin American countries. While in some countries, competition has increased throughout the years (Argentina, Colombia, Dominican Republic, Mexico), in others competition has decreased (Brazil, Costa Rica, Panama, Venezuela). Competition has not changed significantly through time in Peru and Chile.

For some countries there are even years where the Boone indicator is not statistically different from 0 (zero) or significantly positive. As we have already stated before, positive values for this measure may mean perfect collusion or competition in quality. The latter, however, may result in an increase barriers to entry, i.e. more collusion as well. Consequently, perfect collusion may be the case of Argentina in the years of 2001-2002 (peak of the economic crisis this country has faced); Chile for all the years except 2007; Costa Rica in 2008; Dominican Republic from 2001 to 2003; Mexico in 2001; Panama in 2007 and 2008; and Venezuela in 2001 and in 2005 to 2008.

4.2 Competition-Stability analysis

In this section, we present the results of our main model, whose objective is to estimate the relationship between competition and banks' risk-taking behavior, and how this competition changes due to the influence of capitalization and size on risk-taking, as well. For example, Hellman et al. (2000) and Allen and Gale (2000) suggests that larger banks have a higher profit margin in collusive markets, and this is why these banks are more stable in these conditions. Competition can also pressure banks to take more risks depending on size and capitalization of these banks.

Tables 10 to 13 show the estimations of equation (7), where we regress a series of explanatory variables variables on the "stability inefficiency". Negative coefficients mean that the corresponding variables are inversely proportional to financial fragility, and thus they appear to increase stability. Positive coefficients, on the other hand, means that the variables are directly proportional to fragility. In the first column of every Table we employ the Boone indicator as the proxy of competition. Since this indicator is inversely proportional to competition (the more negative is this measure, the more competitive is a banking market), in reality we add the opposite of this indicator (Boone $= -\beta_t$) so as to make it directly proportional to competition. In addition, the second to fourth columns of each Table employs dummies that represent high, average and low competition, respectively. Each table has one different specification as well in which we add interactions between the competition proxies, size, and capitalization variables.

Place Table 10 About Here

We note from column [1] of Table 10 that the relationship between competition and risk taking appears to be $\bigcap$-shaped. In other words, banks operating under low and high competition levels are the less fragile ones, while banks under average competition are those with a more aggressive risk-taking behavior. The negative and significant coefficients of high and low competition dummies and the positive coefficient of average competition in columns [2] to [4] confirm this result. Our findings accept (and at the same time reject) the "concentration-fragility" and "concentration-stability" theories at the same time for Latin American banks. These results are similar to those of Berger et al. (2009) for 30 developed economies' banking sectors. These authors state that finding evidence to support one of the theories does not necessarily excludes the other. However, we cannot yet affirm what are the reasons of why banks are better of in both competitive and collusive banking markets. We expect that the other specifications will clarify these reasons.

In what regards the other control variables, we may observe that loan loss reserves have a detrimental effect on stability. We have already expected this result, since the motive of adding this variable was to control for banks' exposure degree. The capital ratio has a negative and significant coefficient, which confirms the idea that banks are more cautions when the shareholders have more capital at stake, i.e. the *moral hazard hypothesis* (see Berger and DeYoung, 1997). The coefficient of liquidity is positive and significant, and thus banks with more liquidity seem be farther from the stability frontier. We also conclude that private and foreign banks appear to be more inefficient in terms of stability in relation to public banks, as well.

Place Table 11 About Here

Table 11 shows the results on the specification in which we interact SIZE and competition variables, in which we want to know whether the impact of size varies with competition levels. In column [1], the interactions of SIZE and Boone and its square value show that the effect of SIZE on financial fragility is $\bigcap$ shaped as a function of the Boone indicator. We must take the first derivative of the first column in respect of SIZE to understand better how this effect varies with the Boone indicator. This effect is as follows: $\partial \mu / \partial SIZE = -9.10 * Boone^2 + 7.75 * Boone - 1.65$, whose roots are 0.417 and 0.435. In fact, when we interact SIZE and the dummy of high competition in column [2], we find from the sign of its coefficient that large banks appear to perform better in less collusive markets. If the variable SIZE is larger than 10.13, i.e. with at least U$25.2 million assets, the coefficient of the competition dummy becomes negative [6]. In column [3], the interaction between the average competition dummy and SIZE is insignificant. Finally, column [4] shows that under a low competition, banks are more stable for all values for SIZE, but decreasing in this last variable. At the same time, when Low = 1 the effect of SIZE becomes slightly positive, but not significant in accordance with a Wald Test (p-value = 0.27). The other control variables have similar coefficients than those of the last Table.

The result above implies that we do not have reasons to accept the statement of the concentration-stability literature that larger banks in collusive markets are more stable, even though we cannot reject this theory *per se* (or at least half of it as discussed before), i.e. the fact that banks under low competition are more stable. In fact, our findings suggest that larger banks are less risk-takers in a competitive environment. However, we cannot say that under lower competitive levels, the effect of size is detrimental to overall stability due to the insignificant effects of columns [3] and [4]. There must be other reasons, therefore, for why low competition is also positive for banks' stability, such as the amount of shareholder's capital, which we will analyze in Table 12.

Place Table 12 About Here

The $\bigcap$-shaped effect on risk-taking as a function of competition also appears to be the case of the Capital Ratio, as we can see by the first column of Table 12. Column [4] supports these results, due to the negative coefficient of the interaction between the low competition dummy and capital ratio. The interaction coefficients in columns [2] and [3] are both insignificant, suggesting that high and average competition levels do not change the negative effect of capital ratio on stability inefficiency. Additionally, these findings also point out under low competition this negative impact of capital ratio is more pronounced. Therefore, collusive banking markets is positive for overall bank stability, specially for those banks with a high capital ratio.

[6] A wald test shows that the effect of SIZE on inefficiency under high competition becomes significantly negative at approximately SIZE= 11.7.

This last statement gives support to Berger et al. (2009) when they affirm that even if collusion leads to riskier loan portfolios (as in Boyd and Nicoló, 2005), banks may increase their equity capital in order to protect maintain their overall stability. An effective regulamentary policy to reduce financial fragility would be the imposition of higher capital requirement that implies lower liabilities[7].

Consequently, the results above show that capitalization explains why collusion reduces risk-taking in the Latin American banking market. According to the definitions of Hellman et al. (2000), the *capital-at-risk effect* is greater than the *franchise-value effect* in the case of low competition in the Latin American region. That is, there is no indication that capital ratio affects franchise values so as to force a bank to take risks. For example, Repullo (2004) affirms that this effect is insignificant if one assumes that the costs of higher capital requirements are fully transferred to the depositors of that bank.

Although we have tested how size and capital interacts with competition separately, there is also the need to understand how is their jointly influence on risk-taking. In other words, the question we pose is whether large banks benefits the most from high (or low) capital ratios given the competitive level. Table 13 shows these results.

Place Table 13 About Here

Column [2] of this Table shows that, supposing the high competition dummy equals to one, the interaction between SIZE and Capital Ratio becomes more negative, and the coefficient of capital ratio alone becomes more positive as well. The coefficients of "High Comp." and SIZE, alone, are insignificant, as well as its interaction. Therefore, the interpretation of the results in the final column of this Table is as follows: for banks with assets larger than U$ 222.2 million (SIZE = 12.31) and operating under high competition (i.e. High Comp. = 1) , the capital ratio appears to reduce stability inefficiency. Regarding column [3], when average competition is equal to one, we can conclude that the coefficient of the interaction of SIZE and capital ratio becomes closer to zero. Thus, there appears to be a positive effect of

[7]According to Carletti (2010), even within bank's liabilities, the funding structure can have an important role in explaining stability. In the recent financial crisis, banks are more stable when they rely more on depository than on wholesale funding. In other words, banks that were more exposed to short-term borrowing, were deeply affected by the financial crisis (Carletti, 2010)

Capital Ratio on the “stability inefficiency” for all banking sizes, but decreasing in this last variable. Finally, all the interactions with the dummy of low competition are insignificant in column [4].

5 Conclusion

This paper has the purpose of determining whether competition improves or reduces banking stability for 10 Latin American countries between the years 2001 and 2008. Although there have been several articles concerning this issue, the literature has not yet reached a clear consensus of whether competition stimulates banks to take risks. Since competition cannot be calculated directly, we estimate, as a competition measure, the Boone indicator of the loans market, whose value shows how intense is the effect of more efficient banks earning market share. Then, we regress this indicator on risk-taking so as to identify how financial stability reacts with different competition levels. Finally, we evaluate how this relationship changes with both bank's size and capital ratio.

Our results support both theories of concentration-stability and concentration-fragility due to a nonlinearity of the effect of competition on risk-taking. Banks under high and low competition are both, on average, more stable than banks under average competition. However, the reasons for these results are different. Banks in competitive markets are more stable, specially if they are larger in size. Under competition, capitalization only seems be a positive influence for financial stability for banks of higher size as well. On the other hand, in collusive markets it is capitalization that matters, since banks with a larger capital ratio are more stable. The reasons of why average competition appear to increase financial fragility are not clarified in our model.

Besides addressing to a gap in the literature, this paper contributes to the current discussion on financial regulation in the light of the Basel III implementation. As one of the proposition of this regulatory standard, a harsher capital requirement might benefit larger Latin American banks operating under high competition and banks in general under low competition. Therefore, there are clear indications that Basel III, if implemented, would be advantageous for the region in terms of financial stability.

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Table 1: Literature on banking competition - Bresnahan (1982) approach.

Author(s)	Period	Countries	Results
Shaffer (1989)	1941-1983	USA	Perfect competition
Shaffer (1993)	1965-1989	Canada	Perfect competition despite high concentration
Shaffer (2002)	1979-1991	Switzerland	Foreign-owned banks have more market power
			than the state-owned
Coccorese (2008)	1995-2004	Italy	Imperfect competition.
Coccorese (2005)	1988-2000	Italy	The eight largest banks are under imperfect competition.
Uchida and Tsutsui (2005)	1974-2000	Japan	On average, competition is increasing.
Canhoto (2004)	1990-1995	Portugal	Imperfect competition in the deposit market
Toolsema (2002)	1993-1999	The Netherlands	Consumer credit market was under perfect competition.

Table 2: Literature on banking competition - Panzar and Rosse (1987) approach

Author(s)	Period	Countries	Results
Nathan and Neave (1989)	1982-1984	Canada	Perfect competition for 1982 and monopolistic competition for 1983 and 1984.
Shaffer and DiSalvo (1994)	1970-86	Pennsylvania(USA)	Duopoly; high competition.
Hondroyiannis et al. (1999)	1993-95	Greece	Monopolistic Competition.
Rozas (2007)	1986-2005	Spain	Monopolistic competition; larger banks are more competitive.
Mamatzakis et al. (2005)	1998-2002	SEE countries	Monopolistic competition.
Coccorese (2004)	1997-1999	Italy	Monopolistic competition.
Trivieri (2007)	1996-2000	Italy	Monopolistic competition; Banks involved in cross-ownership are less competitive.
Deltuvaite et al. (2007)	2000-2006	Lithuania	Monopolistic competition.
Maudos and Solís (2007)	1993-2005	Mexico	Monopolistic Competition
Bikker and Haaf (2002)	1988-1998	23 countries	Monopolistic Competition for almost all countries; perfect competition cannot be rejected in some cases.
Bikker and Groeneveld (1998)	1989-1996	EU-15 countries	Monopolistic competition; concentration impairs competition
Bikker and Spierdijk (2008)	1986-2004	101 countries	Declining competition for developed countries; increasing for emerging economies.
Bikker et al. (2006)	1986-2005	120 countries	Monopolistic competition is predominant.
Bandt and Davis (2000)	1992-1996	Germany, USA, France and Italy	Competition is lower in small banks and higher in US banks.
Molyneux et al. (1994)	1986-1989	France, UK, Spain, Germany, and Italy	Monopoly for Italy and monopolistic competition for the rest.
Chan et al. (2007)	1996-2005	Australia and New Zealand	Conjectural variation oligopoly or monopoly for both markets.
Smith and Tripe (2001)	1996-1999	New Zealand	Monopolistic competition; in 1997, monopoly.
Yuan (2006)	1996-2000	China	Perfect competition.
Yildirim and Philippatos (2007)	1993-2000	11 Latin American countries	Monopolistic Competition.
Yeyati and Micco (2007)	1993-2002	8 Latin American countries	Monopolistic Competition.
Duncan (2003)	1989-2002	Jamaica	Monopolistic competition.
Belaisch (2003)	1997-2000	Brazil	Monopolistic competition.
Park (2009)	1992-2004	Korea	Monopolistic competition and perfect competition during the crisis
Molyneux et al. (1996)	1986;1988	Japan	Monopoly for 1986; monopolistic competition for 1988.
Turk-Ariss (2009)	2000-2006	12 MENA countries	Monopoly for North African countries and monopolistic competition for the others.
Al-Muharrami et al. (2006)	1993-2002	8 GCC countries	Perfect Competition for Kuwait, Saudi Arabia and UAE; monopolistic competition for Bahrain and Qatar and monopoly for Oman.

[1] SEE stands for South Eastern Europe.
[2] GCC means Gulf Cooperation Council; MENA represents the Middle East and North Africa Region, and UAE is the United Arab Emirates.

Table 3: Formal description of the main variables of the paper

Variable	Description
Dep. Vars.	
C	Total expenses; dependent variable in equation (2). Source: BankScope and LA Central Banks
Z-score	Sum of the means of ROA and of Capital Ratio to the standard deviation of ROA ratio; dependent variable in equation (6). Source: BankScope and LA Central Banks
MS_l	Market share in the loans market; dependent variable in equations (4) and (5). Source: the authors.
Indep. Vars.	
y_1	Total loans net of loan loss provisions; bank output in equations (2) and (6). Source: BankScope and LA Central Banks
y_2	Total other earning assets; bank output in equations (2) and (6). Source: BankScope and LA Central Banks
y_3	Total liquid assets; bank output in equations (2) and (6). Source: BankScope and LA Central Banks
y_4	Total Deposits; bank output in equations (2) and (6). Source: BankScope and LA Central Banks
w_1	Price of funds: total interest expenses to total deposits ratio; bank input price in equations (2) and (6). Source: BankScope and LA Central Banks
w_2	price of capital: total non-interest expenses to total assets ratio; bank input price in equations (2) and (6). Source: BankScope and LA Central Banks
MC_l	Marginal costs in the loan market. It is derived from equation (2) as in equation (3). Source: the authors.
Capital Ratio	Equity capital to total assets ratio; independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
NPI	Negative Performance Indicator; equal to the absolute value of the Z-score if non-positive and equal to one otherwise. Source: the authors.
Liquidity	Liquid assets to total assets ratio; independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
SIZE	The natural logarithm of total assets; independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
LLR	Loan loss reserves to gross loans ratio (in %); independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
Private	Equal to 1 if the bank is private-owned; independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
Foreign	Equal to 1 if the bank is foreign-owned; independent variable in all specifications of equation (7). Source: BankScope and LA Central Banks
Boone indicator	Competition proxy; independent variable of one specification of equation (7). The absolute value of the β_t in equation (5). Source: the authors.
High Comp.	Equal to 1 when the Boone indicator $\geq \overline{Boone} + 0.5\sigma_{Boone}$; independent variable of one specification of equation (7). Source: the authors.
Low Comp.	Equal to 1 when the Boone indicator $\leq \overline{Boone} + 0.5\sigma_{Boone}$; independent variable of one specification of equation (7). Source: the authors.
Avg Comp.	Equal to 1 when both High Comp. and Low Comp. are equal to 0; independent variable of one specification of equation (7). Source: the authors.
ROA	Total profit-before-taxes to total assets ratio Source: BankScope and LA Central Banks

Note: this table presents the description of the main variables we employ throughout the paper. Also, we specify to which equation each variable belongs.

Table 4: Mean and Std. Dev. of outputs and input prices employed in the translog specification

Country/variables	Expenses	Z-Score*	Loans	Deposits	NII	OEA	Price of Funds	Price of Capital	OBS
Argentina	152749	20.982	672903	878409	82747	748337	0.109	0.082	338
	(293837)	(51.407)	(1348218)	(159862)	(161821)	(1557448)	(0.213)	(0.059)	
Brazil	1383722	27.288	3212067	4230787	252384	5301560	1.074	0.084	535
	(3636441)	(38.477)	(9950336)	(13000000)	(781117)	(15400000)	(6.507)	(0.075)	
Chile	411081	55.459	3727192	3619562	82683	1092382	0.059	0.037	154
	(592297)	(61.251)	(5240769)	(5082460)	(110201)	(1633905)	(0.032)	(0.026)	
Colombia	262049	35.100	1404781	1714300	121790	644983	0.169	0.064	210
	(401354)	(77.035)	(2391686)	(2582393)	(180123)	(762196)	(0.816)	(0.042)	
Costa Rica	66279	72.772	320153	425616	12088	173177	0.110	0.055	202
	(114858)	(121.064)	(497015)	(765862)	(23698)	(379610)	(0.103)	(0.021)	
Dominican	75124	29.342	279828	373063	19125	151416	0.680	0.085	159
	(115846)	(31.670)	(507883)	(714574)	(40109)	(287855)	(5.342)	(0.063)	
Mexico	1104384	31.868	4967057	6242088	207100	2798891	0.182	0.058	218
	(1668294)	(37.403)	(7441757)	(9761256)	(428361)	(5637125)	(0.452)	(0.050)	
Panama	94447	56.002	853835	999884	27397	339442	0.045	0.028	230
	(160108)	(39.730)	(1405369)	(1527944)	(54732)	(431514)	(0.019)	(0.022)	
Peru	206494	35.885	1459859	2067655	68783	776308	0.042	0.053	84
	(232745)	(31.361)	(1864046)	(2533111)	(101109)	(975164)	(0.032)	(0.027)	
Venezuela	191186	23.928	788014	1440600	51848	506641	0.073	0.071	220
	(290065)	(31.375)	(1435133)	(2171726)	(82265)	(686350)	(0.066)	(0.033)	

Note: Standard deviations are in parenthesis.
*The Z-score ranges from 2003 to 2008, since we use two-lagged variables in its calculation.

Table 5: Summary statistics

Variable	Mean	Std. Dev.	p0	p25	p50	p75	p100
Liquidity	0.250	0.171	0.001	0.131	0.212	0.338	0.970
Capital Ratio	0.140	0.112	-0.683	0.084	0.110	0.153	0.947
SIZE	13.840	1.827	8.941	12.610	13.740	15.040	19.360
LLR (in %)	4.771	5.226	0	1.965	3.310	5.850	76.920
ROA	0.023	0.036	-0.656	0.011	0.020	0.032	0.313
ROE	0.153	1.378	-52.440	0.101	0.179	0.276	3.735
Z-score	35.470	59.666	-1.676	10.980	20.620	39.640	1278

Table 6: Cross-Correlation Table

Variables	Z-Score	SIZE	Liquidity	Capital	ROA	ROE	LLR	Private	Forreign
Z-Score	1.000								
SIZE	0.001	1.000							
Liquidity	-0.161	0.044	1.000						
Capital	0.158	-0.343	0.025	1.000					
ROA	0.035	-0.022	0.033	0.407	1.000				
ROE	0.012	0.027	0.032	0.013	0.062	1.000			
LLR	-0.106	-0.065	0.105	0.054	-0.161	-0.063	1.000		
Private	0.004	-0.233	-0.101	-0.037	0.039	-0.013	-0.004	1.000	
Foreign	-0.047	0.092	0.010	-0.000	-0.060	0.003	-0.127	-0.697	1.000

Table 7: Country-environmental variables

	GDP growth	GDP [a] per cap.	$\frac{Loans}{Deposits}$	$\frac{Population}{km2}$	$\frac{Deposits}{km2}$	$\frac{Equity}{Assets}$
Argentina	8.487	5.383	0.715	13.952	15.600	0.113
	(0.885)	(1.777)	(0.137)	(0.253)	(2.182)	(0.005)
Brazil	4.123	5.466	0.935	21.679	43.870	0.093
	(1.768)	(2.013)	(0.034)	(0.458)	(19.423)	(0.005)
Chile	4.668	7.818	1.027	21.524	110.483	0.084
	(1.043)	(2.200)	(0.050)	(0.494)	(35.126)	(0.007)
Colombia	5.337	3.425	0.826	40.656	46.440	0.121
	(1.813)	(1.108)	(0.077)	(1.206)	(19.215)	(0.007)
Costa Rica	5.956	5.174	0.756	84.357	248.524	0.133
	(2.265)	(0.892)	(0.101)	(3.243)	(59.150)	(0.006)
Dominican	5.787	3.757	0.702	176.315	180.328	0.116
	(4.471)	(1.043)	(0.080)	(4.722)	(48.467)	(0.010)
Mexico	3.116	8.540	0.779	53.308	103.746	0.113
	(1.418)	(1.347)	(0.044)	(0.696)	(9.959)	(0.016)
Panama	8.029	5.207	0.846	43.136	501.525	0.111
	(2.429)	(0.970)	(0.071)	(1.419)	(122.404)	(0.003)
Peru [b]	7.648	3.422	0.708	21.559	20.805	0.105
	(1.875)	(0.730)	(0.044)	(0.580)	(7.386)	(0.012)
Venezuela	7.403	6.599	0.516	29.284	54.820	0.160
	(8.638)	(2.938)	(0.103)	(1.087)	(30.614)	(0.047)

[a] In thousands of Dollars (USD) per individual.
[b] The time period for period ranges only from 2004 to 2008 due to the lack of data.
Source: World Bank, International Monetary Fund, and Latin American central banks.

Table 8: Boone indicator of the loans market by banking sector

	B	t	Method	Endogeneity test (p-value)
Argentina	-0.436***	-2.96	OLS	0.31
Brazil	-0.480***	-5.04	OLS	0.50
Chile	-0.233	-1.34	OLS	0.61
Colombia	-1.200**	-6.20	OLS	0.32
Costa Rica	-0.218**	-2.60	OLS	0.86
Dominican Rep.	-0.349*	-1.94	OLS	0.96
Mexico	-0.493**	-2.79	OLS	0.16
Panama	-0.622**	-2.88	OLS	0.64
Peru	-1.207***	-5.77	GMM	0.04
Venezuela	-0.416***	-2.92	OLS	0.20

Note: this table presents the estimation of the Boone indicator (β) as in equation (4). The more negative it is, the more competitive is the banking market considered. Before deciding which estimator to employ, we conduct a endogeneity test for the marginal cost variable. If we reject the null hypothesis of exogeneity, we use the GMM estimator. On the other hand, if we cannot reject this null hypothesis, we employ the OLS fixed effects estimator. In both cases, we consider heteroskedasticity-autocorrelation robust standard errors (HAC).

*** p<0.01, **p<0.05,* p<0.1

Table 9: Boone scores of the loans market by banking sector and time

Year/ Countries	ARG		BRA		CHI		COL		COR		DOM		MEX		PAN		PER		VEN	
	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t	Boone	t
2001	0.322*	1.68	-0.554***	-5.89	-0.221	-1.4	-0.697***	-5.40	-0.257***	-2.84	0.597***	4.33	-0.218	-0.86	-0.445**	-2.45	-	-	-0.242	-1.63
2002	-0.580	-1.56	-0.366***	-3.45	-0.252	-1.54	-0.620***	-3.98	-0.216**	-2.52	0.286	1.13	-0.600***	-3.68	-0.677***	-3.45	-1.232***	-4.38	-0.866***	-3.90
2003	-0.429***	-2.63	-0.504***	-5.97	-0.275	-1.59	-0.710***	-4.59	-0.285**	-2.39	0.292	0.92	-0.551***	-3.76	-0.700***	-3.30	-1.303***	-3.63	-0.596***	-4.45
2004	-0.590***	-2.68	-0.511***	-5.61	-0.285	-1.64	-0.916***	-6.62	-0.298***	-2.99	-0.624***	-3.53	-0.517***	-3.37	-0.751**	-2.36	-1.304***	-3.65	-0.680***	-4.87
2005	-0.262*	-1.75	-0.363***	-4.04	-0.279	-1.64	-0.979***	-7.49	-0.282***	-2.86	-0.606***	-3.38	-0.461***	-3.19	-0.585***	-3.15	-1.192***	-3.83	-0.202	-1.27
2006	-0.363***	-3.14	-0.461***	-5.32	-0.279	-1.65	-1.167***	-10.59	-0.228**	-2.41	-0.975***	-4.04	-0.466***	-3.04	-0.286**	-2.02	-1.230***	-4.04	-0.158	-0.95
2007	-0.346***	-2.68	-0.496***	-4.97	-0.250*	-1.67	-1.141***	-7.86	-0.262**	-2.30	-1.591***	-4.15	-0.405***	-2.78	-0.286	-0.76	-1.283***	-4.64	-0.140	-0.81
2008	-0.471***	-3.73	-0.383***	-4.48	-0.219	-1.49	-0.731***	-5.53	-0.166	-1.65	-1.366***	-3.13	-0.639***	-2.93	-0.353	-0.99	-1.242***	-5.69	0.957***	3.51
Model:	OLS		OLS		OLS		OLS		OLS		OLS		OLS		OLS		GMM		OLS	

Note: this table presents the estimation of Boone indicator that depends on time (β_t) as in equation (5). The more negative it is, the more competitive is the banking market at that specific point of time. Before deciding which estimator to employ, we conduct a endogeneity test for the marginal cost variable. If we reject the null hypothesis of exogeneity, we use the GMM estimator. On the other hand, if we cannot reject this null hypothesis, we employ the OLS fixed effects estimator. In both cases, we consider heteroskedasticity-autocorrelation robust standard errors (HAC).
*** p<0.01, **p<0.05,* p<0.1

Table 10: The effect of competition on Stability Inefficiency

VARIABLES	[1] Z-Score Ineff.	[2] Z-Score Ineff.	[3] Z-Score Ineff.	[4] Z-Score Ineff.
Intercept	-3.4760**	-2.6470*	-1.9455	0.8755
	(1.5475)	(1.5528)	(1.7249)	(1.2637)
LLR	0.1374***	0.1219***	0.1018***	0.0931***
	(0.0234)	(0.0227)	(0.0162)	(0.0132)
Capital Ratio	-5.6428***	-2.4240**	-2.3524***	-2.155***
	(1.6410)	(0.9949)	(0.8759)	(0.7766)
Boone	-11.008***			
	(2.5781)			
Boone^2	-9.9437***			
	(2.2668)			
High Comp.		-2.5307**		
		(1.1565)		
Avg Comp.			2.3951***	
			(0.8057)	
Low Comp.				-2.9853**
				(1.2606)
SIZE	-0.0802	0.0658	-0.1227	-0.1879**
	(0.0721)	(0.0806)	(0.0763)	(0.0883)
Liquidity	2.0273***	1.5065**	1.6201***	1.8411***
	(0.6816)	(0.6388)	(0.5991)	(0.6106)
Private	0.9061***	0.8666***	0.7415***	0.8034***
	(0.3179)	(0.3213)	(0.2714)	(0.2998)
Foreign	1.7874***	1.5274***	1.6524***	1.8161***
	(0.4791)	(0.4505)	(0.4137)	(0.4336)
σ^2	1.9299***	1.7881***	1.7101***	1.6776***
	(0.3288)	(0.3479)	(0.2735)	(0.2657)
γ	0.6353***	0.5936***	0.5787***	0.5343***
	(0.0695)	(0.0907)	(0.0786)	(0.0892)
Max. Likel.	-2117.846	-2141.079	-2108.971	-2126.329

Note: this table presents the estimation results of our main model, where we test whether competition influences stability inefficiency controlling by other variables. We estimate the Z-score translog function, as in equation (6), which Fang et al. (2011) propose. Unlikely the common efficiency frontiers of costs and profits, this approach takes into account the bank's risk-taking behavior. The measure of competition is the time-varying Boone Indicator that we have estimated previously and reported the results in table 9. In fact, in order to facilitate the results' interpretation, we have employed the absolute value of this indicator. Again, to make the results more presentable, we have also added (in columns [2] to [4]) specifications were we use dummies of high, average and low competition, respectively, whose construction we explain in section 2.2. Finally, σ^2 is the sum of the variance of the error terms in equation (2), i.e. $\sigma^2 = \sigma_\upsilon^2 + \sigma_\nu^2$. The ratio between the variance of the inefficiency variance and total variance is equal to γ. Standard errors in parentheses.
*** p<0.01, **p<0.05,* p<0.1

Table 11: The effect of competition on Stability Inefficiency and how it changes with bank's size

VARIABLES	[2] Z-Score Ineff.	[2] Z-Score Ineff.	[2] Z-Score Ineff.	[2] Z-Score Ineff.
Intercept	11.7495**	-1.4727	-0.6018	0.5837
	(5.9157)	(1.3087)	(4.0078)	(1.3112)
LLR	0.1148***	0.1010***	0.1008***	0.0923***
	(0.0191)	(0.0158)	(0.0168)	(0.0138)
Capital Ratio	-2.5280**	-1.3793*	-2.2419**	-2.1551***
	(1.2403)	(0.7881)	(0.9156)	(0.7567)
Boone	66.0032***			
	(23.2243)			
Boone^2	82.9374***			
	(24.4611)			
High Comp.		6.6336*		
		(3.8043)		
Avg Comp.			1.1310	
			(3.5155)	
Low Comp.				-9.2362*
				(4.7948)
Boone*SIZE	7.7528***			
	(2.3420)			
Boone^{2}SIZE	-9.1027***			
	(2.5533)			
High Comp. * SIZE		-0.6546*		
		(0.3359)		
Avg Comp. * SIZE			0.0992	
			(0.2809)	
Low Comp. * SIZE				0.4970*
				(0.2936)
SIZE	-1.6533***	0.0179	-0.2296	-0.1529*
	(0.5660)	(0.0724)	(0.3151)	(0.0815)
Liquidity	2.2415***	1.3576**	1.6619***	1.6595***
	(0.6198)	(0.5349)	(0.6349)	(0.6267)
Private	0.7039***	0.7226**	0.7403**	0.7665**
	(0.2647)	(0.2827)	(0.2980)	(0.3336)
Foreign	1.5409***	1.2734***	1.6484***	1.7511***
	(0.3829)	(0.3563)	(0.4407)	(0.4710)
σ^2	1.7257***	1.6424***	1.7107***	1.6659***
	(0.2686)	(0.2651)	(0.2811)	(0.2631)
γ	0.5755***	0.5783***	0.5772***	0.5447***
	(0.0720)	(0.0791)	(0.0766)	(0.0900)
Max. Likel.	-2093.823	-2138.599	-2108.904	-2124.979

Note: this table presents the estimation results of our main model, where we test whether competition influences stability inefficiency controlling by other variables. We estimate the Z-score translog function, as in equation (6), which Fang et al. (2011) propose. Unlikely the common efficiency frontiers of costs and profits, this approach takes into account the bank's risk-taking behavior. The measure of competition is the time-varying Boone Indicator that we have estimated previously and reported the results in table 9. In fact, in order to facilitate the results' interpretation, we have employed the absolute value of this indicator. Again, to make the results more presentable, we have also added (in columns [2] to [4]) specifications were we use dummies of high, average and low competition, respectively, whose construction we explain in section 2.2. Specifically in this table, we interact the competition variable and dummies with the variable SIZE to determine whether the effect of competition on risk-taking varies as function of bank's size. Finally, σ^2 is the sum of the variance of the error terms in equation (2), i.e. $\sigma^2 = \sigma_\upsilon^2 + \sigma_\nu^2$. The ratio between the variance of the inefficiency variance and total variance is equal to γ. Standard errors in parentheses.
*** p<0.01, **p<0.05,* p<0.1

Table 12: The effect of competition on Stability Inefficiency and how it changes with the capital ratio

VARIABLES	[1] Z-Score Ineff.	[2] Z-Score Ineff.	[3] Z-Score Ineff.	[4] Z-Score Ineff.
Intercept	-14.6270***	-3.0464	-0.7742	0.7067
	(3.9837)	(2.1282)	(1.6239)	(1.2264)
LLR	0.1153***	0.1352***	0.0848***	0.0921***
	(0.0195)	(0.0399)	(0.0164)	(0.0128)
Capital Ratio	-10.1520	-3.2417*	-3.7974***	-1.9417***
	(6.5661)	(1.9636)	(1.3933)	(0.7496)
Boone	-60.415***			
	(15.736)			
Boone^2	-62.475***			
	(16.016)			
High Comp.		-3.1202*		
		(1.8966)		
Avg Comp.			1.4375*	
			(0.7501)	
Low Comp.				0.8835
				(1.0209)
Boone*Capital Ratio	52.546**			
	(19.296)			
Boone^2*Capital Ratio	-71.577***			
	(19.455)			
High Comp.*Capital Ratio		1.5945		
		(2.5987)		
Avg Comp.*Capital Ratio			2.5072	
			(1.736)	
Low Comp.*Capital Ratio				-29.214**
				(14.893)
SIZE	-0.0670	0.0623	-0.0943	-0.1540**
	(0.0741)	(0.0862)	(0.0790)	(0.0727)
Liquidity	1.8218***	1.7446*	1.2260**	1.5313**
	(0.5407)	(0.9361)	(0.5357)	(0.5654)
Private	0.6354**	0.9799**	0.5780**	0.7519**
	(0.2732)	(0.4246)	(0.2744)	(0.2948)
Foreign	1.4945***	1.7388**	1.3014***	1.6820***
	(0.3860)	(0.6964)	(0.4011)	(0.4154)
σ^2	1.5805***	1.9437***	1.5224***	1.6893***
	(0.2384)	(0.5355)	(0.2414)	(0.2429)
γ	0.50684***	0.6223***	0.5469***	0.5699***
	(0.0800)	(0.1024)	(0.0775)	(0.0744)
Max. Likel.	-2087.235	-2140.934	-2108.136	-2120.743

Note: this table presents the estimation results of our main model, where we test whether competition influences stability inefficiency controlling by other variables. We estimate the Z-score translog function, as in equation (6), which Fang et al. (2011) propose. Unlikely the common efficiency frontiers of costs and profits, this approach takes into account the bank's risk-taking behavior. The measure of competition is the time-varying Boone Indicator that we have estimated previously and reported the results in table 9. In fact, in order to facilitate the results' interpretation, we have employed the absolute value of this indicator. Again, to make the results more presentable, we have also added (in columns [2] to [4]) specifications were we use dummies of high, average and low competition, respectively, whose construction we explain in section 2.2. Specifically in this table, we interact the competition variable and dummies with the variable Capital Ratio to determine whether the effect of competition on risk-taking varies as function of bank's capital ratio. Finally, σ^2 is the sum of the variance of the error terms in equation (2), i.e. $\sigma^2 = \sigma_\upsilon^2 + \sigma_\nu^2$. The ratio between the variance of the inefficiency variance and total variance is equal to γ. Standard errors in parentheses.
*** p<0.01, **p<0.05,* p<0.1

Table 13: The effect of competition on Stability Inefficiency and how it changes with bank's size and the capital ratio

VARIABLES	[1] Z-Score Ineff.	[2] Z-Score Ineff.	[3] Z-Score Ineff.	[4] Z-Score Ineff.
Intercept	-47.081***	-4.1779*	-2.8354	-3.7956
	(10.730)	(2.3203)	(2.7891)	(2.5094)
LLR	0.1083***	0.1283***	0.0935***	0.1264***
	(0.015)	(0.0289)	(0.0155)	(0.0271)
Capital Ratio	278.65***	14.9243***	36.475**	23.511**
	(63.133)	(8.3291)	(17.054)	(10.893)
Boone	-187.20***			
	(42.795)			
$Boone^2$	-192.90***			
	(43.928)			
High Comp.		3.5295		
		(3.9148)		
Avg Comp.			1.9166	
			(2.2354)	
Low Comp.				44.9190
				(39.976)
Boone*SIZE	-13.873***			
	(3.2946)			
$Boone^2$SIZE	14.739***			
	(3.4906)			
High Comp.*SIZE		-0.2709		
		(0.3556)		
Avg Comp.*SIZE			-0.1028	
			(0.1724)	
Low Comp.*SIZE				-3.0854
				(2.7483)
Boone*Capital Ratio	-1212.6***			
	(274.25)			
$Boone^2$*Capital Ratio	1332.7***			
	(298.71)			
High Comp.*Capital Ratio		63.4260*		
		(33.6931)		
Avg Comp.*Capital Ratio			-25.827	
			(16.047)	
Low Comp.*Capital Ratio				-673.1600
				(565.38)
SIZE*Capital Ratio	-27.576***	-1.3843*	-3.7646**	-2.2225**
	(6.2120)	(0.7281)	(1.6484)	(0.9688)
Boone*SIZE*Capital Ratio	122.83***			
	(27.529)			
$Boone^2$*SIZE*Capital Ratio	-137.41***			
	(30.433)			
High Comp.*SIZE*Capital Ratio		-5.9849*		
		(3.1577)		
Avg Comp.*SIZE*Capital Ratio			2.7894*	
			(1.5299)	
Low Comp.*SIZE*Capital Ratio				44.2270
				(37.757)
SIZE	3.3335***	0.1799	0.1229	0.1099
	(0.7818)	(0.1188)	(0.1890)	(0.1218)
Liquidity	1.4607***	1.8270**	1.3554***	2.2636**
	(0.4234)	(0.7633)	(0.5050)	(0.9030)
Private	0.5565***	0.7799**	0.5836**	0.9185**
	(0.1968)	(0.3550)	(0.2475)	(0.4134)
Foreign	1.2232***	1.5362***	1.338***	2.2683***
	(0.2625)	(0.5583)	(0.3688)	(0.6700)
σ^2	1.3835***	1.8112***	1.5655***	2.0358***
	(0.1628)	(0.3989)	(0.2362)	(0.4642)
γ	0.4544***	0.6153***	0.5679***	0.6296***
	(0.0796)	(0.0821)	(0.0751)	(0.0854)
Max. Likel.	-2072.239	-2129.644	-2101.416	-2113.723

Note: this table presents the estimation results of our main model, where we test whether competition influences stability inefficiency controlling by other variables. We estimate the Z-score translog function, as in equation (6), which Fang et al. (2011) propose. Unlikely the common efficiency frontiers of costs and profits, this approach takes into account the bank's risk-taking behavior. The measure of competition is the time-varying Boone Indicator that we have estimated previously and reported the results in table 9. In fact, in order to facilitate the results' interpretation, we have employed the absolute value of this indicator. Again, to make the results more presentable, we have also added (in columns [2] to [4]) specifications were we use dummies of high, average and low competition, respectively, whose construction we explain in section 2.2. Specifically in this table, we interact the competition variable and dummies with the variables SIZE and Capital Ratio to determine whether the effect of competition on risk-taking varies as function of bank's size and capital ratio. Finally, σ^2 is the sum of the variance of the error terms in equation (2), i.e. $\sigma^2 = \sigma_v^2 + \sigma_\nu^2$. The ratio between the variance of the inefficiency variance and total variance is equal to γ. Standard errors in parentheses.
*** p<0.01, **p<0.05,* p<0.1

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