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The relationship between bank competition and financial stability: a case study of the Mexican banking industry

Raúl Osvaldo Fernández[*]
Jesús G. Garza-García[**]

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Abstract

This paper tests both the competition-fragility and competition-stability hypotheses in the Mexican banking sector for the period 2001-2008. In order to account for the degree of competition we use Lerner index, and the Z-index and the ratio of non-performing loans over total loans as proxies of financial stability and bank portfolio risks respectively. The main results indicate there is support for both hypotheses. However, the benefits of greater competition on the overall stability of the system outweigh the increases in bank portfolio risks.

JEL Classification**:** D4; G15; G21; L11; N2.
Keywords: Financial Stability, Lerner index, Bank Competition, Mexican Banking Sector, Generalised Method of Moments (GMM).

Resumen

Este artículo analiza las hipótesis de competencia-fragilidad y competencia-estabilidad en el sistema bancario mexicano, para el periodo 2001-2008. Para medir el nivel de competencia, se emplea el índice de Lerner y el índice-Z, así como la razón de créditos morosos entre créditos totales como proxies de estabilidad financiera y riesgo de portafolio, respectivamente. Los resultados indican que existen argumentos para sustentar ambos modelos. Sin embargo, los beneficios de un mayor nivel de estabilidad financiera en el sistema tienen más peso que el incremento en los riesgos de portafolio.

[*] Financial Researcher, Directorate of Financial Stability, *Banco de México*. Address: Ave. 5 de mayo # 1 piso 1, Del. Cuauhtémoc, México, D.F. Phone: + 52 (55)52372000, ext. 3252. E-mail: rfernandez@banxico.org.mx.

[**] *Corresponding author:* Chief Mexico Economist, *Itaú BBA.* Address: Avenida Santa Fé 462, Piso 14, Col. Santa Fé, Del. Cuajimalpa, CP. 05438, Mexico City. Phone: +52 (55)41618908. E-mail address: jesus.garza@itaubba.com.

***Clasificación JEL*:** D4; G15; G21; L11; N2.
Palabras Clave: estabilidad financiera, índice de Lerner, competencia bancaria, sector bancario mexicano, método generalizado de momentos (GMM).

Introduction

There have been recent debates on the relationship between banking competition and the overall stability of the financial system. As such, two opposing views have emerged: competition-fragility and competition-stability. The competition-fragility view suggests a negative relationship between bank competition and financial stability, while the competition-stability view proposes a positive relationship. Many authors have tested these relationships in various countries and regions and have obtained contrasting results. However, as far as we know, no such study has been done for the Mexican banking industry.

Beck (2008) explains that similarly to other non-financial industries, competition in the banking sector is desirable since it often generates a more efficient market, with all the benefits that come along (e.g. efficient allocation of resources and better prices for consumers). However, there are theories suggesting that more competitive banking sectors may increase the instability of the financial system. As greater banking competition decreases bank profit margins, banks are encouraged to take on riskier investments in order to boost their profits, supporting the competition-fragility view (Berger et al., 2008). However, Boyd and De Nicolo (2005) argue that greater bank concentration in the lending markets may increase instability through increased risks, since higher interest rates charged on consumers may make it harder for them to repay their loans, thus supporting the competition-stability view. It is therefore interesting to test both hypotheses and find whether bank competition is desirable in order to increase financial stability.

More specifically, it is interesting to test these relationships in the Mexican banking industry. This industry has recently experienced a period of banking consolidation and a reduction in competition, whilst at the same recovered from the recent international financial crisis. To the best of our knowledge no country specific studies have been done with regards to the Mexican banking industry.

This paper is divided into six sections: Section 1 addresses the background of the Mexican banking industry, Section 2 presents the literature review on the competition-stability relationships, Section 3 introduces the data and

methodology used, Section 4 presents the main results of the study, and finally Section 5 summarizes the main conclusions of the study.

1. Background

The Mexican banking sector has gradually experienced a period of consolidation commencing with financial liberalisation policies implemented during the 1990s. As a result of the 1995 financial crisis in Mexico, foreign banks were permitted to enter the market and a series of mergers and acquisitions were observed[1]. This new merger wave generated a concentrated market with the three largest banks controlling close to 60% of the market share[2]. One of the main benefits of such consolidation has been the contribution to the capitalisation of the banking industry as well as the improvement in the quality of bank assets (Hernandez-Murillo 2007). Figure 1 shows the Herfindahl-Hirschman[3] index (HHI) in the Mexican banking industry for the period 1996-2008. Overall, there seems to be no important change in the degree of concentration throughout this period; however, it is important to note that during 2006-2008 several new banks entered the market which has resulted in a recent marginal decline in the Herfindahl-Hirschman index[4].

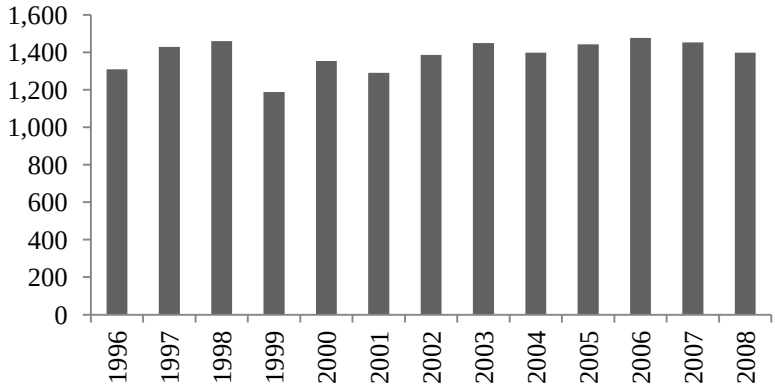
[1] Whilst Mexican banks had been protected from foreign competition for many years, restrictions were relaxed after the signing of the North American Free Trade Agreement (NAFTA), removing all of them by the end of 1998 (see Yacaman, 2001).

[2] As of September 2000, BBVA-Bancomer, Banamex and Santander-Serfin controlled 59% of the market share in terms of assets (see Yacaman, 2001).

[3] The Herfindahl-Hirschman index is calculated as the sum of the squared market shares (in terms of assets) of all the banks.

[4] Registered new commercial banks for the period 2006-2008 include: BANCOPPEL, THE BANK OF NEW YORK MELLON, CIBANCO, DEUNO, VOLKSWAGEN BANK, BANCO FACIL, UBS, BANCO AMIGO, BANCO REGIONAL, BANCO WALMART, ACTINVER, MULTIVA, BANCO DE AHORRO FAMSA, COMPARTAMOS, BARCLAYS BANK, and AUTOFIN.

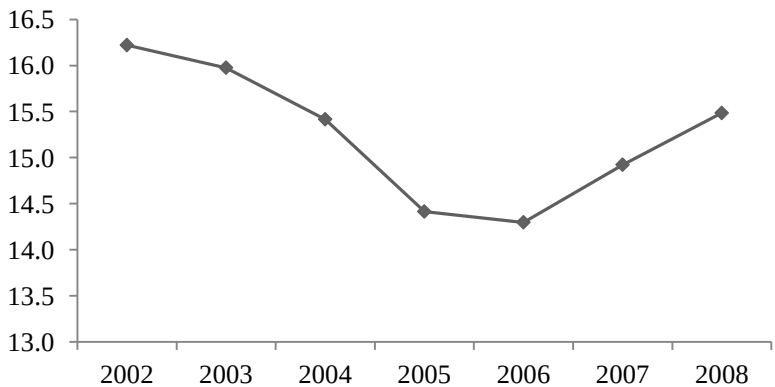
Figure 1
Herfindahl-Hirschman Index (in terms of total assets)



Source: National Banking Supervisor (CNBV).

Figure 2 shows the average capitalisation level of the Mexican banking industry for the period 2001-2008. As seen in Figure 2, the capitalisation index suggests that the banking sector has developed a strong financial position throughout this last decade. A slight decline in the index is observed from 2002 to 2006, followed by a stiff recovery. However the capitalisation levels are almost twice as the regulatory 8% minimum.

Figure 2
Capitalisation index (total capital over total assets)

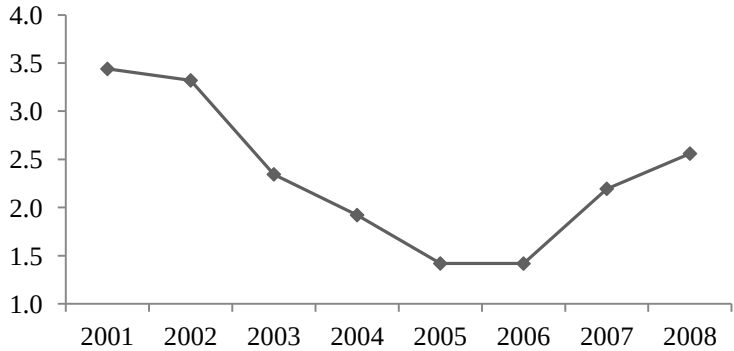


Source: National Banking Supervisor (CNBV).

One of the benefits of allowing foreign ownership in the Mexican banking industry has been the decline in bad debt, through better risk assessment and

market analysis (Hernandez-Murillo 2007). Figure 3 shows the level of non-performing loans in terms of total loans in Mexico. In general, there is a steep decline in the level of non-performing loans in the industry from 2001 to 2006, however a recent rise can be observed, from 2006 onwards, probably due to the recent financial crisis which has affected the quality of the banks' assets.

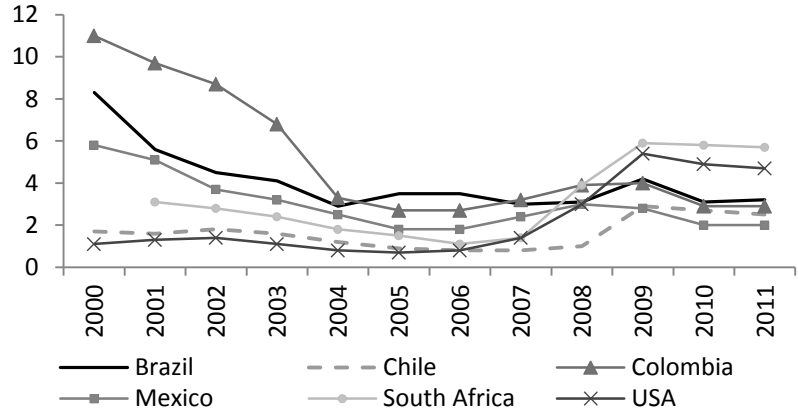
Figure 3
Non-performing loans (in terms of total loans)



Source: National Banking Supervisor (CNBV).

At the same time the levels of non-performing in terms of total loans in the Mexican banking sector have been declining and if compared to other developed and emerging economies are low (see Figure 4).

Figure 4
Non-performing loans (in terms of total loans)



Source: World Bank.

2. Literature Review

There is an ongoing debate in the literature discussing the implications of the degree of bank competition on the overall stability of the financial system. As observed in the recent financial crisis, the banking industry is a major conduct through which instability may be transmitted to the wider economy. The main mechanisms of transmission are through the disruption of the interbank lending markets and payment mechanisms, the reduction of the supply of credit, and the freezing of deposits (Berger *et al*. 2008).

There is vast literature which suggests that greater bank competition produces financial instability by decreasing the degree of market power in the sector, which consequently erodes profits and reduces franchise value, supporting the competition-fragility view[5]. Thus, banks are encouraged to take on more risks to increase their returns, deteriorating the quality of their portfolios (Marcus, 1984; Keeley, 1990 and Carletti and Hartmaan, 2002). There are various empirical studies supporting this relationship. Keeley (1990) finds that increased banking competition and deregulation in the US during the 1990s decreased monopoly rents and contributed to bank failures. Hellmann, Murdock and Stiglitz (2000) conclude that the removal of interest rate ceilings, and thus generating more competitive prices, decreases franchise value and encourages moral hazard behaviour in banks. Jimenez, Lopez and Saurina (2007) study the banking sector in Spain and find that greater

[5] For a review of the literature on the "competition-fragility" see Carletti and Hartmaan (2002).

banking competition is associated with a higher risk loan portfolios (increased non-performing loans). Berger *et al*. (2008) study 23 developed nations and find arguments in favour of the competition-fragility view, suggesting that higher market power reduces the risk exposure of banks. However, they also find that greater market power increases loan portfolio risks which could be interpreted as some evidence supporting the competition-stability view. Vives (2010) reviews the theoretical and empirical literature on the competition-stability relationship and argues that although competition is not a determinant of instability, it may exacerbate instability problems.

However, recent studies have argued in favour of a positive relationship between bank competition and financial stability. Beck, Demirguc-Kunt and Levine (2006) study a group of 69 countries and find that countries experiencing less market concentration are less likely to suffer a financial crisis. Boyd and De Nicolo (2005) suggest that greater market power in the loan markets increases bank risks since higher interest rates charged on consumers are harder to repay. This may exacerbate moral hazard problems and, at the same time, higher interest rates attract riskier borrowers due to adverse selection problems. Moreover, in highly concentrated markets, financial institutions may believe they are "too-big-to-fail" and this may lead to riskier investments (Berger *et al*., 2008). Empirically, there are several recent studies which have supported this hypothesis. Boyd, De Nicolo and Jalal (2006) and De Nicolo and Loukoianova (2006) both find an inverse relationship between higher market concentration and financial stability suggesting that the risk of bank failures increase in more concentrated markets. They estimate financial stability by the Z-index (an inverse measure of bank risks) and market concentration by the Herfindahl-Hirschman index. Schaeck, Cihak and Wolfe (2006) study the banking sectors of a group of countries by applying a Logit model and duration analysis. Furthermore, they estimate the Rosse-Panzar H-statistic as a measure of competition[6]. Their main findings argue that more competitive banking sectors have a lower likelihood of bank failure (they are more stable than in monopolistic systems).

Other studies have applied the Lerner index of competition and bank stability measures to examine the competition-stability relationship in banking. Berger *et al*. (2008) study a sample of over 8,000 banks in 23 countries by

[6] Many authors employ the Rosse-Panzar H-statistic as a measure of competition in banking (Claessens and Laeven, 2004; Schaeck *et al*., 2006; and Molyneux and Nguyen-Linh, 2008), however, there are issues when applying the H-statistic, particularly that it requires to be in long-run equilibrium.

employing the Generalised Methods of Moments (GMM) dynamic panel data framework. They include measures of market concentration, Herfindahl-Hirschman index, as well as the Lerner index of competition to account for market power. Moreover, they include the Z-index as a proxy for bank stability and non-performing loans over total loans as a measure of bank portfolio risks in order to test both the competition-stability and competition-fragility relationships respectively. Their main results indicate that banks with a higher degree of market power have less overall risks supportive of the competition-fragility hypothesis; on the other hand, they also find evidence of a positive relationship between competition and stability, implying that market power increases total loan risks. Turk-Ariss (2010) studies how the degree of market power affects both bank efficiency and financial stability in the banking sector for a group of emerging economies; however she does not include Mexico in the sample. She applies three different specifications of the Lerner index of competition[7] and uses a Z-index to proxy for financial stability. Her main results indicate that increased market power results in greater bank stability, although with a significant loss in cost efficiency. Liu, Molyneux and Wilson (2013) analyse the competitive conditions in 11 EU countries for the period 2000-2008 in order to examine the competition-stability relationship in banking. They employ the Lerner index of competition and the Z-index in order to proxy for bank competition and bank stability respectively. Their results suggest that a non-linear relationship between competition and stability exists in European banking. More specifically, they find risk-shifting effects in highly concentrated markets, where an increase in banking competition lowers net interest margins (higher deposit rates and lower loan rates) and increases bank stability. However, they find that marginal effects exist in highly competitive markets, where increased competition reduces loan interest payments and the provisions for non-performing loans.

There are several studies that analyze the efficiency and market structure of the Mexican banking sector. Guerrero and Negrin (2006) study the evolution of the efficiency of the Mexican banking sector for the period 1997-2004. The main findings suggest two different paths, during 1997-2001, the efficiency indicators decreased significantly. In this period important banking sector reforms were adopted. On the other hand, from 2001 to 2004, the efficiency of the banking sector improved consistently as a consequence of the implemented banking sector reforms. Overall, the article finds inefficiency levels of 19% on average for the period of study, similar to other international studies. On the other hand, Ruiz, Vasquez and Nuñez (2006)

[7] The three measures of the Lerner index include: a traditional Lerner index, an efficiency-adjusted Lerner and a funding adjusted Lerner, for more information see Turk-Ariss (2010).

analyze the effects of financial globalization on the banking management in Mexico. They find empirically that financial globalization brought benefits and costs to the Mexican banking sector; the benefits included greater systemic stability, higher profitability and efficiency. Within greater costs the article highlights the level of concentration of the industry and lower credit to housing and commerce. Guerrero and Villalpando (2009) test the market structure (structure-conduct performance and relative-market power) hypotheses and the two variants of the efficient-structure (X- and scale efficiency) hypotheses in Mexico for the period 1997-2005. Their main findings suggest that the market power hypotheses are responsible for explaining bank profitability in Mexico. Ruiz *et al*. (2006) study the effects of financial globalization on Mexican banking administration. The results indicate that financial globalization brought both costs (market concentration, reduced private credit lending) and benefits (greater systemic stability, higher profitability and efficiency). Ruiz (2008) studied the banking competition-fragility relationship for a group of 47 countries, including Mexico, between 1990 and 1997. The main findings indicate that the financial structure matters for the fragility of the financial system.

3. Data and Methodology

3.1. Data

The data in this study was obtained from the National Mexican Banking Supervisor *(Comision Nacional Bancaria y de Valores*-CNBV). The sample includes 14 Mexican banks that appeared during the period of study representing 81% of the total market share on average. The 14 banks used in this study are: BANAMEX, BBVA BANCOMER, SANTANDER, HSBC, BAJIO, IXE, INTERACCIONES, MIFEL, SCOTIABANK, BANREGIO, INVEX, BANSI, AFIRME and BANORTE. The data includes annual information of balance sheet items for the period 2000 to 2008 in real terms. However, when computing the Z-index a rolling average of two years of the data was used. This method was selected since Cihak, Maechler, Schaeck and Stolz (2009) argue that a rolling average allows capturing the dynamics of bank stability[8]. The study follows the methodology of Beck, De Jonghe and Schepens. (2010). Table 1 presents the description of the variables used in this study.

[8] In their study, Cihak *et al*. (2009) apply a 3-year rolling window average; however, because of data availability, this study applies a 2-year rolling window average.

Table 1
Variable description

Variable	Description
Z-index	Measure of bank stability: the sum of return on assets plus equity over assets divided by the standard deviation of the return on assets. $Z_{it} = \frac{ROA_{it}+EQTA_{it}}{\sigma_{it}^{ROA}}$
Lerner index	Measure of bank competition: price minus marginal cost over price. $Lerner_{it} = (p_{it} - mc_{it})/p_{it}$
NPL (%)	Measure of bank portfolio risks: the level of non-performing loans over total loans.
LnASSETS	Measure of bank size: the logarithm of assets.
LOATA (%)	Measure of liquidity: loans over total assets.
OWN	Measure of ownership: 1 if foreign 0 otherwise.

On the other hand, Table 2 presents the descriptive statistics of the main variables used in the study.

Table 2
Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Z-index	8,788.023	16,419.15	144.252	139,280.5
Lerner index	0.194	0.095	-0.193	0.354
NPL (%)	2.231	1.649	0.151	9.118
LnASSETS	6.346	1.616	4.048	9.047
LOATA (%)	37.879	11.66	17.769	69.564
OWN	0.357	0.482	0	1

Note: Z-index is a measure of bank stability, LERNER is the Lerner index of competition, LNASSSETS is the natural log of assets, LOATA is the measure of loans over assets and OWN is a measure of ownership.

3.2. Methodology

The methodology involves firstly the estimation of the Lerner index of competition and the Z-index, and secondly the application of the system Generalised Method of Moments (GMM) dynamic panel data, in order to test the competition-stability and competition-fragility relationships respectively. The system GMM is chosen since it generally produces more efficient and precise estimates compared to difference GMM (see Baltagi, 2008).

This study uses the Lerner index of competition since it captures the disparity between prices and marginal costs in terms of prices, that is:

$$Lerner_{it} = (p_{it} - mc_{it})/p_{it} \quad (1)$$

Where p is the price of each bank and is measured as the number of total revenues over total assets and mc is the marginal cost of each bank which is derived from a Translog function which includes three costs and several control variables. The following Translog cost function is used:

$$lnTC = \alpha_0 + \alpha_j \sum_{j=1}^{3} w_{it}^{j} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} \alpha_{jk}\, lnw_{it}^{j} w_{it}^{k} + \beta_1 lnY_{it} + \frac{1}{2}\beta_2 (lnY_{it})^2 + \sum_{j=1}^{3} \beta_3\, lnY_{it} lnw_{it}^{j} + \varphi_{1t} T + \frac{1}{2}\varphi_{2t} T^2 + \sum_{j=1}^{3} \varphi_{3t}\, T lnw_{it}^{j} + \varphi_{4t} T lnY_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

Where TC are the total costs, w is the price of the three inputs (personnel expenses/total assets, interest rate expenses/total deposits and other operating expenses/fixed assets), Y is total assets, T is a time trend which captures the effect of technical progress, μ captures the individual fixed effects, and ε is the error term[9]. The price is estimated as total revenues over total assets and the marginal cost is derived from the translog cost function. Notice that we have imposed the followings restriction in the Translog cost function in order to obtain a valid cost function: 1) homogeneous of degree one in factor prices, 2) non-decreasing factor prices, which requires that $\delta TC/\delta w^j \geq 0$ for all j and 3) concavity in factor prices, which requires that the Hessian (the matrix of second-order derivatives with respect to prices) be negative semi-definite.

The next step is the estimation of the Z-index, used as a bank based proxy for financial stability. The Z-index is actually the inverse proxy for a firm´s probability of default; hence, it is an inverse measure of overall bank risks (Berger *et al*., 2008). It is estimated as:

$$Z_{it} = \frac{ROA_{it} + EQTA_{it}}{\sigma_{it}^{ROA}} \quad (3)$$

[9] A fixed effects panel data regression with robust standard errors is run.

Where ROA is the 2-year average return on assets for each bank, $EQTA$ is the 2-year average of capital over assets for each bank, $\sigma^{ROA}$is the standard deviation for return on assets for a period of 2 years. As observed, the Z index increases when the level of return on assets and the level of capitalization increase, however, it is reduced when there is volatility in the level of returns. As a measure of bank portfolio risks, the 2 year average of the level of non-performing loans in terms of total loans is used.

The GMM methodology is employed in order to address the possible endogeneity of the measure of bank competition with regards to measures of loan risks, capitalisation levels and overall bank risks. For example, a well capitalised bank may merge with another bank and increase its market power. Moreover, if a bank increases its loan portfolio and thus its overall risk, it may obtain greater profits, which may result in greater market share (Berger *et al*., 2008). Two different GMM equations are run addressing each of the formerly discussed hypotheses: competition-stability and "competition-fragility." The first equation refers to the competition-stability relationship where the Z-index proxies bank stability:

$$lnZ_{it} = \alpha_{it} + \delta lnZ_{it-1} + \beta_1 lerner_{it} + \beta_2 lerner_{it}^2 + \beta_3 lnassets_{it} + \beta_4 LOATA_{it} + \beta_5 OWN_i + \varepsilon_{it} \quad (4)$$

Where lnZ is the natural logarithm of the Z-index, $lerner$ is the Lerner index of competition, $lerner^2$ is the squared measure of the Lerner index, $lnassets$ $\ln assets$ is the natural logarithm of assets, $LOATA$ is a measure of total loans over total assets, OWN is a dummy variable reflecting foreign ownership and ε is the error term. The second equation refers to the competition-fragility relationship where non-performing loans proxy bank portfolio risks:

$$NPL_{it} = \alpha_{it} + \gamma NPL_{it-1} + \beta_1 lerner_{it} + \beta_2 lerner_{it}^2 + \beta_3 lnassets_{it} + \beta_4 LOATA_{it} + \beta_5 OWN_i + \varepsilon_{it} \quad (5)$$

Where NPL is the measure of non-performing loans in terms of total loans and the remaining variables have the same description as Equation 3.

4. Results

The system GMM regression is run for four models, including the Z-index as the dependent variables and the Lerner index of competition alongside other control variables as the independent variables in models 1 and 2; and NPL as the dependent variable alongside the Lerner index and other control variables in models 3 and 4. In all models the Hansen J-test is accepted as expected meaning that the instruments used are correct[10]. The results are presented in Table 3.

Table 3

GMM regression with Z-index and NPL as dependent variables

Variables	Z-index (Model 1)	Z-index (Model 2)	NPL (Model 3)	NPL (Model 4)
L.DEP	-0.081	-0.109	0.503***	0.557***
LERNER	-39.728**	-36.296**	-14.364*	-20.648***
LERNERSQ	111.197**	107.726**	38.93**	49.681**
LNASSETS	-0.968*	0.273	0.369	0.353
LOATA	0.052	0.097	0.043	0.007
OWN	1.979	-1.42	-0.726	-0.255
TIME		-0.219		0.117
CONS	15.319***	7.759	-1.738	-0.539
Inflection point	0.179	0.168	0.184	0.208
Wald test	18.84	34.45	29.01	49.53
p-value	0	0	0	0
AR(2)	-0.94	-0.94	-1.89	-1.74
p-value	-0.345	-0.346	-0.059	-0.082
Hansen-J Test	3.57	1.97	9.65	8.91
p-value	-0.467	-0.578	-0.14	-0.541
Instruments	11	11	13	18
Observations	84	84	84	84

*,**,*** indicate significance at 10, 5 and 1% confidence intervals.

Where L.DEP is the lagged dependent variables, LERNER is the Lerner index of competition, LERNERSQ is the squared Lerner index, LNASSSETS is the natural log of assets, LOATA is the measure of loans over assets, OWN is a measure of ownership, TIME is a time dummy variable and CONS is the constant term.

As observed from the main results, the Lerner index is consistently negative and significant in all models. In models 1 and 2, the inverse relationship

[10] Up to 3 lags were used as instruments for the equation in levels, and ownership and time were used as instruments in the equation in differences.

between the Lerner index and the Z-index suggests that increased banking competition results in greater financial stability. This result is supportive of the competition-stability view; on the other hand, greater bank competition results in increased bank portfolio risks, supportive of the competition-fragility view, in models 3 and 4. In every case, the LERNERSQ variable is always positive and significant and the inflection point is on average 0.18 representing approximately 40% of the accumulated Lerner distribution, which implies a non-linear relationship between competition and bank stability. With regards to the control variables, we find only LNASSETS to be significant in model 1, and inversely related to the Z-index, thus implying that bank size negatively affects financial stability. However, this variable loses its explanatory power in the remaining models. Finally, the remaining control variables show no significance with regards to the dependent variables.

The main results are supportive of both the competition-stability and the competition-fragility hypotheses, however it is important to note that the benefits of greater banking competition on financial stability outweigh the increases in non-performing loans since the Mexican banking system has relatively low levels of non-performing loans and the positive effects on financial stability are greater.

It is important to highlight the main limitations of this study: the number of observations account to 84 in total since only banks which appeared in the period of time of the study were used, as such, many banks had to be omitted from the analysis.

Conclusion

The Mexican financial system experienced a process of financial liberalization during the last two decades, which resulted in the consolidation of the banking sector, generating a more concentrated market, and as a result reduced competition. At the same time, the Mexican banking sector has proven to be resilient to the recent financial crisis. Thus, the analysis of banking competition and bank stability becomes relevant in the Mexican banking industry. This paper is the first study to address the competition-stability and competition-fragility hypotheses for the Mexican banking industry. The Lerner index of competition alongside two measures of financial stability (Z-index) and bank portfolio risks (NPL) respectively are used in order to test the two aforementioned hypotheses.

The first set of regressions test the relationship between bank competition and financial stability. We find invariably an inverse relationship suggesting

that increased bank competition has resulted in greater financial stability, supportive of the competition-stability hypothesis. On the other hand, the second set of regressions test the competition-fragility hypothesis, and the main results indicate that greater bank competition increases overall bank portfolio risks. However, a stronger relationship between bank competition and financial stability is observed if compared to the increases in bank portfolio risks; furthermore, given the relatively low levels of non-performing loans in the Mexican banking sector, the benefits on the overall stability outweigh the growth in bank portfolio risks.

Appendix

The Lerner index identifies the degree of monopoly with the difference between the firm´s price and its marginal cost $(P - MC)/P$ (a) at the profit-maximizing output rate. Hence, a larger gap would suggest greater monopoly power, or the Lerner index $L_{it} = \frac{P_{it} - MC_{it}}{P_{it}}$ (b).

From equation (a) if we multiply both sides by the level of output Q_{it} and total costs TC_{it} and if we consider that $MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}}$, (c) we obtain:

$$\frac{P_{it}Q_{it}}{TC_{it}} \geq \frac{\partial TC_{it}}{\partial Q_{it}} \frac{Q_{it}}{TC_{it}}, \quad \text{(d)}$$

or

$$\frac{TR_{it}}{TC_{it}} \geq \frac{\partial lnTC_{it}}{\partial lnQ_{it}}. \quad \text{(e)}$$

Where TR_{it} denotes total revenues.

The left-hand side of equation (e) is the share of revenues to total costs for bank i in time t, explained as RC_{it}, and the right-hand side is the cost-elasticity with regards to output.

Since MC_{it} represents the long-run equilibrium price in a perfect competitive market, the deviation from the observed price from the marginal cost, meaning the distance between RC_{it} and $\frac{\partial lnTC_{it}}{\partial lnQ_{it}}$ is a measure of market power.

Equation (e) can be defined as a stochastic cost frontier model (Aigner, Lovell and Schmidt, 1977):

$$RC_{it} = \frac{\partial lnTC_{it}}{\partial lnQ_{it}} + v_{it} + u_{it} \quad \text{(f)}$$

The left-hand side of equation 5 denotes the revenue-cost ratio, while the right-hand side is the minimum level that can be reached, where the deterministic component is $\frac{\partial lnTC_{it}}{\partial lnQ_{it}}$, v_{it} is the stochastic part and u_{it} is a measure of cost inefficiency.

If we assume that total bank costs TC_{it} are a function of output Q_{it} and three input prices W_{jit}, where $j = 1,2,3$, we would obtain the translog function:

$$\begin{aligned} lnTC = {} & \alpha_0 + \alpha_j \sum_{j=1}^{3} w_{it}^{j} + \frac{1}{2}\sum_{j=1}^{3}\sum_{k=1}^{3} \alpha_{jk}\, lnw_{it}^{j} w_{it}^{k} + \beta_1 lnY_{it} + \frac{1}{2}\beta_2 (lnY_{it})^2 \\ & + \sum_{j=1}^{3} \beta_3\, lnY_{it} lnw_{it}^{j} + \varphi_{1t} T + \frac{1}{2}\varphi_{2t} T^2 + \sum_{j=1}^{3} \varphi_{3t}\, T lnw_{it}^{j} \\ & + \varphi_{4t} T lnY_{it} + \mu_i + \varepsilon_{it} \end{aligned} \quad \text{(g)}$$

References

Aigner, D., Lovell, C. A. K., and Schmidt, P. (1977). "Formulation and Estimation of Stochastic Frontier Production Function Models". *Journal of Econometrics*, 6, 21-37.

Baltagi, B. H. (2008). *Econometric Analysis of Panel Data*. 4th edition, Chichester: John Wiley and Sons Ltd.

Beck, T. (2008). "Bank competition and financial stability: Friends or foes?". *World Bank Policy Research Working Paper No. 4656.*

Beck, T., De Jonghe, O., and Schepens, G. (2010). "Bank Competition and Stability: Reconciling Conflicting Empirical Evidence". *Cass Business School Working Paper*.

Beck, T., Demirguc-Kunt, A., and Levine, R. (2006). "Bank concentration, competition, and crises: First results". *Journal of Banking and Finance*, 30(5), 1581-1603.

Berger, A., Klapper, L., and Turk-Ariss, R. (2008). "Bank competition and financial stability." *World Bank Policy Research Working Paper No. 4696.*

Boyd, J., and De Nicolo, G. (2005) "The theory of bank risk taking revisited". *Journal of Finance,* 60(3), 1329-1343.

Boyd, J., De Nicolo, G., and Jalal, A. M. (2006). "Bank risk taking and competition revisited: New theory and evidence". *IMF Working Paper No. 297.*

Carletti, E. and Hartmann, P. (2002). "Competition and financial stability: What's special about banking?". *ECB Working Paper No. 146.*

Cihak, M., Maechler, A., Schaeck, K., and Stolz, S. (2009). "Who disciplines bank managers?". *IMF Working Paper Series No. 272.*

Claessens, S., and Laeven, L. (2004). "What drives competition? Some international evidence". *Journal of Money, Credit and Banking,* 36(3), 563-583.

De Nicolo, G., and Loukoianovam, E. (2006). "Bank ownership, market structure, and risk". *IMF Working Paper No.215.*

Guerrero, R. and Villalpando, M. (2009). "Rentabilidad, concentración y eficiencia en el sistema bancario mexicano". *El Trimestre Económico,* 76(1), 237-263.

Guerrero, R. and Negrin, J. L. (2006) "Eficiencia del sistema bancário mexicano 1997-2004: uma estimación dinâmica." Monetaria, Centro de Estudios Monetarios Latinoamericanos, 0(3), pp. 235-259.

Hellmann, T. F., Murdock, K., and Stiglitz, J. (2000). "Liberalization, moral hazard in banking and prudential regulation: Are capital requirements enough?". *American Economic Review,* 90(1), 147-165.

Hernandez-Murillo, R. (2007). "Experiments in financial liberalization: The Mexican banking industry". *Federal Reserve Bank of St. Louis Review,* 89(5), 415-432.

Jimenez, G., Lopez, J., and Saurina, J. (2007). "How does competition impact bank risk taking?". *Banco de España Working Papers No. 1005*.

Keeley, M. (1990). "Deposit insurance, risk and market power in banking". *American Economic Review,* 80(5), 1183-1200.

Liu, H., Molyneux, P., and Wilson, J., (2013). "Competition and stability in European banking: A regional analysis". *Manchester School,* 81(2), 176-201.

Marcus, A. J. (1984). "Deregulation and bank financial policy". *Journal of Banking and Finance,* 8(4), 557-565.

Molyneux, P., and Nguyen-Linh, H. (2008). "Competition and risk in the South East Asian banking*". Bangor Business School Working Paper, Bangor, Wales.*

Ruiz-Porras, A., Vasquez-Quevedo, N., and Nuñez Mora, J. A. (2006). "Efectos de la globalización financiera en la administración y regulación de riesgos bancarios en México". *Contaduría y Administración*, 219, 115-141.

Ruiz-Porras, A. (2008). "Banking competition and financial fragility: Evidence from panel-data." *Estudios Economicos*, 23(1), 49-87.

Schaeck, K., Cihak, M., and Wolfe, S. (2006). "Are more competitive banking systems more stable?". *IMF Working Paper No. 143.*

Turk-Ariss, R. (2010). "On the implications of market power in banking: Evidence from developing countries". *Journal of Banking and Finance*, 34(4), 765-775.

Vives, X. (2010). "Competition and stability in banking". *IESE Working Paper No. 852.*

Yacaman, J. M. (2001). "Competition and consolidation in the Mexican banking industry after the 1995 crisis in the banking industry in the emerging economies: Competition, consolidation and systemic stability". *BIS papers No. 4.*