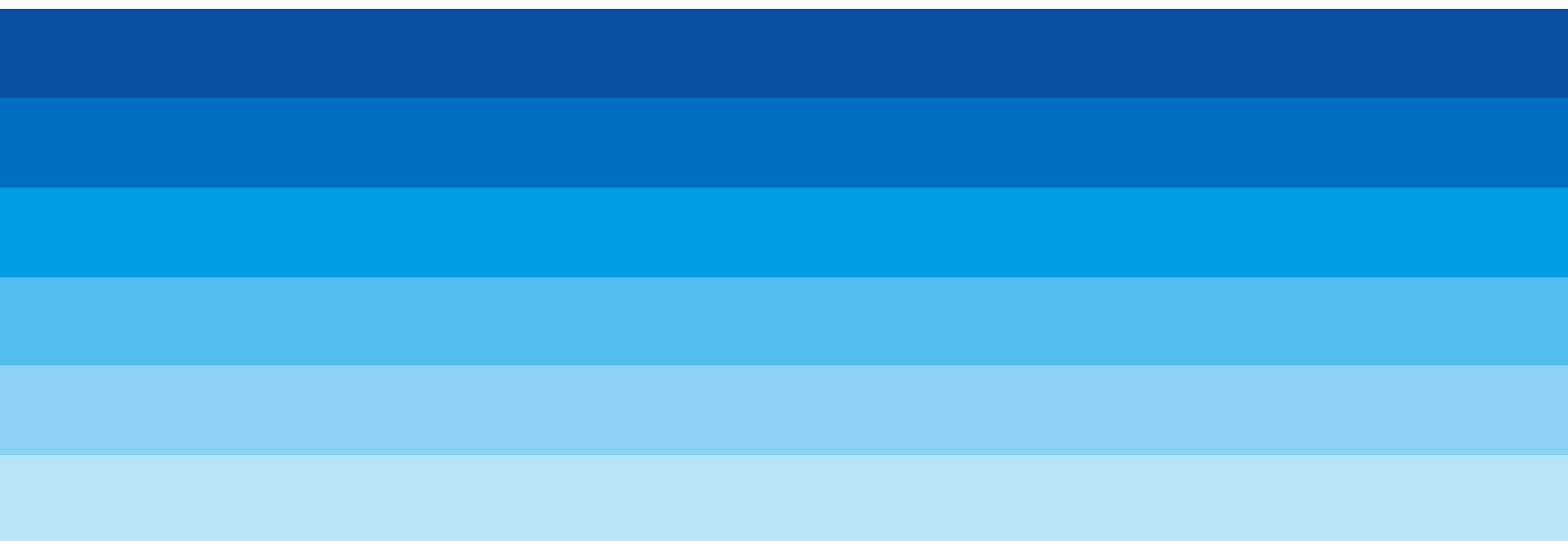


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# Competition and Efficiency in the Mexican Banking Sector

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## Abstract

The Mexican banking sector experienced a process of liberalization which aimed towards increasing the level of competition and efficiency. This paper studies the evolution of the efficiency of the Mexican banking sector from 2002 to 2012 and also analyses its relationship with the degree of banking competition. To do so, efficiency scores are estimated by applying the non-parametric methodology, Data Envelopment Analysis. Furthermore, the Boone Indicator is used to assess the degree of competition and included among other possible determinants of bank efficiency. The main results indicate increasing trends of efficiency in the banking sector during the period of study. Moreover, a direct relationship between banking competition and efficiency is observed. Besides, the capitalization index, market share and loan intensity increase efficiency whereas noninterest expenses and non performing loans decrease the level of efficiency. Lastly, in regards to the relative efficiency of local or foreign ownership of banks, it is found that the system's average efficiency trend is observed among both local and foreign banks, but local banks are somewhat more efficient.

Key words: Panel Data, Bank Competition, Mexican Banking Sector, Boone Indicator.

JEL: D4, G15, G21, L11, N2

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# 1. Introduction

The performance of Mexico's banking sector has been analyzed by various authors before. Several developments have contributed to this interest. Private banks were nationalized in 1982 and then sold back to private sector local owners in the early 90s as part of a financial liberalization strategy oriented towards increasing the efficiency and competitiveness of the banking sector. In 1995 Mexico experienced the Tequila Crisis during which many banks became insolvent and were intervened by the Government, who sold them back to private sector owners in the late 90s; this time without restricting sales to foreign ownership. This happened at the same time that the banking regulation and supervision framework, whose severe deficiencies were revealed precisely during the Tequila Crisis, were improved in order to fulfill international standards. The system's resilience after the global financial crisis that started on September 2008, after Lehman Brothers' collapse, suggests that this goal was accomplished successfully. Nonetheless, since the banking system's penetration is lower than in other emerging and developing countries according to international statistics, its efficiency and degree of competition continues to be a subject of interest and debate. In fact, last May 2013, a comprehensive Financial Reform Initiative was presented that among its key objectives includes the reduction of the cost of borrowing by introducing more competition among the largely foreign-owned banks<sup>1</sup>. Hence, Mexico has experienced in the past 20 years, several of the events and policies that the economic theory predicts can change both the efficiency and competition conditions of the banking sector.

To contribute to this literature, this paper estimates efficiency indicators for Mexico's banking system for the period 2002-2012 using the Data Envelopment Analysis (DEA) technique. Besides presenting estimations for the aftermath of the 2008 financial crisis that allow to examine its effect on the system's efficiency compared with previous results, it tests through Tobit panel regressions the relevance of several factors that affect efficiency, including bank characteristics, macroeconomic and regulatory conditions, and market structure. The most salient innovation with respect to previous studies is the estimation of the index proposed by Boone, Griffith and Harrison (2005) to assess competition and its inclusion as an explanatory variable in the model of bank efficiency determinants. However, this paper also contributes to the literature since it differentiates each bank type in a more detailed manner than ownership in two dimensions that recent studies deem as relevant. First, institutions are distinguished not only as local- or foreign-owned, but in the latter case also by their condition as a bank that became foreign by means of a merger or acquisition or as a new investment. Second, foreign-owned institutions are also distinguished by country of nationality of the parent bank. A last innovative aspect of the model is the inclusion of regulatory variables that identify changes to payment systems, which may affect banks' efficiency through their balance sheets.

The rest of this paper is organized as follows. Section 2 presents a review of the previous bank efficiency studies. Section 3 is divided into three parts in which the methodologies, data and estimation results are presented for the efficiency indicators, the competition index, and the model of efficiency determinants. The conclusions are summarized in Section 4.

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1: See, for instance, in the Financial Times, Thomson (2013a) and (2013b).

## 2. Literature review

DEA techniques have been employed to examine bank efficiency in several developing countries, such as Brazil (Tecles and Tabak, 2010) and China (Fadzlan, 2009), and regions, such as Central America (Wezel, 2010), Middle East and North Africa (MENA) (Naceur, Ben-Khedhiri, and Casu, 2009), selected European countries that recently acceded the European Union (Delis and Papanikolaou, 2009), or in broader samples of countries from all around the world (Chen, Liu and Lu, 2010). A common finding of these studies is that foreign banks, especially if large, are more efficient than local banks. Several of these studies also document that banks' efficiency is affected by other factors. High levels of capitalization, liquidity, loan intensity, and assets are positively associated with efficiency, while lower equity to total assets and non-interest expenses to average assets exhibit a negative association with efficiency. Of particular relevance for the present analysis, Naceur et al. (2009) documents that higher market concentration, as a proxy of competition, is found to decrease bank efficiency.<sup>2</sup>

DEA techniques have also been used to analyze the efficiency of Mexico's banking sector in several studies, in light of the Tequila Crisis of 1995 and the liberalization that followed it.<sup>3</sup> The first analysis, performed by Taylor, Thompson, Thrall and Dharmapala (1997), estimates the average efficiency of the financial system from 1989-1991 between 69% and 75%, similar to that of banks in the United States at that time. León (1999) calculated an average efficiency of 76% for the year of 1997; that is, two years after the Tequila Crisis. In contrast with the findings for other studies mentioned above, León reports that, within the sample of the 23 banks analyzed, the largest banks and foreign-owned banks were the most inefficient.<sup>4</sup> Other studies have used other parametric methodologies in order to estimate efficiency. Guerrero and Negrín (2006) apply the Free Distribution Approach (FDA) to study the efficiency of the Mexican banking sector for the 1997-2004 period, they find that the system's average efficiency lies within 80% and 86%, depending on the efficiency measurement considered. Moreover, Guerrero and Negrín (2006) find that even though efficiency dropped during the period of 1997 to 2001, it later rose. They attribute this trend to various improvements in the macroeconomic and regulatory framework, such as the increase of minimum capital requirements and the improvement of accounting standards in 1997, the elimination of restrictions to foreign investment and the creation of a limited banking deposits insurance scheme in 1998, and the creation of credit bureaus between 1995 and 1997.

More recently, Garza-García (2012a) analyses the developments and main determinants of bank efficiency in the Mexican banking industry during 2001-2009 using a two stage approach. First, he obtains efficiency estimates through the DEA methodology. Then he runs a Tobit model to find the main determinants of efficiency. He reports an average efficiency for the Mexican banking sector within the 79% and 86% range, depending on the efficiency measure considered, and detects loan intensity, Gross Domestic Product (GDP) growth and foreign ownership as the main determinants of increased bank efficiency. The coefficient associated to market concentration has a positive sign but is not statistically significant in the equations of some efficiency measures. On the other hand, Garza-García (2012b) focuses on the question of whether profits of Mexican banks are driven by efficiency gains, also determined through the DEA methodology, or by market power. He finds that market share is a key determinant of bank profits, in line with the Relative Market Power hypothesis, and that these profits persist over time and adjust slowly to the average level, which suggests weak

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2: It should be noted that at least five different approaches have been employed to analyze bank efficiency through DEA techniques. They basically differ on data assumptions regarding: a) the functional form of the best practice frontier, b) if a random error is associated temporally high products, costs or profits, and c) if a random error is added, the type of probability distribution of inefficiencies used. See for more details, Berger and Humphrey (1997).

3: The studies of Haber (2005), Haber and Musacchio (2010), and Haber and Musacchio (2013) about the effects of privatization and foreign capital entry on the performance of Mexico's banking system can be considered as related to the efficiency analysis literature, but they measure impacts on accounting ratios that can be considered as outcomes of efficiency (such as returns on assets, returns on equity or administrative costs over assets) rather than on efficiency indexes. See, Rodríguez and Venegas (2010) for another recent example of this type of analysis of efficiency trends through accounting ratios.

4: It should be noted that in 1997 restrictions to the foreign ownership of banks still were in place in Mexico and the largest banks of the system were not foreign but local, in contrast with present times, when the five largest institutions of the system are owned by foreign global banks.

competition. On the other hand, he does not find statistically significant evidence of the positive relationship between greater efficiency and bank profits. This finding motivates the estimation of a measure of competition that is more reliable than simple structural market estimates and then observe its relationship with efficiency, as will be done in the present analysis.

Specifically, with regards to the measurement of competition in Mexico's banking sector, most available studies in the literature rely on a combination of concentration indexes and regulation/institutional analysis of market contestability (see, for example, Avalos and Hernandez, 2006; or, for the credit card market in particular, Negrín and O'Dogherty, 2004, and Banco de México, 2013). The H-statistic proposed by Panzar and Rosse (1987) has also been applied to analyze Mexico's banking sector by López and Vargas (1999), Dueñas (2003), and Negrín, Ocampo and Struck (2010). In the three studies the authors conclude that the structure that best characterizes the sector is monopolistic competition. As will be explained in the following section, the estimation of the competition index proposed by Boone et al. (2005) is an innovation in the analysis of the Mexico's banking sector.

## 3. Methodology, data and results

### 3.1 Efficiency indicators

Following the studies by Garza-García (2012a) and (2012b), in order to measure efficiency we estimate three measures of efficiency (Technical Efficiency (TE), Pure Technical Efficiency (PTE) and Scale Efficiency (SE)) through the nonparametric DEA methodology. Following Banker, Charnes and Cooper (1984) we estimate the TE index by applying the following Variable Returns to Scale (VRS) model:

$$\begin{aligned} \text{Min}_{\theta, \lambda} \quad & \theta \\ \text{subject to:} \quad & y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & N1\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \tag{1}$$

where  $\theta$  is a scalar representing the efficiency score for the  $i$ th bank and ranges from 0 to 1;  $\lambda$  is a vector of  $N \times 1$  constants;  $y$  is the output vector for the  $i$ th Decision-Making Unit (DMU);  $Y$  is the matrix of outputs of the other DMUs and the number of DMUs range from  $i = 1 \dots n$ ;  $x$  is a vector of input of the  $i$ th DMU; and  $X$  is the matrix of input of the other DMUs. To obtain the PTE index the convexity constraint  $\lambda=1$  is omitted from the above model, in order to consider a Constant Returns to Scale (CRS) production function in the estimation of the efficiency scores, while the efficiency index SE is obtained as the ratio of both technical efficiency scores (that is,  $SE = CRS/VRS$ ).

We consider three inputs: total deposits, capital and total costs (personnel expenses + administrative expenses + interest rate expenses), and two outputs: total loans and other earning assets (liquid assets + equity investments + operations with derivatives). The monthly data to construct all these variables is available from the National Banking and Securities Commission (CNBV, by its Spanish acronym) database of banking institutions' balance sheets for 49 banks that were active during the analysis period from January 2001 to April 2012.

To describe the evolution of the three efficiency indexes proposed above, we define different sets of banks defined according to the nationality of the control group. As Haber and Musacchio (2010), a bank is classified as "Foreign" if the share of its equity held by foreigners is 51% or more; otherwise, it is classified as local. There are 15 "Foreign" and 23 "Local" banks in the sample. Foreign banks can be further divided into different categories depending on:

- a. Whether they were local banks that were merged or acquired (M&A) by a global foreign institution (5 Foreign banks in the sample are M&A banks) or the result of a De novo or Greenfield investment (10 Foreign banks in the sample are De novo banks). According to Haber and Musacchio (2010) and (2013) this distinction is relevant because M&A and De novo banks may exhibit different lending patterns in view of weak property rights protection, as Mexico has been characterized in rankings produced by the World Bank's Doing Business Report or the World Economic Forum Global Competitiveness Index.<sup>5</sup>
- b. Whether the parent bank's country of origin is Spain (2 banks), the United States or Canada (1 bank from each of this two countries is found in the dataset), or any other country (11 banks of the dataset with the parent bank located in the United Kingdom, Germany, Netherlands, Switzerland or Japan). Some recent studies of credit from global financial institutions after the Lehman Brothers crisis have found that these banks may differ by nationality because in their home countries they may face different rules regarding the proportion of long-term obligations and the requirements of financial autonomy in the management of liquidity of the subsidiaries with respect to their parent banks (see Kamil and Rai, 2009, or Galindo, Izquierdo and Rojas-Suárez, 2010). Another recent study of bank efficiency, Curi, Guarda, Lozano-Vivas, and Zelenyuk (2011), investigates whether home or host country characteristics, like organizational forms (subsidiary vs. branch) or level of asset diversification (diversified vs. focused banks) and exchange rate risk (euro area vs. non-euro area) drive the efficiency of banks that operate in Luxembourg, a financial hub.<sup>6</sup>

In Table 1 the monthly data for 24 banks is averaged and divided into four 3-year periods for analysis and comparison (2001-2003, 2004-2006, 2007-2009, and 2010-2012) to examine the differences in efficiency indexes by nationality and by time of operation. In general, the three efficiency indicators VRS, CRS and SCALE for the group of banks examined display an increasing trend at least until 2003-2006 (the system's VRS index actually shows a small increase during 2007-2009) and then a decline; only the SCALE index recovers a value higher than observed before by 2009-2012. On the other hand, the average VRS, CRS, and SCALE for the 2001-2009 period, examined in Garza-García (2012a), are 0.76, 0.85 and 0.82, respectively; that is, present results are within the range found in that study. However, it should be stressed that the results may not be strictly comparable because that study focuses on 18 banks only and uses a slightly different cost function.<sup>7</sup>

The efficiency indexes for each bank are presented in the appendix for further detail, but only on a yearly basis for the period 2008-2012 during which most of the banks in the sample were active. Nonetheless, it should be kept in mind that, as Berger and Humphrey (1997) suggests, due to the fact that confidence intervals tend to be large, comparisons of efficiency estimates across observations may be more meaningful if groups of observations are being compared rather than individual observations, even if these are averages for a given period as in this case.

The dynamics described above are also appreciated among both Local and Foreign banks. But the first group displays higher efficiency indexes than the second group.<sup>8</sup> We can also appreciate differences within the group of Foreign banks, between M&A and De Novo banks.

5: According to these researchers, foreign M&A banks appear to charge lower net interest margins, earn higher rates of return on assets and equity, and participate more aggressively in the market for mortgage loans, while being less involved in the commercial lending market. Foreign de Novo banks do not appear to mirror the behaviour or performance of Foreign M&A banks, but neither do they mirror the behaviour and performance of domestically-owned banks. The data suggest, in short, that these three types of banks may operate in different segments of the credit market. See Haber and Musacchio (2012) for more details.

6: In regards to the relevance of the nationality of the bank's parent bank, it should be noticed that in contrast with Luxembourg's case, for Mexico the distinction by organization form in the host country is not applicable because the law establishes that all banks, whether local or foreign, must operate as subsidiaries. The distinction by level of asset diversification is not relevant during the analysis period either because although the law was reformed in 2007 to allow the creation of niche banks the first licenses for this type of institution were granted during the second semester of 2012.

7: In effect, Garza-García (2012a) considers two inputs: the total costs (personnel expenses, administrative expenses and interest rate expenses) and total deposits and two outputs: total loans and other earning assets.

8: It is worth to notice that since our measure of efficiency per group is the simple average of the efficiency of the individual banks that belong to the group, without any weighting by bank size, it is robust to small variations in the group composition. In particular, the basic finding that average efficiency is higher for the group of local banks than for the group of foreign banks is robust if Banorte is classified as a foreign bank instead of as a local bank. This fact is important since the share of equity in hands of foreigners is one of many criteria that can be used to classify banks, although it is the one that has been most commonly used in the case of Mexico (Gonzalez and Peña, 2012, contains a more in depth discussion of this issue).

In particular, M&A banks display higher efficiency indexes than De Novo banks. This feature is in line with Haber and Musacchio (2010) and (2013), who relate their findings about administrative efficiency to better internal controls to judge the quality of borrowers in M&A banks than in the other two groups.

On the other hand, there are also differences in the efficiency indexes among Foreign banks by nationality. The VRS and CRS indexes are higher for the subset of 2 banks with the parent bank from Spain than for the other two subsets of Foreign banks. But in terms of the SCALE efficiency index, the differences among banks from Spain and banks from the US or Canada are very small until the period 2010-2012, when the index of the first group falls with respect to the other. With regards to this last finding, Kamil and Rai (2009) reports that after the Lehman Brother crisis, Spanish banks showed the most resiliencies in their lending behavior in emerging countries among global foreign banks of different nationalities. In particular, they report that loans of Spanish banks slowed down during the financial crisis at a lower proportion than those of other foreign banks. At the same time, Galindo, Izquierdo and Rojas Suarez (2010) find that Spanish banks in Latin America do not exhibit a significantly different behavior from that of local banks.

To sum up, the results point towards an increase of efficiency of the Mexican banking system during the period of analysis, even though the financial crisis had an adverse effect on banks' efficiency; particularly on foreign banks' efficiency. Also, M&A institutions broadly exhibit better efficiency indexes than De novo institutions. More generally, the previous trends suggest that it may be useful to incorporate some control variables into the econometric analysis of efficiency trends that reflect the banks' origin, whether local or foreign and, in the latter case the type of acquisition and nationality, as factors that may affect them.

Table 1  
**Efficiency indexes by nationality, 2001-2012**

Group	2001-03	2004-06	2007-09	2010-2012*
<b>VRS</b>				
System	0.73	0.80	0.82	0.73
Local	0.77	0.88	0.87	0.83
Foreign	0.67	0.71	0.76	0.62
Foreign M&A	0.77	0.80	0.81	0.73
Foreign De novo	0.59	0.64	0.72	0.52
Foreign US or Canada	0.67	0.70	0.78	0.62
Foreign Spain	0.82	0.85	0.89	0.79
Foreign Other	0.61	0.66	0.69	0.55
<b>CRS</b>				
System	0.80	0.90	0.86	0.79
Local	0.79	0.94	0.88	0.84
Foreign	0.81	0.85	0.83	0.73
Foreign M&A	0.93	0.98	0.92	0.89
Foreign De novo	0.70	0.74	0.75	0.60
Foreign US or Canada	0.79	0.85	0.85	0.69
Foreign Spain	0.97	1.00	0.97	0.97
Foreign Other	0.75	0.79	0.75	0.66
<b>SCALE</b>				
System	0.79	0.85	0.84	0.87
Local	0.85	0.93	0.89	0.94
Foreign	0.72	0.76	0.78	0.79
Foreign M&A	0.78	0.81	0.81	0.79
Foreign De novo	0.67	0.72	0.76	0.79
Foreign US or Canada	0.81	0.83	0.86	0.86
Foreign Spain	0.80	0.85	0.85	0.77
Foreign Other	0.61	0.67	0.70	0.75

\* Data until April 2012

Source: Authors' own estimations with data of the CNBV.

### 3.2 Boone's competition indicator

Many studies have assessed the degree of banking competition using structural measures such as the level of market concentration and market share (e.g. Lloyd-Williams and Molyneux, 1994; Berger and Hannan, 1998; among others). However, the New Industrial Organisation paradigm has emerged with ideas of analyzing competition through direct measures of static and dynamic competition. Examples of these measures include the Lerner index of competition, the H-statistic (Panzar and Rosse, 1987) and the Bresnahan model (Bresnahan, 1982). A more recent measure of competition currently used in the literature is the Boone indicator, which measures the effect of efficiency on performance, in terms of profits and market share. The idea behind is that efficient firms (firms with lower marginal costs) impair the performance of inefficient firms and this is reflected in lower profits or smaller market shares (van Leuvensteijn, Bikker, van Rixtel and Sorensen, 2007). At the same time, efficiency can be directly affected by competition since it has been shown that banks become more specialized in their intermediation activity. Some authors have pointed as an advantage of Boone's indicator with respect to the Bresnahan model that the first is less data intensive than the other (van Leuvensteijn et al, 2007). In turn, an advantage of using the Boone indicator over other models such as the H-statistic is that while for the latter an increase does not necessarily mean more competition, when the Boone indicator changes it does reflect a change in competition; for example, if the H-statistic results in 0.80 for A and 0.90 for B this does not imply that B is more competitive than A, but instead that both experience monopolistic competition. Hence, since several studies have argued in favour of more competitive markets since it enhances efficiency in the banking sector (Berger and Hannan, 1998; Jayaratne and Strahan, 1998; DeYoung, Hasan and Kirchhoff, 1998; Evanoff and Örs, 2008) it seems suitable to prefer the Boone indicator over the other alternatives for analyzing this hypothesis.

In this paper we employ a version of the Boone indicator firstly presented by Boone, Griffith, and Harrison (2005) and later developed by Boone (2008) and Schaeck and Cihak (2010). Following Boone et al. (2005) and Schaeck and Cihak (2010) we can define the model as:<sup>9</sup>

$$\pi_{it} = \alpha + \beta \ln(c_{it}) \quad (2)$$

Where  $\pi_{it}$  is a measure of bank profits for bank  $i$  at time  $t$ ,  $\beta$  is the Boone indicator,  $d_t$  and  $c_{it}$  refers to marginal costs. Following Schaeck and Cihak (2010) we use a measure of average costs as a proxy for marginal costs. Average costs are defined as total costs (administrative and personnel expenses plus interest rate expenses) over total income.

A regression is then performed using the return on assets (ROA) as the dependent variable and average costs and time dummies as the independent variables, hence:

$$\pi_{it} = \alpha_i + \sum_{t=1, \dots, T} \beta_t \ln(c_{it}) + \sum_{t=1, \dots, T-1} \gamma_{dt} + v_{it} \quad (3)$$

Where  $\pi_{it}$  is a measure of profitability,  $\beta$  is the Boone indicator,  $d_t$  is a variable representing time dummies and  $v_{it}$  is the error term. The hypothesis behind this model is that profits increase in time due to lower marginal costs and therefore competition increases profits in more efficient banks in relation to less efficient ones. The Boone indicator coefficient measures the degree of this relationship and a larger absolute value indicates greater competition.

A fixed effects panel data model is run in order to obtain the Boone indicator for each year. Monthly data from the CNBV for the period of study is used. The Boone indicator results can be observed in Table 2.

9: For more information on the elaboration of the Boone indicator please refer to Boone et al. (2005) and Boone (2008).



Table 2  
Boone Indicator

Year	Boone indicator
2002	-2.476
2003	-0.576
2004	-2.809
2005	-2.479
2006	0.038
2007	-2.023
2008	-5.127
2009	-0.041
2010	-0.347
2011	-0.832
2012*	-0.329

\*The year 2012 includes the period January-April.  
Source: Authors' own estimations with data of the CNBV

As observed in Table 2, there is a period of increased competition from 2002 to 2005 considering the negative high values of the Boone indicator. The degree of competition then decreases in 2006 and increases until achieving the highest level of competition in 2008. It is important to mention that during the period 2006-2008, 16 commercial banks entered the market, which could explain the high levels of competition in this year.<sup>10</sup> Afterwards, and probably due to the financial crisis, the Boone indicator reflects a decline in competition levels, particularly in 2009, and a weak recovery thereafter.

### 3.3 Determinants of bank efficiency

To assess the impact of competition and of other factors on bank efficiency, as Garza-García (2012a) for each of our efficiency measures we estimate a Panel Tobit Model.

The Tobit regression is useful when the dependent variables are limited by a specific threshold, which is the case in this study. DEA efficiency measures obtained in the first step are then run as dependent variables within the restricted (0, 1) range. Estimation with OLS would lead to biased results for the efficiency parameter since it assumes normality and a homoskedastic distribution of the error term. The Tobit model used in this study is the following:

$$\begin{aligned}
 y_0^* &= \beta'x_0 + \varepsilon_0 \\
 y_0 &= y_0^* \text{ if } y_0^* > 0 \text{ otherwise,} \\
 y_0 &= 0, \quad \varepsilon_0 \approx N(0, \sigma^2)
 \end{aligned} \tag{4}$$

Where  $x_0$  and  $\beta$  are the vectors of explanatory variables and its coefficients respectively, and  $y_0$  and  $y_0^*$  are the vectors of the observed DEA efficiency score and the vector of the latent variable. Afterwards, a likelihood function is maximized in order to find the values for the coefficients and variance of the explanatory variables based on the observed values of the explanatory variables and the DEA scores:

$$L = \prod_{y_0=0} (1 - P_0) \prod_{y_0^*=0} \frac{1}{(2\pi\sigma^2)^{1/2}} \times e^{-\frac{1}{2\sigma^2}(y_0 - \beta'x_0)^2} \tag{5}$$

Where

$$P_0 = \int_{-\infty}^{\beta'x_0} \frac{1}{(2\pi)^{1/2}} \times e^{-t^2/2} dt \tag{6}$$

10: 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.

The extended equation is:

$$\begin{aligned} \text{EFF}_{it} = & \alpha + \beta_1 \cdot \text{Boone}_{it} + \beta_2 \cdot \text{EQTA}_{it} + \beta_3 \cdot \text{NIM}_{it} + \beta_4 \cdot \text{ROA}_{it} + \beta_5 \cdot \text{NIE}_{it} + \beta_6 \cdot \text{NII}_{it} + \\ & + \beta_7 \cdot \text{NPL}_{it} + \beta_8 \cdot \text{MS}_{it} + \beta_9 \cdot \text{CONC}_t + \beta_{10} \cdot \text{SIZE}_{it} + \beta_{11} \cdot \text{LOATA}_{it} + \beta_{12} \cdot \text{INPC}_t + \\ & + \beta_{13} \cdot \text{GDP}_t + \beta_{14} \cdot \text{TIE28}_t + \beta_{15} \cdot \text{NAC1}_t + \beta_{16} \cdot \text{NAC2}_t + \beta_{17} \cdot \text{NAC3}_t + \\ & + \beta_{18} \cdot \text{REG}_t + \beta_{19} \cdot \text{NB}_t + \varepsilon_{it} \end{aligned} \quad (7)$$

where for institution  $i$  at time  $t$  denoting yearly observations,  $\text{EFF}_{it}$  is either of the efficiency indicators VRS, CRS or SCALE,  $\text{Boone}_{it}$  is Boone's competition index,  $\text{EQTA}_{it}$  is the degree of capitalization;  $\text{NIM}_{it}$  is the net interest rate margin;  $\text{ROA}_{it}$  is the return on assets;  $\text{NIE}_{it}$  is the ratio of noninterest expenses over total assets;  $\text{NII}_{it}$  is the ratio of noninterest income over total assets;  $\text{NPL}_{it}$  is the ratio of nonperforming loans over total loans;  $\text{MS}_{it}$  is the market share measured in terms of assets;  $\text{CONC}_t$  is the Herfindahl-Hirschman Concentration Index at time  $t$  measured in terms of assets;  $\text{SIZE}_{it}$  is the logarithm of total assets; and  $\text{LOATA}_{it}$  is the ratio of total loans over total assets. All these variables are constructed from the information of the CNBV database of the banking institutions' balance sheets.

As control variables, we include three dummy variables that aim to capture the nationality of banking institutions and the type of foreign bank, based on our preliminary analysis of the efficiency trends:  $\text{NAC1}_{it}=0$  if the bank is local and 1 if it is foreign;  $\text{NAC2}_{it}=0$  if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank; and  $\text{NAC3}_{it}=0$  if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country (in effect, United Kingdom, Germany, Netherlands, Switzerland or Japan). Each of these three variables is included separately, since they are highly collinear by definition.

Another dummy variable included in the model is: NB that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise, in order to distinguish the period marked by high entrance of new institutions into the banking sector identified before.

In other specifications, to capture the macroeconomic situation we include separately the following variables, defined for each time period  $t$ :  $\text{INPC}_t$  is Mexico's Consumer Price Index produced by the National Statistics and Information Institute (INEGI, by its Spanish acronym),  $\text{TIE28}_t$  is the 28 days interbank interest rate published by Mexico's central Bank (Banco de México, Banxico), and  $\text{GDP}_t$  is the annual Gross Domestic Product (GDP) growth produced by INEGI.

On the other hand, to capture institutional changes we add a dummy variable  $\text{REG}_t$  that equals 1 for the years 2002, 2003, 2004, 2005, 2006, 2007, 2008 and 2010 in which some major changes in the institutional framework took place that may induce a more efficient operation of the banking sector (Table 3) and equals 0 for the other years. The institutional changes identified deal with the operation of large value payment systems whose operation rules have an impact on banks' balance sheet through holdings of cash and securities. This variable was constructed from the summaries of key financial system reforms produced by Banxico. Although there are still few studies about the impact of regulation on bank efficiency and they have focused primarily on the impact of Basel II regulations, Pasiouras (2007) and Delis, Molyneux and Pasiouras (2009) report that that restrictions on banks' activities related to their involvement in securities, insurance, real estate and ownership of non-financial firms have a positive impact on efficiency, while capital requirements and official supervisory power do not appear to have a statistically significant impact on productivity. In view of these results and given that the most salient changes captured in  $\text{REG}_t$  are those that seek to limit the type of assets that banks can use to guarantee in their large value payment system operations the present work's hypothesis is that  $\text{REG}_t$  has a positive effect on bank efficiency.<sup>11</sup>

11: Besides the possible impact of payment system regulation on efficiency has not been assessed before, it seems reasonable to consider it in the case of Mexico because the most relevant modifications to bank ownership, accounting methods and prudential regulation were by the year 2001. Nonetheless, in the analysis period were passed new laws to foster guaranteed loans, to promote more transparent and ordered financial services, to improve protection for financial services users and to buttress development banks' activity, among others. So, although it is likely that the payment systems reforms have a more direct impact by determining the conditions for banks everyday operation, the sign and magnitude of the detected effects cannot be attributed only to such reforms due to the use of dummy variables to measure them.

Table 3

**Major changes to Mexico's banking institutional framework**

Year	Description
2002	Banxico issued rules to prohibit institutions from the same financial group grant credits to each other through the interbank payment system (SPEUA) to reduce credit risks incurred by the central bank.
2003	A Payment Systems Law was passed to protect high value payment systems from systemic risks. This law granted Banxico powers to issue rules for payment system participants with the aim of securing the operation of the systemically important payment systems
2004	Banxico issued rules to improve the quality of securities that payment system participants (banks and brokerage houses) can use to collateralize their operations in the systemically important payment systems and reduce overdrafting limits
2005	Banxico created a new and more efficient real time gross settling payment system (SPEI) that substituted the previous SPEUA.
2006	Banxico issued rules to allow the direct participation in the SPEI of pension funds, investment funds, money exchanges, and other regulated financial institutions (SOFOLES and SOFOMES).
2007	Banxico prohibited that payment system's participants set minimum amounts for sending payments through SPEI and mandated that all participants must send payments to any other participating institution.
2008	A new and more efficient securities deposit, administration and settlement System (DALI) was created to substitute the previous one (SIDV).
2010	Banxico issued rules to allow the direct participation in SPEI of Mexico's Telecommunication Company (TELECOMM), which acts as non bank correspondent of several financial institutions and to standardize payment orders and extend SPEI's operating hours.

Source: Banco de México, Summary of Key Financial System Reforms, various years

Table 4 presents the basic statistics of the variables. It is worth noting that the efficiency scores average 76, 87 and 87% in terms of CRS, VRS and SCALE for the period of study, respectively. Similar results are found in Garza-Garcia (2012a,b) and Guerrero and Negrin (2006). Also, the Boone indicator shows an average level of -1.58 with a maximum of -5.127 in 2008.

Table 4

**Variables summary**

	Min	Max	Mean
CRS	0.04	1	0.76
VRS	0.167	1	0.87
SCALE	0.057	1	0.87
TIIE28	4.8	8.93	6.79
GDP	-5.95	5.28	2.02
INPC	70.962	103.551	89.04
NB	0	1	.29
REG	0	1	0.73
NAC2	0	2	0.73
NAC1	0	1	0.45
NAC3	0	3	1.03
EQTA	0.013	0.939	0.15
NIM	-0.031	0.528	0.05
ROA	-82.943	24.361	0.25
NIE	0.002	0.954	0.07
NII	0	0.328	0.02
NPL	0	0.252	0.03
MS	0.003	26.162	3.34
CONC	1223.687	1442.118	1367.73
SIZE	2.177	6.087	4.43
LOATA	0	0.927	0.38
Boone	-5.127	0.038	-1.58

Source: Authors' calculations with data of the CNBV and Banco de México.

The next step is to run a Tobit regression using the efficiency scores, namely VRS, CRS and SCALE, as the dependent variables. The results are shown in Tables 5, 6 and 7.

Table 5

**Tobit regression, efficiency coefficient as the dependent variable (VRS)**

Variables	Coefficients							
Boone	-.01	-.014	.027	-.017	-.017	-.016	-.01	-.015
EQTA	.483*	.31	.448*	.45*	.409*	.394	.351	.299
NIM	.813	.962*	.765	1.343***	1.425***	1.286***	.967*	1.018*
ROA	-.0188***	-.02***	-.018***	-.026***	-.026***	-.025***	-.02***	-.021***
NIE	-2.305***	-2.442***	-2.242***	-2.974***	-3.023***	-2.893***	-2.449***	-2.494***
NII	.664	.53	.584	1.327*	1.309*	1.051	.593	.622
NPL	-1.994***	-2.135***	-1.9***	-2.741***	-2.785***	-2.565***	-2.163***	-2.255***
MS	.034***	.041***	.035***	.048***	.042***	.046***	.039***	.041***
CONC	.001***	.001***	.001**	.001***	.001***	.001***	.001***	.001***
SIZE	-.067	-.118**	-.078	-.107**	-.119**	-.119**	-.104*	-.119**
LOATA	.288***	.297***	.293***	.195**	.187**	.217***	.292***	.292
INPC	-.005**							
GDP		.008						
TIE28			.053***					
NAC1				-.182***				
NAC2					-.086***			
NAC3						-.052***		
REG							.06	
NB								.012
Cons	.572	-.098	.118	.112	.185	.175	.176	.155
Pseudo R <sup>2</sup>	.415	.406	.419	.461	.444	.432	.404	.399
LR chi2(12)	122.69	120.03	123.82	136.27	131.41	127.69	119.45	118.08
Obs	277	277	277	277	277	277	277	277

Notes: VRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations.

Table 6

**Tobit regression, efficiency coefficient as the dependent variable (CRS)**

Variables	Coefficients							
Boone	-.019**	-.024***	.023	-.027***	-.027***	-.027***	-.011	-.022**
EQTA	-.09	-.238	-.129	-.175	-.202	-.188	-.165	-.267
NIM	.753*	.797*	.69	1.112***	1.192***	1.082***	.81*	.87*
ROA	-.014***	-.015***	-.014***	-.019***	-.019***	-.018***	-.015***	-.015***
NIE	-2.06***	-2.121***	-1.976***	-2.511***	-2.572***	-2.488***	-2.13***	-2.189***
NII	1.105**	.901	1.026*	1.494***	1.491***	1.356***	.983*	1.011*
NPL	-1.779***	-1.796***	-1.651***	-2.324***	-2.378***	-2.22***	-1.82***	-1.974***
MS	-.012***	-.008*	-.011***	-.004	-.006	-.007	-.01***	-.008*
CONC	.0002	.001***	-.00003	.0004*	.0004*	.0004*	.0001	.0003
SIZE	.083**	.043	.074*	.048	.0365	.045	.062	.037
LOATA	.368***	.38***	.372***	.297***	.289***	.309***	.372	.373***
INPC	-.005***							
GDP		.0131***						
TIE28			.061***					
NAC1				-.136***				
NAC2					-.067***			
NAC3						-.043***		
REG							.133***	
NB								.048
Cons	.633	-.231	.159	.14	.2	.149	.251	.267
Pseudo R <sup>2</sup>	.517	.515	.531	.543	.527	.522	.524	.486
LR chi2(12)	128.85	128.38	132.52	135.34	131.56	130.30	130.68	121.11
Obs	277	277	277	277	277	277	277	277

Notes: CRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations.

Table 7

## Tobit regression, efficiency coefficient as the dependent variable (SCALE)

Variables	Coefficients							
Boone	-.015***	-.014**	.007	-.017***	-.017***	-.017***	-.007	-.0104
EQTA	-.371***	-.415***	-.364***	-.38***	-.398***	-.378***	-.369***	-.443***
NIM	.52*	.492*	.469	.683**	.71***	.705***	.513*	.543*
ROA	-.004	-.004	-.003	-.006*	-.006*	-.006*	-.004	-.004
NIE	-1.02***	-.997***	-.957***	-1.233***	-1.245***	-1.273***	-1.015***	-1.043***
NII	.863**	.74**	.837**	1.101***	1.071***	1.086***	.81**	.816**
NPL	-.891***	-.804***	-.797***	-1.14***	-1.147***	-1.126***	-.848***	-.938***
MS	-.018***	-.017***	-.019***	-.015***	-.016***	-.016***	-.018***	-.017***
CONC	-.0002	-6.30e-06	-.0004**	-.0002	-.0002	-.0002	-.0003**	-.0003**
SIZE	.083***	.071***	.085***	.074***	.068***	.072***	.083***	.064***
LOATA	.188***	.194***	.189***	.149***	.149***	.142***	.189***	.189***
INPC	-.002							
GDP		.01***						
TIIE28			.029***					
NAC1				-.078***				
NAC2					-.033***			
NAC3						-.033***		
REG							.084***	
NB								.056**
Cons	1.06***	.649***	.93***	.927***	.953***	.946***	.998***	1.11***
Pseudo R <sup>2</sup>	1.429	1.523	1.469	1.511	1.472	1.537	1.503	1.452
LR	152.99	163.05	157.32	161.74	157.55	164.56	160.92	155.45
chi2(12)								
Obs	277	277	277	277	277	277	277	277

Notes : SCALE is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations.

The first set of results indicate that the Boone indicator is negatively associated with efficiency when estimating CRS and SCALE, but not significant when using VRS as the dependent variable. Thus, in the first two cases greater bank competition increases efficiency when considering that firms operate at constant returns to scale and with scale efficiencies. It is clear from this first result that fostering bank competition enhances efficiency such that firms find ways to minimize costs, offer better products and services and reducing rates (Cetorelli, 2001).

With regards to the structural variables, market share, *MS*, and concentration, *CONC*, we find an ambiguous relationship: market share is positive and significant when considering that firms operate at variable returns to scale (supporting the Relative-Market Power hypothesis) but negative or not significant otherwise. Considering concentration, we find positive and significant values when considering variable and constant returns to scale (thus, supportive of the Structure-Conduct hypothesis) but not significant when considering that firms operate with scale efficiencies. According to Casu and Girardone (2009) greater market concentration may induce increased bank efficiency when economies of scale drive M&As.

Turning to the bank-specific variables, the degree of capitalization, *EQTA*, is positive and significant when using VRS as the dependent variable but negative and significant when using scale efficiency. Net interest rate margins, *NIM*, seem to be positive and significant in all cases, suggesting that a better pricing mix of financial products may be resulting in greater efficiencies and thus higher interest margins. On the other hand, noninterest rate expenses, *NIE*, and nonperforming loans, *NPL*, are negatively associated with efficiency in all cases as expected, whilst noninterest income, *NII*, and the size of banks, *SIZE*, seem to enhance efficiency in all regressions. Moreover, loan intensity, *LOATA*, seems to be one of the most important variables increasing efficiency since it is positive and significant and with high values. Isik and Hassan (2003) consider that greater loans increase efficiency through lowering costs

and increasing the quality of loans. On the other hand, the degree of profitability, *ROA*, is negatively associated with efficiency although with a very low coefficient. Notice that in regards to the trend of the average efficiency of the banking system, these findings suggest that both increases in the amount of nonperforming loans and decreases in loan intensity that occurred in the aftermath of the 2008 global financial crisis would have contributed to the deterioration of efficiency that has been observed between 2010 and 2012.

Looking at the macroeconomic variables, inflation affects efficiency negatively, as expected. GDP growth has a positive sign but only is statistically significant in the regression of SE. Garza-García (2012a) finds this coefficient to be positively signed but statistically significant only in the regression of VRS. In turn, interest rate increases enhance bank efficiency, possibly due to passing this cost to consumers and increasing their profitability, a finding shared by Lensink, Meesters, and Naaborg (2008). On the other hand, the variable referring to bank regulation has a positive impact, suggesting that the banking regulation reforms adopted in Mexico during the period of analysis have increased the efficiency in the banking sector. Therefore, this finding would be in line with those of Pasiouras (2007) and Delis et al. (2009). In turn, the variable that captures the period of high entrance of new banks into the system NB has, as expected and as another indication of the strong association between competition and efficiency, a positive sign but is only significant in the regression of SE.

Finally, the ownership variables NAC1, NAC2 and NAC3 are always negative and significant. This last finding is consistent with the preliminary analysis of the average efficiencies obtained for the different subsets of banks; that is, Local banks are more efficient than Foreign banks, but within the group of Foreign banks, M&A banks are more efficient than De Novo banks. In turn, the breakdown by nationality of the parent bank indicates that banks from Spain are more efficient than banks from the United States or Canada, which in turn are more efficient than banks from the other countries.

As robustness checks, fixed and random effects panel data estimations of the model are shown in the appendix. The basic results described before are obtained.<sup>12</sup>

## 4. Conclusions

In this paper new efficiency indicators for the Mexican banking sector were estimated through DEA techniques. Results suggest that its efficiency increased during the last decade until 2008, when the global financial crises started, when it declined noticeably and has improved since then. But it has not recovered to the levels observed before the crisis.

The Boone competition index trend suggests that competition increases efficiency and this is verified in a multivariable Tobit panel regression. This variable is significant even in the presence of other variables that measure market characteristics and are sometimes used as proxies of competition, like market share and concentration indexes. Other factors that increase Mexican banks' efficiency, besides competition, are the level of capitalization and loan intensity. Noninterest rate expenses and nonperforming loans, on the other hand, decrease bank efficiency, as also do increased inflation rates. In addition, reforms undertaken to improve large value payment systems of Mexico are found to have contributed positively to the system's efficiency.

Lastly, in regards to the relative efficiency of local or foreign ownership of banks, it is found that the system's efficiency trend is observed among both local and foreign banks, but local banks are somewhat more efficient. Banks that became foreign through a merger or

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12: In other robustness check we verified the sign and statistical significance of the Boone competition index in specifications where MS and CONC were not included among the explanatory variables. We find that the Boone competition index's sign and statistical significance is in fact robust to such modifications. Results of these checks are not reported in the paper for the sake of brevity and because the most worrying case would be that this measure of competition is not significant in the presence of other variables related to competition are included, but are available from the authors upon request..

acquisition are more efficient than De Novo banks, while the Spanish banks display higher efficiency indexes than those of other nationalities.

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## Appendix

## Efficiency indexes per bank

Table A.1.

VRS efficiency index, 2008-2012\*. Annual averages of monthly data

Bank	2008	2009	2010	2011	2012*
ABC Capital	0.17	0.29	0.34	0.88	1.00
Actinver	0.97	0.88	0.70	0.38	0.39
Afirme	0.75	0.97	0.87	0.75	0.87
American Express	0.81	0.77	0.68	0.53	0.42
Autofin	0.95	0.94	0.88	0.83	0.84
Banamex	0.69	0.82	0.78	0.69	0.85
Banca Mifel	0.98	1.00	1.00	1.00	0.96
Banco Ahorro Famsa	0.39	0.74	0.89	0.73	0.69
Banco Azteca	0.46	0.52	0.48	0.60	0.71
Banco Credit Suisse	0.08	0.29	0.31	0.23	0.64
Banco del Bajío	1.00	0.96	1.00	1.00	1.00
Banco Facil	0.50	0.38	0.23	0.90	1.00
Banco Walmart	0.06	0.19	0.30	0.40	0.41
Bancoppel	0.44	0.54	0.82	0.39	0.35
Bank of America	0.69	0.98	0.57	0.36	0.44
Bank of Tokyo-Mitsubishi UFJ	1.00	0.94	0.76	0.53	0.59
Banorte	0.85	0.89	0.84	0.78	0.81
Banregio	0.93	0.83	0.88	0.83	0.86
Bansi	0.86	0.97	0.96	0.86	0.83
BBVA Bancomer	0.94	0.95	0.88	0.82	0.81
Cibanco	0.28	0.29	0.41	0.43	0.58
Compartamos	0.59	0.94	0.90	0.85	0.81
HSBC	0.77	0.81	0.63	0.59	0.65
Inbursa	0.99	1.00	1.00	1.00	1.00
ING	0.97	0.96	0.97	0.60	0.70
Inter Banco	1.00	0.68	0.41	0.76	0.67
Interacciones	1.00	0.98	1.00	1.00	1.00
Invex	0.77	0.78	0.72	0.57	0.53
IXE	0.92	0.76	0.80	0.77	0.83
Monex	0.42	0.56	0.58	0.46	0.40
Multiva	0.66	0.85	0.71	0.79	0.96
Santander	0.84	0.82	0.78	0.76	0.72
Scotiabank	0.70	0.71	0.71	0.70	0.65
The Bank of New York Mellon		0.22	0.14	0.16	0.18
The Royal Bank of Scotland	0.52	0.58	0.51	0.27	0.24
UBS	0.47	0.23	0.24	0.75	0.79
Ve por mas	1.00	0.86	0.97	0.99	0.98
VolksWagen Bank	0.73	1.00	0.97	0.96	0.86

\* Data until April 2012.

Note: VRS is obtained from as the minimization of the banks' cost function under the assumption of variable returns to scale.

Source: Authors' own estimations with data of the CNBV.

Table A.2.

## CRS efficiency index, 2008-2012\* .Annual averages of monthly data

Bank	2008	2009	2010	2011	2012*
ABC Capital	0.98	0.85	0.57	0.94	1.00
Actinver	1.00	0.89	0.69	0.41	0.43
Afirme	0.78	0.98	0.84	0.76	0.88
American Express	0.82	0.78	0.64	0.58	0.54
Autofin	1.00	1.00	0.86	0.93	0.89
Banamex	0.96	0.99	0.92	1.00	1.00
Banca Mifel	0.99	1.00	0.92	1.00	0.97
Banco Ahorro Famsa	0.97	0.82	0.83	0.73	0.71
Banco Azteca	0.55	0.61	0.54	0.64	0.72
Banco Credit Suisse	0.08	0.29	0.38	0.29	0.64
Banco del Bajío	1.00	0.98	0.92	1.00	1.00
Banco Facil	0.88	0.93	0.52	0.97	1.00
Banco Walmart	0.96	0.81	0.40	0.41	0.43
Bancoppel	0.83	0.81	0.84	0.44	0.37
Bank of America	0.71	0.98	0.54	0.37	0.47
Bank of Tokyo-Mitsubishi UFJ	1.00	1.00	0.88	0.79	0.74
Banorte	1.00	1.00	0.92	1.00	1.00
Banregio	0.94	0.84	0.82	0.83	0.88
Bansi	0.92	0.99	0.90	0.87	0.85
BBVA Bancomer	1.00	1.00	0.92	1.00	1.00
Cibanco	0.57	0.56	0.58	0.54	0.66
Compartamos	0.62	0.96	0.85	0.94	1.00
HSBC	0.93	0.92	0.70	0.83	0.76
Inbursa	1.00	1.00	0.92	1.00	1.00
ING	1.00	1.00	0.92	0.75	0.74
Inter Banco	1.00	0.76	0.41	0.83	0.75
Interacciones	1.00	1.00	0.92	1.00	1.00
Invex	0.78	0.80	0.68	0.57	0.54
IXE	0.96	0.86	0.78	0.78	0.84
Monex	0.62	0.66	0.57	0.47	0.40
Multiva	0.73	0.87	0.67	0.81	0.97
Santander	1.00	0.98	0.92	1.00	1.00
Scotiabank	0.80	0.82	0.70	0.79	0.75
The Bank of New York Mellon		1.00	0.89	0.97	0.72
The Royal Bank of Scotland	0.72	0.82	0.66	0.46	0.39
UBS	1.00	1.00	0.65	0.88	0.90
Ve por mas	1.00	0.93	0.92	1.00	1.00
VolksWagen Bank	1.00	1.00	0.91	0.97	0.91

\* Data until April 2012.

Note: CRS is obtained from as the minimization of the banks' cost function under the assumption of constant returns to scale.  
Source: Authors' own estimations with data of the CNBV.

Table A.3.

## Scale efficiency index, 2008-2012\* .Annual averages of monthly data

Bank	2008	2009	2010	2011	2012*
ABC Capital	0.16	0.38	0.59	0.92	1.00
Actinver	0.88	0.99	0.85	0.92	0.90
Afirme	0.90	0.99	0.88	0.99	0.99
American Express	0.92	0.99	0.90	0.93	0.79
Autofin	0.88	0.95	0.88	0.89	0.93
Banamex	0.66	0.83	0.72	0.69	0.85
Banca Mifel	0.91	1.00	0.92	1.00	0.98
Banco Ahorro Famsa	0.37	0.90	0.90	0.99	0.98
Banco Azteca	0.72	0.85	0.70	0.93	0.99
Banco Credit Suisse	0.08	0.33	0.47	0.77	0.99
Banco del Bajío	0.92	0.98	0.92	1.00	1.00
Banco Facil	0.53	0.39	0.29	0.90	1.00
Banco Walmart	0.06	0.26	0.65	0.97	0.96
Bancoppel	0.49	0.64	0.81	0.88	0.93
Bank of America	0.89	1.00	0.90	0.97	0.91
Bank of Tokyo-Mitsubishi UFJ	0.92	0.94	0.74	0.66	0.79
Banorte	0.78	0.89	0.78	0.78	0.81
Banregio	0.91	1.00	0.92	0.99	0.98
Bansi	0.87	0.98	0.91	0.99	0.98
BBVA Bancomer	0.87	0.95	0.81	0.82	0.81
Cibanco	0.24	0.51	0.63	0.79	0.87
Compartamos	0.89	0.98	0.89	0.91	0.81
HSBC	0.76	0.88	0.76	0.71	0.86
Inbursa	0.92	1.00	0.92	1.00	1.00
ING	0.90	0.96	0.90	0.82	0.95
Inter Banco	0.92	0.76	0.80	0.90	0.89
Interacciones	0.92	0.98	0.92	1.00	1.00
Invex	0.91	0.98	0.91	0.99	0.99
IXE	0.88	0.88	0.87	0.99	0.99
Monex	0.61	0.86	0.89	0.98	0.99
Multiva	0.85	0.98	0.91	0.96	0.99
Santander	0.77	0.83	0.72	0.75	0.72
Scotiabank	0.81	0.87	0.87	0.88	0.87
The Bank of New York Mellon		0.22	0.12	0.17	0.24
The Royal Bank of Scotland	0.60	0.69	0.61	0.55	0.62
UBS	0.23	0.23	0.30	0.82	0.86
Ve por mas	0.92	0.92	0.90	0.98	0.98
VolksWagen Bank	0.64	1.00	0.90	0.99	0.95

\* Data until April 2012.

Note: SCALE = VRS / CRS.

Source: Authors' own estimations with data of the CNBV.

## Robustness checks

Table A.4.

## Panel data-random effects, efficiency coefficient as the dependent variable (VRS)

Variables	Coefficients							
Boone	-.006	-.01*	.021**	-.011*	-.011**	-.011**	-.007	-.01
EQTA	.278*	.076	.182	.103	.103	.088	.115	.076
NIM	-.093	.047	-.125	.216	.261	.14	.082	.097
ROA	-.006*	-.007*	-.004	-.009***	-.009***	-.008**	-.007*	-.007*
NIE	-.512	-.669*	-.473	-.907***	-.962***	-.793**	-.721**	-.724**
NII	.505	.244	.369	.448	.476	.356	.321	.308
NPL	-1.023***	-1.119***	-.922***	-1.317***	-1.348***	-1.237***	-1.15***	-1.194***
MS	.006	.014***	.009*	.0149***	.014***	.014***	.013***	.0142***
CONC	.0004***	.0006***	.0003**	.0005***	.001***	.001***	.0005***	.0005***
SIZE	.035	-.054	.0003	-.046	-.047	-.051	-.038	-.055
LOATA	.251***	.243***	.255***	.209***	.201***	.227***	.237***	.237***
INPC	-.005***							
GDP		.003						
TIIE28			.041***					
NAC1				-.056				
NAC2					-.031			
NAC3						-.009		
REG							.039	
NB								.006
Cons	.455*	.195	.13	.274	.285	.272	.267	
R <sup>2</sup>	.327	.295	.324	.322	.325	.302	.307	.294
Wald	96.68	80.16	95.05	86.52	88.12	81.01	83.03	79.38
chi2(12)								
Obs	277	277	277	277	277	277	277	277

Notes : VRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations with data of the CNBV.

Table A.5.

## Panel data-random effects, efficiency coefficient as the dependent variable (SCALE)

Variables	Coefficients							
Boone	-.011***	-.01***	.01	-.012***	-.012***	-.012***	-.005	-.008
EQTA	-.316***	-.405***	-.323	-.399***	-.401***	-.398***	-.341***	-.435***
NIM	.202	.196	.125	.297	.287	.315	.217	.259
ROA	.004	.003	.004	.002	.003	.002	.003	.003
NIE	-.486*	-.495*	-.404	-.588**	-.572**	-.612**	-.511*	-.541*
NII	.701*	.494	.664*	.663*	.644*	.682*	-.529	.582
NPL	-.559*	-.459*	-.435	-.652**	-.635**	-.666***	.602*	-.597**
MS	-.015***	-.011***	-.015	-.011***	-.011***	-.011***	-.529**	-.01***
CONC	-.0003***	-.00009	-.0004	-.0002**	-.0002**	-.0002**	-.0003***	-.0003***
SIZE	.078***	.04	.081***	.041	.041*	.042*	.067***	.027
LOATA	.128***	.132***	.134***	.119***	.123***	.115**	.126***	.122***
INPC	-.002**							
GDP		.007***						
TIIE28			.029***					
NAC1				-.018				
NAC2					-.002			
NAC3						-.011		
REG							.068***	
NB								.038**
Cons	1.107***	.871***	.928***	1.05***	-.002***	1.055***	1.035***	1.242***
R <sup>2</sup>	.469	.485	.479	.471	.465	.478	.484	.465
Wald	179.77	196.73	191.87	175.41	174.70	176.95	194.99	181.18
chi2(12)								
Obs	277	277	277	277	277	277	277	277

Notes : SCALE is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations with data of the CNBV.

Table A.6.

## Panel data-random effects, efficiency coefficient as the dependent variable (CRS)

Variables	Coefficients							
Boone	-.013**	-.016***	.028***	-.019***	-.019***	-.018***	-.008	-.013*
EQTA	-.056	-.316**	-.15	-.286*	-.291*	-.295*	-.221	-.344**
NIM	.089	.2003	-.013	-.286	.512	.444	.267	.3057
ROA	-.003	-.004	-.002	-.286*	-.007*	-.006	-.005	-.004
NIE	-.84**	-.991***	-.73*	-1.323***	-1.339***	-1.262***	-1.053***	-1.075***
NII	.771	.36	.618	.795	.799	.715	.571	.514
NPL	-1.18***	-1.153***	-.973***	-1.547***	-1.552***	-1.491***	-1.260***	-1.359***
MS	-.008	.003	-.006	.003	.002	.002	-.001	.004
CONC	.0001	.0004***	.00007	.0002*	.0003**	.0003**	.0001	.0002
SIZE	.098**	-.02	.068*	-.007	-.009	-.011	.022	-.032
LOATA	.332***	.328***	.342***	.284***	.283***	.294***	.317***	.315***
INPC	-.005***							
GDP		.01***						
TIIE28			.060***					
NAC1				-.063				
NAC2					-.029			
NAC3						-.016		
REG							.1002***	
NB								.039
Cons	.591**	.184	.169	.407	.413	.412	.4007	.616*
R <sup>2</sup>	.407	.393	.417	.407	.401	.395	.410	.372
Wald	117.58	112.26	126.93	107.96	107.72	103.96	115.96	99.84
chi2(12)								
Obs	277	277	277	277	277	277	277	277

Notes : CRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively

Source: Authors' own estimations with data of the CNBV.

Table A.7.

## Panel data-fixed effects, efficiency coefficient as the dependent variable (VRS)

Variables	Coefficients							
Boone	-.004	-.0057645	.026***	-.007	-.007	-.007	-.005	-.005
EQTA	.417**	.049424	.186	.052	.052	.052	.075	.032
NIM	-.394	-.88	-.8	-.802	-.802	-.802	-.779	-.811
ROA	-.003	-.005	-.004	-.005	-.005	-.005	-.005	-.005
NIE	.312	.043	.27	.008	.008	.008	.023	.013
NII	.065	.128	.162	.196	.1964	.1964	.15	.218
NPL	-.863**	-.709	-.595	-.826*	-.826*	-.826*	-.807*	-.802*
MS	.008	.018*	.012	.019*	.019*	.019*	.018*	.019*
CONC	.0004***	.0005***	.0002*	.0005***	.0005***	.0005***	.0004***	.0004***
SIZE	.161**	-.091**	.019	-.09**	-.09**	-.09**	-.074	-.1003**
LOATA	.341***	.337***	.349***	.329***	.329***	.329***	.33***	.327***
INPC	-.007***							
GDP		.0037						
TIIE28			.044***					
NAC1				OMITTED				
NAC2					OMITTED			
NAC3						OMITTED		
REG							.023	
NB								.017
Cons	.076	.388	.016	.274	.274	.274	.426	
R <sup>2</sup>	.211	.184	.248	.188	.188	.188	.202	.179
F(12,228)	6.80	5.39	6.46	5.69	5.69	5.69	5.27	5.24
Obs	277	277	277	277	277	277	277	277

Notes : VRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations with data of the CNBV.



Table A.8.

## Panel data-fixed effects, efficiency coefficient as the dependent variable (CRS)

Variables	Coefficients							
Boone	-.013**	-.014**	.033***	-.016***	-.016***	-.016***	-.008	-.01
EQTA	.182	-.302*	-.091	-.296*	-.296*	-.296*	-.201	-.349**
NIM	-.42	-1.167	-.95	-.953	-.953	-.953	-.861	-.978
ROA	.006	.005	.006	.004	.004	.004	.004	.004
NIE	.052	-.251	.051	-.346	-.346	-.346	-.286	-.332
NII	-1.411	-1.427	-1.292	-1.239	-1.239	-1.239	-1.428	-1.181
NPL	-1.004**	-.634	-.605	-.956**	-.956**	-.956**	-.879*	-.89*
MS	-.001	.01	.003	.013	.013	.013	.010	.013
CONC	.00009	.0004***	-.0001	.0002*	.0002*	.0002*	.0001	.0001
SIZE	.281***	-.05	.118**	-.048	-.048	-.048	.018	-.075
LOATA	.456***	.461***	.471***	.441***	.441***	.441***	.445***	.435***
INPC	-.009***							
GDP		.01***						
TIIE28			.067***					
NAC1				OMITTED				
NAC2					OMITTED			
NAC3						OMITTED		
REG							.094***	
NB								.047*
Cons	.039	.327	-.136	.556*	.556*	.556*	.369	.86***
R <sup>2</sup>	.234	.3	.302	.277	.277	.277	.302	.28
F(12,228)	8.36	7.32	8.58	6.54	6.54	6.54	7.16	6.31
Obs	277	277	277	277	277	277	277	277

Notes : CRS is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations with data of the CNBV.

Table A.9.

## Panel data-fixed effects, efficiency coefficient as the dependent variable (SCALE)

Variables	Coefficients							
Boone	-.012***	-.012***	.013	-.014***	-.014***	-.014***	-.007	-.009*
EQTA	-.146	-.365***	-.253**	-.361***	-.361***	-.361***	-.285***	-.403***
NIM	-.172	-.56	-.411	-.412	-.412	-.412	-.339	-.432
ROA	.012***	.011***	.012***	.011***	.011***	.011***	.011***	.011***
NIE	-.104	-.217	-.074	-.283	-.283	-.283	-.235	-.272
NII	-1.175**	-1.227**	-1.125*	-1.097*	-1.097*	-1.097*	-1.247**	-1.052*
NPL	-.524*	-.28	-.317	-.502	-.502	-.502	-.441	-.45
MS	-.008	-.004	-.007	-.001	-.001	-.001	-.004	-.001
CONC	-.0003***	-.00008	-.0004***	-.0002**	-.0002**	-.0002**	-.0003***	-.0003***
SIZE	.189***	.039	.128***	.041	.041	.041	.093***	.019
LOATA	.189***	.196***	.198***	.182***	.182***	.182***	.186***	.178***
INPC	-.004***							
GDP		.007***						
TIIE28			.035***					
NAC1				OMITTED				
NAC2					OMITTED			
NAC3						OMITTED		
REG							.075	
NB								.037**
Cons	.768***	.843***	.637***	1.0007	1.0007	1.0007	.852***	1.239***
R <sup>2</sup>	.239	.325	.285	.291	.291	.291	.292	.311
F(12,228)	15.17	15.72	15.87	15.11	15.11	15.11	16.08	14.42
Obs	277	277	277	277	277	277	277	277

Notes : SCALE is the efficiency indicator, Boone is Boone's competition indicator, EQTA is the degree of capitalization, NIM is the net interest rate margin, ROA is the return on assets, NIE is the ratio of noninterest expenses over total assets, NII is the ratio of noninterest income over total assets, NPL is the ratio of nonperforming loans over total loans, MS is the market share measured in terms of assets, CONC is the Herfindahl-Hirschman Concentration Index measured in terms of assets, SIZE is the logarithm of total assets, LOATA is the ratio of total loans over total assets, INPC is Mexico's Costumer Price Index, GDP refers to economic growth, TIIE28 is the 28 days interbank interest rate, NAC1 is a dummy variable that equals 0 if the bank is local and 1 if it is foreign, NAC2 is a dummy variable that equals 0 if the bank is local, 1 if it is a foreign merged or acquired bank, and 2 if it is a foreign De Novo bank, NAC3 is a dummy variable that equals 0 if the bank is local, 1 if the parent bank's country of origin is Spain, 2 if it is the United States or Canada, and 3 if it is another country, REG is a dummy that refers to regulation, NB is a dummy variable that equals 1 if the date of the observation is between 2006 and 2008, 0 otherwise.

\*, \*\* and \*\*\* represents significance at the 10, 5, 1% confidence intervals, respectively.

Source: Authors' own estimations with data of the CNBV.

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