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Bank size and type impact on efficiency: Evidence from Ecuador

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Abstract– *Bank efficiency in Latin America has been limitedly analyzed in the literature. The objective of the paper is to analyze whether bank size and bank focus have any influence on efficiency in a setting like Ecuador in which banks are dominant and alternatives available in the financial system are very limited. Therefore, we proposed a two-stage Data Envelopment Analysis (DEA) approach, where in the first stage a DEA was performed to calculate the technical efficiency scores of Ecuadorian banks between 2002-2017, and in the second stage a population average probit model was applied to capture the impact of bank size and focus on efficiency using Average Marginal Effects. The results show that bank size has a positive and significant effect on efficiency; however, this effect has been decreasing over the window of analysis.*

Keywords-- *Bank efficiency, Bank size, Two-stage DEA, Data Envelopment Analysis*

I. Introduction

The analysis of performance and efficiency in the banking sector has aroused interest in the literature. This is due to the importance of the financial sector in the economy, especially in developing countries such as Ecuador, where banks are the major financial intermediary. It is important to mention that in such conditions companies and small businesses depend on banks for financial resources. Ecuadorian banks are considered to have excess capacity in infrastructure, branches, and human resources. This causes them to charge higher interest rates and commissions for financial services. Therefore, they have been recommended to reduce their costs and use new technologies to increase their efficiency.

According to the microeconomic theory large banks should be more efficient than small banks because average fixed costs decrease as firm size increases, so it is argued that bank size should be strongly associated with efficiency [9]. Also, it is expected that larger banks are more capable of developing technical, financial, human, and material resources that improve their efficiency [38]. On the other hand, some studies have assessed the impact of economies of scale in the banking sector [26], [61].

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Several studies have addressed the effects of bank size on efficiency; however, few studies have focused on the latter relationship in a setting of dominant banking sector. Most of the studies found in the literature have evaluated the performance of banks in developed countries, especially in the United States or the European Union [14], [40],[47], [23]. Thus, very few studies have focused on the efficiency of the banking sector and its determinants in developing countries, especially in Latin America [34], [36].

Therefore, to narrow the above-mentioned gap, we analyzed the effect of bank size on the efficiency of Ecuadorian active banks during 2002-2017 using a two-stage approach, where in the first stage we use a Data Envelopment Analysis (DEA), a non-parametric technique that can be used to evaluate the relative efficiency of decision-making units (DMUs), banks in this case. In addition, the DEA method allows us to focus on the technical efficiency of input savings, which can be broken down into its pure technical efficiency and scale components. We will also implement in a second stage, a population-averaged probit model with the objective of analyzing the impact of bank size through Average Marginal Effects. We built several models using different controls including bank focus and a categorical operator of bank size. Finally, we contribute to the literature by analyzing bank efficiency in a setting of bank dominance and to our knowledge no other studies has been conducted using an Ecuadorian sample with the proposed methodology.

This paper is presented as follows: section 2 provides a literature review of studies related to bank efficiency, bank size, and describes the context of Ecuadorian banking. Section 3 explains the data used for this study. In addition, we explain the methodologies and variables used in the analysis. Section 4 shows the results obtained from the estimations. Finally, section 5 presents the conclusions, future lines of research and the limitations of the study.

II. Literature Review

Larger banks have higher profits than smaller banks [42], as they benefit from economies of scale. This strengthens their competitive advantage over their peers and reduces the cost of collecting and processing information [57], [2], [13]. In

addition, larger banks may have more professional management team and therefore earn higher profits [25].

According to the literature, some studies have found that bank size positively influences financial institutions efficiency [3], [27], [5], [24]. For instance, Reference [63] founded that Chinese commercial banks have significant difference in their market efficiency, and differences in the size can influence their market. Reference [60] applied a two-stage process to find that cost efficiency is explained by both merger and acquisition and size, while productive efficiency is explained by merger and acquisition and public status. Reference [62] applied two-stage DEA bootstrapped meta-frontier approach to find that larger microfinance institutions tend to have higher financial and social efficiency.

Moreover, there is evidence that bank efficiency increases with size, but only up to a maximum beyond which efficiency levels decline [53], [3]. Additionally, Reference [46] studied the impact of regulation and supervision on the technical efficiency of 715 banks using a two-stage DEA. The study shows that larger bank size is related to higher pure technical efficiency. On the other hand, there is also some evidence that there is a negative relationship between bank size and efficiency [32], [37], [20]. But also, other studies found a no relationship between bank size and efficiency [10], [11], [8], [54], [1], [31].

Reference [5] developed a two-staged inverse DEA model to assess the potential merger gain in the US banking industry. The results show a direct relationship between the financial gains generated by a merger and technical efficiency. Usually through mergers, banks improve their optimal mix of inputs at higher efficiency levels. Reference [31] evaluated the determinants of bank efficiency in with a two-stage DEA, Tobit Model. The growth intensity, GDP growth and foreign ownership were the main determinants of bank efficiency. Similarly, References [54] and [1] found that the effect of bank size on technical efficiency was not statically significant.

Most banks efficiency studies have focused on the United States [8], [41], [53], the European Union [16], [15], Asia [33], [1], [55], [63], Africa [3], [24], and cross-countries comparisons [27], [46]. On the other hand, less attention has been directed to efficiency in Latin America countries [54], [60]. Also, these studies have used different techniques such as Stochastic Frontier Analysis, Data Envelopment Analysis, the Distribution-Free Approach, among others.

Due to this lack in the literature, this study aims to evaluate the efficiency of banks in Ecuador by applying a two-step Data Envelopment Analysis (DEA) approach to assess the relative efficiency of decision-making units (DMUs) and an averaged probit model to analyze the impact of bank size.

A. The Ecuadorian Banking Environment.

During 1999 Ecuador suffered a financial crisis that negatively affected the economy. As a result, some banks had to be bailed out by the government, others were forced to merge with other financial institutions and others were forced to cease operations. By the end of 2000, 24 banks had failed, and the government owned two of the largest banks. Currently, the economy has stabilized, although at the end of 2002 the level of financial intermediation had not yet recovered to its pre-crisis level [35].

Ecuador implemented the U.S. dollar as its official currency in March 2000, since then banks have been under strict control of the Superintendency of Banks (SB). In addition, in 2007 the new government immediately implemented reforms and regulations to the financial system. The main changes were interest rates regulation, fees limitations for financial services, and prohibiting financial institutions from owning credit unions or insurance companies. In addition, the reforms prohibited the government from bailing out distressed institutions and imposed restrictions on the independence of the country's Central Bank.

The financial system in Ecuador is divided into three sectors: private financial (private banks), public financial (government banks), and the cooperative and solidarity financial sector (cooperatives and credit unions). However, public, and private institutions must follow regulations issued by the Superintendency of Banks. The cooperative and solidarity sector is made up of savings and credit cooperatives, which are regulated by a different set of norms and control institutions. On the other hand, it is important to mention that the stock market is underdeveloped in Ecuador, so very few firms are listed on the stock exchange. It is necessary to evaluate the efficiency of the financial sector to identify the factors that need to be improved.

On the other hand, Ecuador's banking sector is divided in private and government banks. Government banks do are known for not accepting public deposits but lending to various sectors of the economy (manufacturing, agriculture, education, housing, etc.). In addition, private banks accept deposits and make loans. Public and private institutions must comply with the same banking and insurance regulatory rules. The cooperative sector has its own supervisory authority, allowing these institutions to receive deposits and make loans. All economic and financial reforms are decided by the Minister for Economic Policy.

III. Methodology

A. Data and Sources

This study uses the financial statements of foreign and domestic private active banks between 2002-2017. The information was collected through the Superintendency of Banks, which is the bank regulatory institution in Ecuador. It is important to mention that an unbalanced data panel of 32 banks was obtained, since not all banks were active during the entire period under study. It was observed that some banks went through a liquidation process, whereby financial entities were forced to cease operations by order of the SB (forced liquidation) or by concession of their shareholders' meeting (voluntary liquidation). Also, some banks were subject to acquisitions and takeovers by other banks, either because they sold their operations, bought a large percentage of shares or were in the process of liquidation. The integration into a single entity had to be approved by the Superintendency of Banks.

During data selection, the [29] process was followed, in which banks with at least five years of data are included to obtain reliable estimates of efficiency. This requirement helps to reliably distinguish random noise that might exist. In addition, three banks did not report the values of the required variables in the first stage, so that year's data was not included. Therefore, with this consideration, a sample of 374 observations from 28 banks was obtained. On the other hand, we follow the classification of banks given by the SB, to separate medium and small banks. However, these were merged into a single group that we call small banks, because they have many similarities between them compared to large banks.

B. *Technical efficiency, a non-parametric approach*

According to the literature, it is common to use conventional ratios to measure bank efficiency, such as: return on equity, return on assets, etc., although several alternative techniques have also been applied. The most common non-parametric techniques are Data Envelopment Analysis (DEA) [7], Free Available Hull Analysis (FDH) [18], [48], while the parametric techniques are the Stochastic Frontier Approach (SFA) [39], [43], [59] and the Distribution Free Approach (DFA) [22].

The DEA methodology is the most widely used tool for estimating efficiency, performance, or productivity for several reasons. First, this method does not require specifying the functional form in traditional statistical regression approaches [19]. Second, it allows us to work with different unit systems and without limits on the specification of inputs and outputs [58]. Finally, it provides a systemic and integrated perspective to study the performance of the production units under analysis [50].

To evaluate the efficiency of the banks under study, a two-stage DEA was applied. In the first stage, we measured efficiency values assuming constant returns to scale (CRS) and variable returns to scale (VRS). And in the second stage, we used a population-averaged probit model to estimate whether the variables under study can affect the efficiency of a bank using Average Marginal Effects.

1) *Data envelopment Analysis (DEA)*

The DEA technique was developed by [17]. The main idea of this non-parametric approach is based on a linear programming technique that transforms inputs and outputs into a measure of efficiency and creates an efficient frontier to evaluate homogeneous organizational units. In this case, the most efficient bank is identified using the DEA technique and this efficiency value is used to compare it with its counterparts. Although the DEA method does not give a measure of optimal efficiency, this is not an impediment. According to [12] and [49], this efficiency is related to technical efficiency, which can transform multiple resources into multiple financial or banking services.

To calculate efficiency, we applied two approaches: Constant Returns Scale (CRS) proposed by [17], which is calculated under a common technology for all banks where a common frontier is assumed. Therefore, this orientation provides technical efficiency. On the other hand, Variable Returns to Scale (VRS) provides managerial efficiency [6], [30] due to it is calculated under differentiated frontiers.

In this study, both methods were used for comparison purposes. If the banks are homogenous and operate under similar conditions, the most appropriate is to use CRS. Otherwise, if conditions are different among banks, it is best to apply VRS. At present, issues such as reserve requirements and the level of the deposit rate indicate if conditions are different, therefore, in this case the appropriate method is the VRS. It is expected that in the CRS results there is no effect of bank size on efficiency.

2) *Inputs and Outputs selection.*

The input and output selection in DEA studies of the banking sector has been the subject of debate, however, the literature does not have a consensus on what constitutes inputs and outputs for a bank institution. One of the main questions concerns the "stock" or "flow" variables that should be used to measure inputs and outputs, but most research is based on stock measures. Another issue is based on which are the best inputs or outputs to analyze efficiency and productivity using the DEA technique.

The literature indicates three approaches to measuring efficiency. The first approach considers banks as financial services institutions; banks use labor and physical capital to

produce payments and loan financing [44], [28], [45]. Usually, the number of accounts and number of loans are used as outputs. On the other hand, staff costs are usually considered as bank inputs. The second approach emphasizes the relationship between income and expenses; under this perspective, interest expenses are considered inputs and interest, and non-interest income are considered the bank's output. Finally, the third approach considers banks as financial intermediaries, which means that banks borrow funds from depositors and lend this money to other economic agents [64], [52].

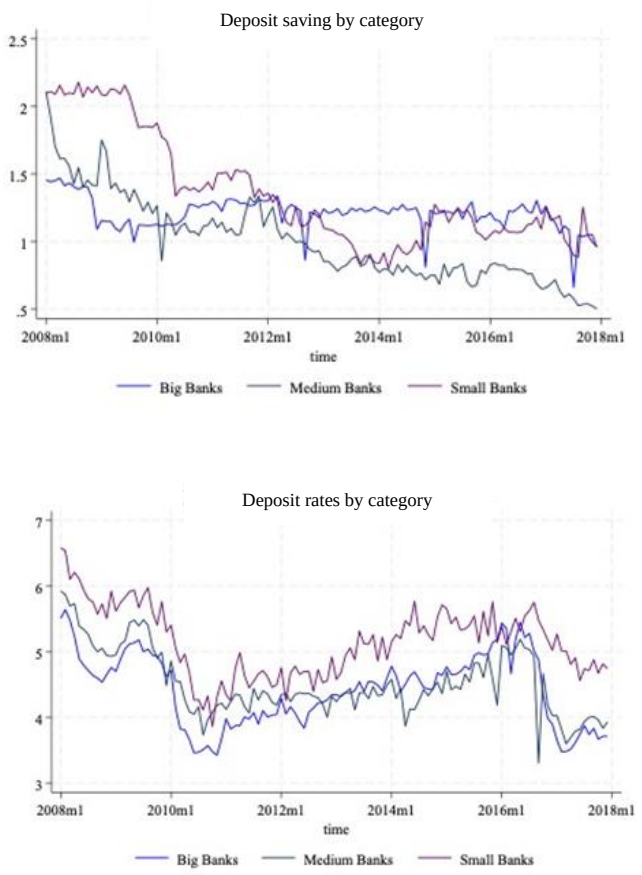

Fig. 1: Deposits Savings and Rates
Source: Elaborated by authors

This study uses the third approach. [15] and [56] argue that the intermediation approach developed by [51], may be superior to assess the efficiency frontier for bank profitability. This is because total cost minimization is necessary to maximize profits and not only production costs minimization. Table I specifies the sets of input-output variables considered in this DEA study of Ecuadorian banking efficiency.

TABLE I.
INPUT AND OUTPUT SELECTION

Variables	Inputs	Outputs	Obs.
x_1	Total deposits (1)		374
x_2	Total operating expenses		374
y_1		Loans	374
y_2		Investment assets	374

(1) Customer and short-term funding

Information on deposits level, investments, total loans, and operating expenses was obtained from the financial statements presented to the SBS. Table II presents the descriptive statistics of the efficiency ratios by year and bank size.

TABLE II
DESCRIPTIVE STATISTICS OF THE VARIABLES USED TO COMPUTE THE EFFICIENCY SCORE

	Obs.	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)
Panel A: Small Banks					
Investments	312	50,019.84	87,010.96	0	606,751
Loans	312	215,486.6	319,418.7	23	2’055,123
Deposits	312	315,923.4	507,479.3	0	3’013,199
Expenditures	312	21,410.68	23,771.02	113	114,654.4
Panel B: Big Banks					
Investments	62	483,056.4	365,326.7	82,997.08	1’789,490
Loans	62	1’762,546	1’456,417	156,007.1	6’228,963
Deposits	62	2’663,413	2’033,832	339,527.2	8’705,535
Expenditures	62	175,512.4	146,533.5	40,418.51	601,166.8

(1)(2)(3)(4) Values are expressed in thousands of dollars.

3) *Two-stage DEA*

In the second stage, a population-averaged probit model was applied to describe the expected mean value of the dependent variable conditional on the regressors, these parameters predict the average efficiency of banks, assuming that the unobserved component overtime is unrelated to the regressors. This model provides useful parameter estimates to obtain consistent average marginal effects over the population, this means that we focus on the marginal interpretation over time.

Finally, the objective of this study is to find out if bank size and bank focus have any effect on bank efficiency. We control several variables that have been considered in literature. Additionally, we run three models. The first includes controls and bank size. The second adds the variable bank focus and the

last model includes the latter and a control variable for time. There are few studies that have used categorical variables as proxy of bank size to determine its impact on bank efficiency [54], [60], [55], [62], [24]. Meanwhile, other authors used continuous variables as proxy of bank size, such as total assets.

In this study, we use the bank size classification according to the Bank Superintendency, we created a dummy variable named *sizecat* where 1 is assigned to large banks and 0 otherwise.

Additionally, we evaluate the influence of bank focus on efficiency. In Ecuador banks focus on housing, consumer, commercial and microenterprise. We created indicator variables for consumer, commercial and microenterprise, setting housing as the base level.

On the other hand, two types of efficiency were used: technical efficiency (CRS) and managerial efficiency (VRS). Therefore, our models will be as follows:

$$\theta_{Efficiency} = \beta_0 + \beta_1 sizecat + \gamma X + \mu_i \qquad (1)$$

Where the vector X contains the control variables that are explained in the following section. In addition, the descriptive statistics of the variables used in this study are given in Table III.

1) Control variables.

The information to compute the control variables was obtained from the Superintendency of Banks. The variable *proviassets* is the ratio of doubtful accounts provision divided by total assets. This ratio allows controlling the bank's capacity to collect its debts; the higher the ratio, the greater the amount of loans that cannot be collected in full. Provisions for doubtful accounts receivable results in lower bank efficiency [21], [4] and productivity [3].

On the other hand, the bank's profitability was approximated by the *marginassets* variable as a ratio of net income to total assets. This indicator allows us to monitor the bank's profits during the fiscal period. Finally, the *propfixed* variable is the proportion of fixed assets. This ratio is composed of non-cash assets to total assets. It also allows us to monitor the bank size in terms of its infrastructure.

Also, we assessed whether strong bank regulations introduced in 2007 had influenced banking efficiency, through a dummy variable named *reform*, assigning a value of 0 prior to 2008 (reflecting the period in which the banking sector reforms were implemented), and 1 to all years after 2008. Finally, a dummy variable was added for each year reported to capture year fixed effects.

TABLE III
DESCRIPTIVE STATISTICS OF EFFICIENCY INDEXES

		Years															
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CRS Index																	
Panel A: Small Banks																	
	Obs	18	18	20	20	20	20	21	20	20	22	22	20	18	17	17	17
	Mean	0.79416	0.78929	0.70776	0.73314	0.70717	0.72789	0.77191	0.79184	0.80713	0.76952	0.84746	0.84357	0.83548	0.77684	0.80884	0.81353
	Std. Dev.	0.18870	0.19084	0.22168	0.20771	0.25385	0.24524	0.22618	0.21366	0.18059	0.21478	0.14908	0.16001	0.17650	0.15961	0.16057	0.14132
	Min	0.35941	0.30582	0.21237	0.33217	0.21494	0.35011	0.36267	0.42805	0.49740	0.34790	0.55516	0.53580	0.42129	0.45187	0.47613	0.49425
	Max	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Panel B: Big Banks																	
	Obs	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Mean	0.80500	0.77036	0.58359	0.81581	0.89572	0.85704	0.83863	0.88519	0.86598	0.82515	0.86462	0.88926	0.92850	0.85691	0.86667	0.88023
	Std. Dev.	0.09459	0.15941	0.08223	0.11404	0.10592	0.15268	0.12021	0.09131	0.07079	0.11926	0.09513	0.02925	0.05553	0.11991	0.04579	0.07610
	Min	0.67949	0.63862	0.49794	0.72521	0.76618	0.66663	0.71787	0.80441	0.77402	0.73926	0.79118	0.86886	0.85776	0.71639	0.82494	0.77982
	Max	0.90886	1.00000	0.69226	0.96899	1.00000	0.99682	1.00000	1.00000	0.92708	1.00000	1.00000	0.93129	0.98745	1.00000	0.93200	0.94255
VRS Index																	
Panel A: Small Banks																	
	Obs	18	18	20	20	20	20	21	20	21	22	22	20	18	17	17	17
	Mean	0.84293	0.91854	0.88388	0.86805	0.80908	0.78977	0.82514	0.85228	0.86035	0.84542	0.89747	0.89845	0.95290	0.89268	0.87242	0.90878
	Std. Dev.	0.17917	0.12410	0.18656	0.16583	0.20743	0.22955	0.21257	0.17524	0.16395	0.18129	0.12910	0.12939	0.07403	0.11224	0.12227	0.08233
	Min	0.36511	0.56974	0.25666	0.51569	0.43985	0.35016	0.39011	0.48219	0.54195	0.53172	0.65192	0.66574	0.75558	0.71179	0.57708	0.78794
	Max	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Panel B: Big Banks																	
	Obs	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Mean	0.99909	0.91949	0.94745	0.98945	0.98391	0.99044	0.95096	0.97321	0.95709	0.97810	1.00000	0.97955	0.98439	0.98602	0.98852	0.98652
	Std. Dev.	0.00183	0.12743	0.07165	0.02111	0.03218	0.01911	0.09808	0.05358	0.08581	0.04380	0.00000	0.04089	0.03121	0.02796	0.02296	0.02697
	Min	0.99635	0.73223	0.84825	0.95779	0.93564	0.96177	0.80383	0.89285	0.82837	0.91239	1.00000	0.91821	0.93758	0.94408	0.95408	0.94606
	Max	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

IV. Results

In the first instance it is necessary to check the presence of serial correlation in the model due to the panel data. On the other hand, because of the existence of heteroscedasticity we apply robust standard errors to improve the precision of the estimates. Table IV indicates the variables used as controls, in general, do not significantly affect the efficiency scores individually but do so jointly. In this case we do not seek an interpretation between these variables, but rather to have a better precision of the estimator of the variable of interest and to reduce the omitted variable bias.

TABLE IV
DESCRIPTIVE STATISTICS AND CORRELATIONS.

	Jobs	Mean	Std. Error	Min	Max	Correlation Matrix					
Lnassets	375	12.4125	1.7494	8.7192	16.1778	1.0000					
sizecat	375	0.1707	0.3767	0.0000	1.0000	0.6055	1.0000				
propfixed	375	0.0350	0.0440	0.0000	0.3063	-0.4153	-0.0071	1.0000			
liabiassets	375	0.8366	0.1555	0.0805	1.7979	0.5475	0.1792	-0.5466	1.0000		
proviassets	375	0.0365	0.0319	0.0000	0.2123	-0.1402	0.0714	0.3597	-0.1930	1.0000	
margenassets	375	0.0595	0.0323	0.0042	0.3291	-0.2485	-0.1780	0.0271	-0.0713	0.2403	1.0000

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

We run several models which are presented in table V. Models (1 – 3) assess bank efficiency using CRS and models (4 – 6) VRS. In models 1 and 4 we include control variables and the reform variable. Meanwhile, in models 2 and 5 we added the bank focus dummy variables and in models 3 and 6 we run the full model with the addition of a control for year fixed effects.

The results showed that model 1 was not significant. In the case of model 2, where bank focus operators were included, the relationship between efficiency and the dummy variables of consumer and commercial were negative and significant. Also, the association between bank efficiency and the reform variable is positive and significant. However, we found no significant relationship between bank efficiency and size. In model 3, which adds a control for year fixed effects, we obtained similar results as in model 2. The only difference, the reform variable was not significant.

On the other hand, the results of models 4 to 6 use VRS efficiency. According to Table V, models 4-6 showed a positive association between bank efficiency and size. This means that being a large bank is positively related to bank efficiency. Moreover, the reform variable was not significant in either model.

Therefore, we found no impact of the bank reforms introduced in 2007 on bank efficiency. Finally, we found that in the full model the consumer bank operator was negatively associated with bank efficiency. The latter means that consumer banks are less efficient relative to banks specialized in housing.

The Wald Chi-Square statistics showed a significance in model 2 to 6. Which means that by adding the bank focus operators the models become efficient, considering the other controls in some models.

The Average Marginal Effect for CRS and VRS for the full model (3 and 6) are presented in Figure 2. In the case of VRS efficiency, although bank size positively affects bank efficiency as presented in table 5, this effect has been slightly decreasing over the years. It is possible that larger banks have decreased their efficiency or that smaller banks have improved it.

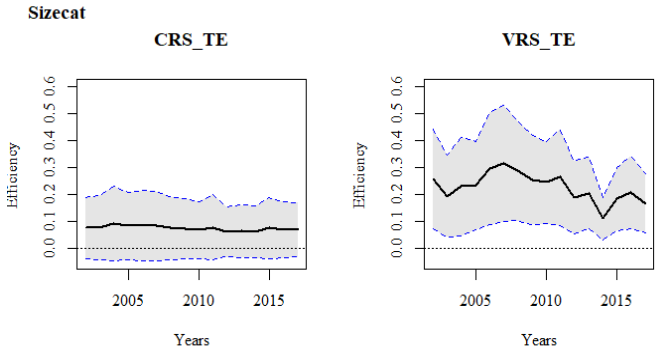

Fig. 2: Average Marginal Effects
Source: by authors

The marginal effects assuming constant returns are shown in Table VI. Consumer bank's efficiency relative to housing banks is reduced by 0.163, while commercial bank's efficiency relative to housing banks is reduced by 0.116. In addition, we found no significant association between bank size and efficiency considering CRS.

TABLE VI
CRS AVERAGE MARGINAL EFFECTS

	CRS TE		
	sizecat	*consumer*	*commercial*
AME	0.076	-0.163***	-0.116***
	(0.0577)	(0.0743)	(0.036)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE V
BANK EFFICIENCY CRS AND VRS MODELS

	CRS_TE				VRS_TE	
	(1)	(2)	(3)	(4)	(5)	(6)
Sizecat	0.238	0.309	0.270	0.824***	1.028***	1.313***
	(0.177)	(0.193)	(0.201)	(0.215)	(0.250)	(0.373)
Propfixed	0.117	0.461	0.270	-0.470	0.343	0.563
	(1.773)	(1.659)	(1.762)	(1.330)	(1.361)	(1.477)
Labises	-0.363	-0.485	-0.483	-0.134	-0.229	-0.375
	(0.391)	(0.417)	(0.468)	(0.348)	(0.369)	(0.422)
Proviassets	-2.346	-2.306	-2.414	-1.802	-1.531	-2.935
	(1.718)	(1.854)	(1.741)	(2.168)	(2.496)	(2.324)
Margennassets	3.942*	3.287	2.842	5.406**	4.237	4.528
	(2.067)	(2.607)	(2.771)	(2.545)	(3.292)	(3.499)
Consumer	-	-0.521***	-0.584***	-	0.080	-0.265**
	-	(0.067)	(0.108)	-	(0.087)	(0.115)
Micro	-	0.194	0.061	-	0.441	0.453
	-	(0.233)	(0.283)	-	(0.341)	(0.359)
Commercial	-	-0.351**	-0.416***	-	-0.167***	-0.058
	-	(0.145)	(0.131)	-	(0.209)	(0.216)
Reform	0.124*	0.174***	0.0819	0.00960	0.0802	0.344
	(0.0730)	(0.0668)	(0.163)	(0.0868)	(0.0866)	(0.251)
Constant	0.861***	1.292***	1.512***	0.993***	1.250***	1.198***
	(0.333)	(0.363)	(0.398)	(0.300)	(0.298)	(0.366)
Year	No	No	Yes	No	No	Yes
Wald Chi-Square	11.19	1.51e+07***	7119032***	20.25***	473.98***	3768.72***
Observations	374	374	374	375	375	375
Number of DMUs	28	28	28	28	28	28

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

According to Table VII, considering variable returns of scale, being categorized as a big bank relative to a small one increases efficiency by 0.229. Also, efficiency of consumer banks relative to housing banks is reduced by 0.046.

TABLE VII
VRS AVERAGE MARGINAL EFFECTS

	VRS TE	
	sizecat	*consumer*
AME	0.2299***	-0.046**
	(0.0743)	(0.0215)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

V. Discussion and Conclusion

This study evaluates the impact of bank size and focus on bank efficiency in the Ecuadorian banking sector between 2002-2017 controlling for bank's capacity to collect its debt, banks profitability and proportion of fixed assets using a two-stage DEA approach. In the first stage we calculate the technical efficiency scores of the banks during the observed period. In the second stage, a population mean probit model was applied to capture the impact of bank size on efficiency using Mean Marginal Effects.

The efficiency levels obtained depend on several issues: (I) the set of input-output variables used in the DEA model, (II) the time captured in the analysis and (III) the characteristics of the banks in the sample. In addition, several models were run using

a categorical proxy of bank size and control variables specified in the literature by prior studies.

We found no significant effect of bank size on efficiency measured by constant returns to scale (models 1-3). However, we evidenced a positive a significant effect of bank size on efficiency using Variable returns to scale (models 4-6) in a setting where banks are dominant and alternatives available in the financial system are very limited. The latter result is supported by several studies in literature [3], [27], [5], [24]. It is possible that as the size of the bank increases, the capacity of top management tends to increase as well. In addition, larger banks experience lower information gathering and processing costs [13]. Also, larger banks are better prepared for developing technical, financial, human, and material resources. However, it was observed that the effect of bank size on bank efficiency has been decreasing over the period analyzed. Following these results, small banks are at a disadvantage compared to big banks regarding efficiency. However, they should overcome this disadvantage by improving their processes and looking for innovative technologies.

On the other hand, in the case of technical efficiency measured by constant returns to scale, we do not observe a significant impact of bank size on efficiency as was found in Reference [46] that studied the impact of regulation and supervision on the technical efficiency. Meanwhile there is some effect of bank focus on bank efficiency. Specifically, after including banks focus operator variables in the model, we found that commercial banks were less efficient than housing banks (model 5). And in full model (6), we found that consumer banks were less efficient than housing banks. Therefore, it is advised that consumer banks should improve their processes and practices to become more efficient.

We also assessed whether policies implemented to regulate the banking sector in 2008 had an impact on bank efficiency, however, we found no improvement or deterioration in efficiency levels for the pre and post reform periods.

Finally, our study had several limitations. For instance, it could be argued that there is endogeneity in the decisions made by top management when determine the bank size, however, we believe that this problem could not exist because there are no incentives for being a large bank compared to a small one. Another limitation is related to the small sample size of Ecuadorian banks. Future research should assess the impact of bank size and focus with a larger sample that includes different Latin American countries and evaluates macroeconomic variables to control for other factors affecting banks.

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