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Analysis of the determinants of bank efficiency in Argentina: A two-stage DEA analysis

Análisis de los factores que determinan la eficiencia de los bancos en Argentina: un análisis DEA en dos etapas

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Abstract

The paper explains the causes of the efficiency of the Argentine Banking System, combining the method of data envelopment analysis (DEA) in a first stage, with the estimation of a regression in a second stage. The study is carried out on 57 entities. For the calculation of efficiency, a DEA VRS model, output oriented, is applied. In the second stage, the parameters of a linear regression are estimated, considering the DEA efficiency measure as the response variable and other factors not considered to calculate the efficiency as independent variables. This methodological strategy allows to exploit the main advantages of both approaches: to construct a function that considers multiple inputs and outputs that are not directly associated, and to include new explanatory variables of efficiency and determine their relative importance. The results allow us to conclude that the nationality of capital is one of the most relevant factors that negatively affects the efficiency of banks and that the equity structure positively contributes to improving it.

JEL Code: C67, G21, C19
Keywords: efficiency, decision making units; banks; two stages DEA

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Resumen

El trabajo explica las causas de la eficiencia del Sistema Bancario Argentino, combinando el método del análisis envolvente de datos (DEA) en una primera etapa, con la estimación de una regresión en una segunda etapa. El estudio se realiza sobre 57 entidades. Para el cálculo de la eficiencia se aplica un modelo DEA VRS, output orientado. En la segunda etapa se estiman los parámetros de una regresión lineal, considerando como variable respuesta la medida de eficiencia DEA y como variables independientes otros factores no considerados para calcular la eficiencia. Esta estrategia metodológica permite explotar las principales ventajas de ambas aproximaciones: construir una función que considera múltiples inputs y outputs que no están directamente asociados, e incluir nuevas variables explicativas de la eficiencia y determinar su importancia relativa. Los resultados permiten concluir que la nacionalidad del capital es uno de los factores más relevantes que afecta negativamente la eficiencia de los bancos y que la estructura patrimonial contribuye positivamente a mejorarla.

Código JEL: C67, G21, C19
Palabras clave: eficiencia; unidades de decisión; bancos; DEA en dos etapas

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Introduction

Some Latin American countries have undergone tremendous transformations in recent years due to the liberalization of the financial system and international integration. One of the responses to these changes has been the accelerated consolidation of their financial systems and, as a result, a more concentrated and competitive banking sector.

By international standards, the financial sector remains small; yet it is expected to continue to grow. This requires the competent authorities to consider financial innovation as a means to strengthen legislation and to establish the stability of the financial system as a priority.

Therefore, efficiency has become an increasingly frequent and familiar concept in today's economy, where it is not enough to maintain steady growth, but it is necessary to grow at a higher rate than competitors to avoid losing market share.

In the Argentinian economy, several sectors have undergone major changes in the structural conditions in which they compete due to the pressure of phenomena such as globalization, changes in regulations, and new technologies, among others. The current economic situation entails important challenges to achieving growth and better global integration. The competitive conditions under which companies operate have expanded the management and control function to include future strategic direction, with the need to make large and small decisions efficiently and effectively.

Efficiency analysis can provide the authorities and regulators with a basis for assessing the health of individual banks by identifying areas of inefficiency while helping to formulate appropriate strategies to improve the relative market position of banks in an attempt to prevent systemic failures

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(Charles, Kumar, Zegarra, & Avolio, 2011).

In this context, this paper aims to contribute to the efficiency literature with evidence from Argentina, a relatively unexplored country with a banking system that has undergone major transformations. The objective is to explain the causes of the efficiency of the Argentinean Banking System, combining the data envelopment analysis (DEA) method in a first stage, and with the estimation of a stochastic frontier in a second stage, using as independent variables factors not previously considered to calculate efficiency. Using this methodological strategy makes it possible to exploit the main advantages of the following two approaches. On the one hand, to construct a function that considers multiple inputs and outputs that are not directly associated, overcoming one of the main limitations of the econometric approach. On the other hand, the subsequent explanation of these efficiencies in terms of a series of factors not considered in the DEA model makes it possible to include new variables that explain efficiency and determine their relative importance.

This paper is organized as follows: Section 2 presents the characteristics of the Argentinian Banking System; Section 3 contains the measurement of efficiency in Argentina; Section 4 the methodology to be used in the efficiency evaluation; Section 5 the application to the Argentinian Banking System; and section 6 the conclusions.

Argentina's banking system

Since 2015, aggregate world economic activity and international trade have grown at limited rates, in line with those observed after the peak of the international financial crisis in 2008-2009. The contrast between the dynamism recorded by developed economies in aggregate terms and the slowdown in growth observed in emerging economies as a whole continued. This situation was aggravated by a considerable increase in the volatility of financial markets due to the situation in Greece and, more recently, in China.

According to BCRA (2016), the Argentinian financial system has a high degree of strength based on high levels of capital and liquidity, low leverage, good asset quality, and a deposit-based funding structure. Nonetheless, it is fulfilling its functions of obtaining and channeling savings to financing, especially for long-term projects, to a limited extent. This configuration is the consequence of the macroeconomic context of the last decades, characterized by negative real interest rates and financial repression. In the last months of 2015, the economic reorganization and the change in the orientation of BCRA policies generated an incentive scheme that promoted greater activity in the sector.

As stated in several BCRA Financial Stability Reports (BCRA, 2017, 2018), banks will have to face the challenge of reaching higher levels of operating efficiency in the coming periods to comply with the expected reduction of their financial margins and thus avoid that this scenario ends up impacting their profitability and solvency. At the individual level, banks should introduce changes in their business and management models that will allow them to achieve cost and revenue efficiency improvements while promoting an expansion of their business volumes that will help them to appropriate eventual economies of scale. At the systemic level, efficiency improvements and the expected expansion of the sector should be seen as interrelated phenomena that will contribute to maintaining adequate solvency levels and mitigate additional risks to financial stability conditions.

Given this diagnosis, it is important to measure the degree of efficiency of the Argentinian banking system to determine its current situation, evaluate measures to improve it, and monitor its evolution over time.

Background of efficiency measurement in banks

Bank performance has traditionally been examined using various methods and techniques, from traditional ratio analysis to more complex tools based on an efficiency frontier approach, which makes it possible to identify strengths and weaknesses and determine best practices in highly competitive environments.

Data envelopment analysis (DEA) has grown popular in banking studies since 1985, as seen in the compilation by Berger and Humphrey (1997). Recent works report the progress of performance studies in the sector. Shi, X., Li, Y., Emrouznejad, A., Xie, J., and Liang, L. (2017) developed a two-stage cost efficiency model to estimate and decompose the potential gains from Mergers and Acquisitions and applied it to the set of the 20 most competitive commercial banks in China. Meanwhile, Ouenniche, J., and Carrales, S. (2018) worked with the UK banking sector proposing a DEA-based analysis combined with a regression-based feedback mechanism, where the regression analysis reports the relevance of inputs and outputs chosen by the analyst. Li, H., Xiong, J., Xie, J., Zhou, Z., and Zhang, J. (2019) investigated efficiency decomposition in a two-stage network DEA model. Kamarudin F., Sufian F., Nassir A., Anwar N., and Hussain H. (2019) examined the income efficiency of the Malaysian banking sector using DEA. In a second stage, they employed regression analysis to investigate the possible internal (bank-specific) and external (macroeconomic) determinants influencing income efficiency.

Recently in Latin America, Vera Gilces P., Camino Mogro S, Ordeñana Rodríguez X., and Cornejo Marcos G. (2020) analyzed the determinants of private bank profitability in Ecuador using a two-stage DEA model.

In Argentina, studies are quite scarce and mostly lack a more systematic research approach. Yanguas (2010) studied the behavior of the Argentinian banking sector, focusing on the evolution of efficiency and market power before and after the economic crisis. Ferro et al. (2013) studied the efficiency of the Argentinian banking system between 2005 and 2011 using econometric and mathematical programming methods to study cost efficiency. Charles, Peretto, and Gherman (2016) studied the efficiency of the Argentine banking system in the period 2001-2010 using nonparametric methods, and Peretto (2016) extended the study by analyzing the efficiency and productivity of the system using the DEA-Malmquist method.

Methodology

In a first step, the efficiency ratios of each bank will be calculated by applying a DEA model with product-oriented variable returns to scale for 2018.

As a second step, the efficiency score achieved by each bank will be explained by estimating a production function with panel data corresponding to those efficiency levels through a set of factors that could explain the characteristics of efficiency in each bank from another perspective of analysis.

This methodological strategy, which has not been used frequently in the literature on efficiency, makes it possible to exploit the advantages of both approaches: on the one hand, to use a function considering multiple products and supplies not directly related to each other; and on the other hand, to explain the effect of certain variables on the efficiency levels achieved by each bank.

Thus, a two-stage model, such as the one employed by Wolszczak-Derlacz and Parteka (2011), supports a deeper level of analysis of the causes of efficiency, not only through the internal factors that DEA studies traditionally use but also through the inclusion of factors that affect the banks' production system but do not tend to correlate with outputs.

First stage: Data envelopment analysis (DEA)

Early work on production and cost frontier functions and the calculation of efficiency measures began with Debreu (1951) and Farrell (1957). Farrell suggested that technical efficiency could be calculated in terms of deviations from an idealized frontier isoquant. Farrell's (1957) paper is a direct antecedent to the DEA approach proposed by Charnes, Cooper, and Rhodes (1978) as a nonparametric technique that creates an efficiency frontier or observed production frontier based on information from each unit analyzed.

Those decision-making units (DMUs) that are not on the frontier will be considered inefficient, which makes it possible to evaluate their relative efficiency, i.e., to compare them with the closest efficient DMUs in terms of the technology they apply.

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The objective is to define the empirical production frontier formed by the best-observed units, constructing a perimeter of efficiency by segments that comprises the studied units in order to quantify the degree of efficiency of the observations in the sample, that is, their distance from the frontier.

Thus, the measurement of a unit's efficiency using the DEA technique involves the construction of a set of technologically feasible production possibilities and the estimation of the maximum possible expansion of the unit's products (outputs) within the set of production possibilities or the maximum possible contraction of the factors (inputs).

According to the Pareto-Koopmans model, a DMU will be considered efficient whenever it is not possible to reduce one (or several) inputs without decreasing some output. Similarly, a DMU will be considered efficient whenever it is not possible to increase one (or several) outputs without increasing some input.

Thus, these models can be classified according to whether they are output or input oriented and according to the type of performance at scale that characterizes the production technology.

The approach adopted by most of the authors considered in the literature indicates that in the case of efficiency evaluation in banks—especially in Argentina—an output-oriented model is preferred. The reason for this decision lies in the limited flexibility of the inputs frequently used to measure efficiency in banks, such as the number of employees, area covered, deposits, or operating expenses and assets.

Model with constant returns to scale (CRS)

Charnes, Cooper, and Rhodes (1978) propose a fractional optimization model from which an equivalent linear model and its dual program are derived by changing variables. These linear models provide, in addition to the efficiency score of each unit, useful information on the weights of inputs and outputs, the referent units, and potential projections to the frontier of inefficient DMUs.

The linear formalization of the output-oriented DEA model with the assumption of constant returns to scale can be presented as follows:

$$\text{Max } I^{(h)}$$

subject to:

$$\sum_{j=1}^{n} z_j \, x_i^{(j)} \leq x_i^{(h)} \text{ for } i = 1, \ldots, m$$

$$I^{(h)} y_r^{(h)} \leq \sum_{j=1}^{n} z_j \, y_r^{(j)} \text{ for } r = 1, \dots, s$$

$$z_j \geq 0$$

(1)

Model (1) measures the technical inefficiency of the evaluated unit (h). Where m is the number of inputs, s the number of outputs, $x_i^{(h)}$ is the i-th input, $y_r^{(h)}$ is the r-th output, $x_i^{(j)}$ is the i-th input of the j-th unit, and $y_r^{(j)}$ is the r-th output of the j-th unit. The variable z_j represents the weighting of the jth observed DMU (j= 1...n). These weights make it possible to define a "potential" DMU against which the DMU_h whose efficiency to be measured is compared.

Since $I^{(h)}$ is a measure of technical inefficiency, its reciprocal $E^{(h)} = 1/I^{(h)}$ measures the technical efficiency of the DMU being evaluated. The index $E^{(h)} \leq 1$.

A unit is efficient if $E^{(h)} = 1$ and all slack variables are zero.

Model with variable returns to scale (VRS)

Banker, Charnes, and Cooper (1984) propose the VRS model in which variable returns to scale are admitted in the DMUs analyzed.

$$\text{Max } I^{(h)}$$

subject to:

$$\sum_{j=1}^{n} z_j \, x_i^{(j)} \leq x_i^{(h)} \text{ for } i = 1, \dots, m$$

$$I^{(h)} y_r^{(h)} \leq \sum_{j=1}^{n} z_j \, y_r^{(j)} \text{ for } r = 1, \dots, s$$

$$\sum_{j=1}^{n} z_j = 1$$

$$z_j \geq 0$$

(2)

In the linear formulation of the model (2), the additional constraint (3) is observed, which, together with $\lambda_j \geq 0$, imposes on the model the convexity condition in which the n DMUs must be combined.

$$e\lambda = \sum_{j=1}^{n} \lambda_j = 1 \tag{3}$$

Second stage: Estimation of a production function

In the second step of the proposed analysis, the efficiency scores calculated by DEA in the previous step are used as a dependent variable in an estimated function with the factors that could affect it. As follows:

$$h_j^* = \beta_0 + \beta_1 x_j + \varepsilon_j , j = 1, 2, \dots, n \tag{4}$$

Where h_j^* is the dependent variable and expresses the efficiency level obtained by each unit in the first stage, and x_j represents the vector of institutional[1] variables that could affect the efficiency levels of DMUs. Similarly, ε_j represents the unobserved factors in the equation that affect the efficiency levels of each bank in a given period.

Empirical application

Data and variables to be used

The efficiency evaluation will be carried out on the banking financial institutions of Argentina, considered homogeneous since they use the same type of resources to produce similar services and products in an intermediation role between depositors and borrowers of funds. For this reason, cooperatives and cooperative banks are excluded since they are organizations whose purpose is social interest rather than intermediation.

Although the banking entities to be considered are those in activity during 2018, considering

[1]Variables that reflect the economic and financial strategies not included in the first stage were used and can be used to identify other explanatory elements of the efficiency achieved by the banks, such as the equity structure, intangible assets such as the bank's "name" and its market trajectory, among others.

that complete information for some of the variables used is not available for that year, the following units were excluded from the study:

- Bacs Banco de Crédito y Securitización SA
- Banco Cetelem Argentina SA
- Banco de Servicios Financieros SA
- RCI Banque SA

Banco de la Nación Argentina was also excluded from the analysis since this mega-entity deserves special consideration due to its size, given that it significantly exceeds the others in each input and output. Considering this, although it is efficient in its evaluation, this result should be treated with caution due to the magnitude of this entity, which means that there are no others with close values with which to compare it, and the method tends to classify it as efficient.

In order to carry out a cross-sectional study, the data corresponding to the 57 entities are obtained from the publications made by the BCRA from the accounting information and economic-financial reports of the entities, which they periodically submit to it.[2]

Considering the origin of their capital, the entities considered can be classified as shown in Table 1:

Table 1
Grouping of banks according to the source of their capital

Origin of Capital	No. of Banks	Percentage
Public	12	21 %
National Private	33	58 %
Foreign (local or branch)	12	21 %

Source: created by the authors based on information from BCRA

It can be observed that the Argentine Banking System is mainly made up of national private capital entities (58%).

It is important to note that in this paper, the bank output is determined using the asset approach, where banks are considered financial intermediaries. The variables to be used will be classified into inputs and outputs using the intermediation approach based on the traditional role of financial institutions that transfer financial assets from surplus units to deficit units. Following Berger and Humphrey (1997), the intermediation approach has been used with a restricted selection of variables. The type of variables to be

2The BCRA, through the Superintendency of Financial and Exchange Entities, periodically publishes this information in the "Financial Entities Report" which can be accessed through the following link: http://www.bcra.gov.ar/Publicaciones/pubinv051300.asp.

used will be mostly flow variables, which will be selected from the income statement of the entities' accounting statements.

As for the variables to be used in the process of transforming inputs into outputs, the following will be considered:

- Inputs: Deposits, Operating Expenses, and Fixed Assets, representing funds borrowed (lending capacity), physical assets and employee compensation, and expenses necessary for the functioning of the bank
- Outputs: Financial income, Income from services, and Investments, which reflect the results obtained by the bank from its financial and intermediation activities, and from medium and long-term investments

Table 2 presents a descriptive statistical analysis of the variables used in the DEA model (first stage) and of the variables used to estimate the second stage model.

Table 2
Descriptive statistics of available variables

Variable	Mean	Minimum	Maximum	Median	DS
Inputs					
Deposits	53888.00	8.44	413867.60	15483.21	96824.48
Operating expenses*	11277.49	65.30	83975.29	3766.14	18790.00
Fixed assets*	2074.80	0.36	20591.47	405.88	3809.60
Outputs					
Financial income*	12744.41	67.89	83630.97	4254.13	19965.77
Income from services*	64795.07	284.67	495272.60	17007.01	112493.10
Investments*	13976.54	55.25	124278.50	2626.17	23784.78
Second Stage					
Total transactions	552455.50	0.00	6602869.00	130617.00	1124505.00
Intangible Assets*	240.76	0.00	3971.60	20.25	700.57
Net Worth*	7190.43	115.86	54846.57	2105.19	11009.48

Note: *represents values expressed in thousands of Argentine pesos

Source: created by the authors

In relation to the variables of the second stage, two figures are included below that illustrate the relationship of the variables in question. First, Figure 1 shows the correlation between the two variables with minimum values equal to zero (Total transactions and Intangible assets). As previously mentioned, the first of these variables shows the number of transactions carried out by the banks, and the figure shows that there is a small group of banks with a large number of transactions, which simultaneously have a high volume of intangible goods (assets). In comparison, other entities concentrate their financial activities on different commercial strategies, which are not reflected in the number of transactions they carry out.

There is no strong correlation between these variables, and the same is true regarding Net Worth.

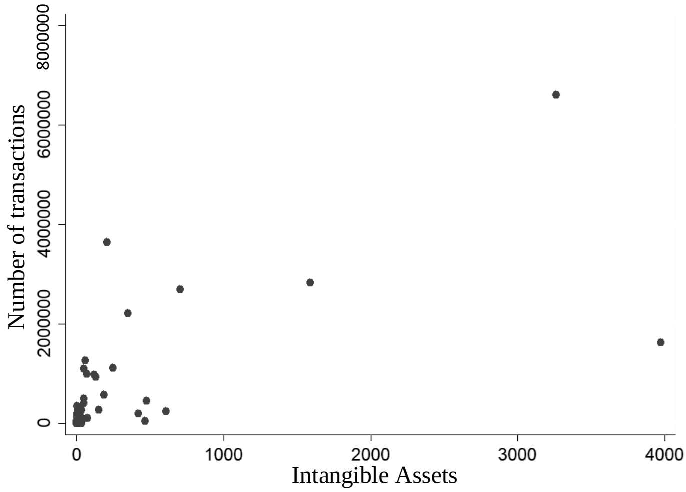

Figure 1. Scatterplot of Total Transactions for Intangible Assets
Source: created by the authors based on the data analyzed

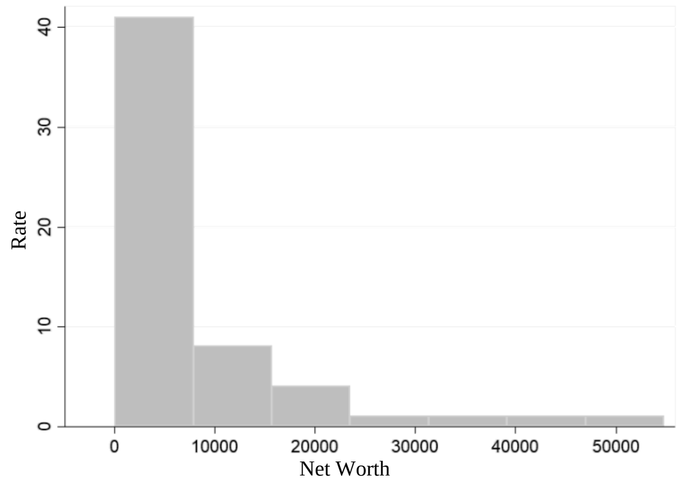

Figure 2. Frequency of the equity structure of the banks analyzed
Source: created by the authors based on the data analyzed

It is observed that the variables used in the first stage (application of the DEA model) and those used in the second stage show a wide range of variation among the different banks.

Concerning the inputs, a high degree of variability is observed, especially in fixed assets and in

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the volume of deposits, reflecting the different commercial strategies that banks may follow. The model's outputs also show a high degree of variability, highlighting the different ways in which banks generate resources. Financial income, which is one of the main sources of income of the DMUs analyzed, has a range of variation of 83563.08 million Argentine pesos with an average of 12744.41, which once again highlights the great differences between the banking entities that comprise the Sector but that help to understand it and characterize it.

The variables used in the second stage present analogous characteristics: a wide range of variation. The values of the variable Intangible Assets stand out, where 15.79% of the analyzed entities do not declare intangibles. Total transactions vary considerably considering the total number of banks, and this difference is maintained if the same variable is analyzed while distinguishing between public and private institutions (see 3).

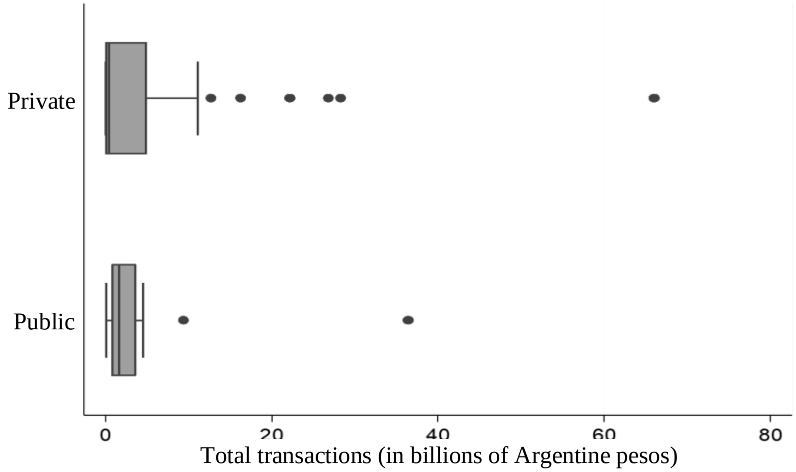

Figure 3. Distribution of total transactions by bank, distinguishing the origin of capital
Source: created by the authors

First stage: Application of the DEA method

First, the DEA efficiency indices of the 57 banks in activity in the period considered are calculated using the VRS model presented in section 4.1.2. In order to select the model's orientation, the selected variables' operational characteristics were analyzed, with relatively less flexibility observed in the inputs, at least in the short term. Therefore, an output-oriented model was chosen (Liu, X., Yang, F., & Wu, J., 2020). In particular, Fixed Assets are not easily modifiable, and it is not convenient to alter them in short-term decisions. Deposits are not easy to modify in the short term either since they depend on interest rates, i.e., they are related to market conditions and to the confidence each entity generates in potential depositors.

The results obtained are shown in Table 3 and Figure 4.

Table 3
Relative Technical Efficiency Ratios of Banking Institutions (2018)

ID	Banks (DMUs)	DEA index (h_j^*)
1	Banco Bica S.A.	0.357
2	Banco Bradesco Argentina S.A.U.	1.000
3	Banco CMF S.A.	0.728
4	Banco COINAG S.A.	0.315
5	Banco Columbia S.A.	0.700
6	Banco Comafi S.A.	0.632
7	Banco Credicoop	1.000
8	Banco de Comercio S.A.	0.287
9	Banco de Corrientes S.A.	0.656
10	Banco de Formosa S.A.	0.532
11	Banco de Galicia y Buenos Aires S.A.	0.965
12	Banco de Inversión y Comercio Exterior S.A.	1.000
13	Banco de la Ciudad de Buenos Aires	0.891
14	Banco de La Pampa Sociedad de Economía Mixta	0.619
15	Banco de la Provincia de Buenos Aires	1.000
16	Banco de la Provincia de Córdoba S.A.	0.898
17	Banco de la República Oriental del Uruguay	1.000
18	Banco de San Juan S.A.	1.000
19	Banco de Santa Cruz S.A.	0.461
20	Banco de Santiago del Estero S.A.	0.984
21	Banco de Servicios y Transacciones S.A.	1.000
22	Banco de Valores S.A.	1.000
23	Banco del Chubut S.A.	0.555
24	Banco del Sol S.A.	0.417
25	Banco del Tucumán S.A.	0.568
26	Banco Hipotecario S.A.	1.000
27	Banco Industrial S.A.	0.966
28	Banco Interfinanzas S.A.	0.327
29	Banco Itau Argentina S.A.	0.713
30	Banco Julio S.A.	0.492
31	Banco Macro S.A.	1.000
32	Banco Mariva S.A.	0.499
33	Banco Masventas S.A.	0.300
34	Banco Meridian S.A.	0.376
35	Banco Municipal de Rosario	0.458
36	Banco Patagonia S.A.	0.865
37	Banco Piano S.A.	0.785
38	Banco Provincia de Tierra del Fuego	0.541
39	Banco Provincia del Neuquén S.A.	0.580
40	Banco Rioja S.A. Unipersonal	0.829
41	Banco Roela S.A.	0.519
42	Banco Saenz S.A.	0.411

ID	Banks (DMUs)	DEA index (h_j^*)
43	Banco Santander Rio S.A.	1.000
44	Banco Supervielle S.A.	1.000
45	Banco Voii S.A.	0.799
46	Bank of America, NA	1.000
47	BBVA Banco Frances S.A.	1.000
48	BNP Paribas	1.000
49	Brubank S.A.U.	1.000
50	Citibank N.A.	1.000
51	HSBC Bank Argentina S.A.	1.000
52	Industrial and Commercial Bank Of China S.A.	1.000
53	J P Morgan Chase Bank, NA	1.000
54	Nuevo Banco de Entre Ríos S.A.	0.571
55	Nuevo Banco de Santa Fe S.A.	0.678
56	Nuevo Banco Del Chaco S. A.	0.574
57	Wilobank S.A.	0.147

Source: created by the authors based on the DEA coefficients obtained

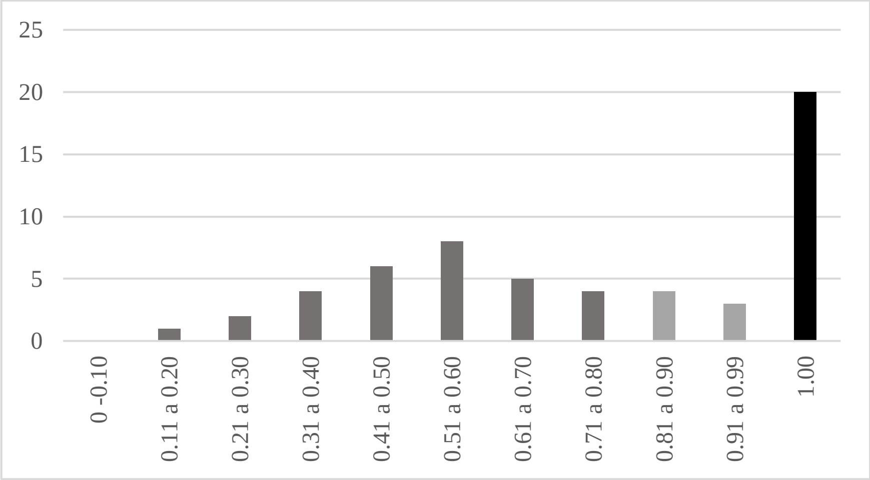

Figure 4. Distribution of efficiency indices obtained using the output-oriented DEA-VRS model
Source: created by the authors based on the DEA coefficients obtained

Of the 57 banks evaluated, 20 were efficient (with an index equal to unity), and the average efficiency of the system was 0.74. 9 inefficient DMUs were above average efficiency. The remaining 28 banks showed below-average ratios; of these, 7 showed highly inefficient behavior with ratios below 0.40.

These efficiency measures will be explained in a second stage in terms of a series of factors specific to the banking activity but not considered in the DEA model applied.

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Second stage: Modeling of efficiency indices

In the second stage, each efficiency index h_j^* in the Table 3 was explained by estimating Equation (4), using different specifications to identify those variables that can explain the efficiency levels achieved by the banks.

Through quantifying each DMU's performance in the first stage, it is possible to identify those DMUs that present better levels of efficiency, using for this purpose a particular group of variables (inputs and outputs) closely linked to the dynamics of the banks.

The second stage included another group of variables that can explain the aforementioned levels of efficiency, i.e., those that by their nature cannot be used in the envelopment analysis method because they are categorical: dummies that identify other characteristics of the DMUs.

The size of the banks was determined through a hierarchical cluster analysis, using variables that provide an idea of their structure and volume of activity. The variables considered were employees and subsidiaries, and as a measure of similarity, Complete Linkage (Furthest Neighbor).

Based on the results of this method, four groupings of Banks were identified, summarized in Table 4, which shows that the System under consideration is mainly made up of small Entities (70% of the total).

Table 4
Classification of Banks according to their size

Bank Size	No. of Banks	Percentage
Small	42	74 %
Medium	10	17 %
Large	4	7 %
Very Large	1	2 %

Source: created by the authors based on the results of the hierarchical cluster

Based on this analysis, a variable was constructed that assumes a value of 1 if the entity is large (medium, large, and very large) and a value of 0 if it is not.

Two categories were established concerning the origin of the capital: national/international and public/private. For the first case, the National variable assumes a value of 1 if the bank has a majority participation of Argentinian capital and 0 if the origin is foreign. The Public variable assumes a value of 1 if the entity is under state control (at any level) and 0 if it is controlled by private capital.

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Furthermore, variables that are not necessarily linked to the practice of the organizations being analyzed but that can influence efficiency levels—such as the volume of Intangible Assets[3]—are included. This variable was used as a proxy for the competitive advantage that the entities may have due to market confidence in the bank's management. Complementarily, the Net Worth variable was added, which reflects the economic capital with which the entities operate and is intrinsically linked to the bank's asset structure.

Finally, the Total Transactions[4] variable was incorporated, which aggregates—in units and not in monetary amount—all the activities of the entity regardless of their characteristics, reflecting the transactional volume with which each bank operates, as opposed to the variables used in the first stage (Deposits, Assets, Expenses, Revenues, and Investments) which are all expressed in monetary units.

Table 5 presents the results of the second stage, starting in the second column of the most detailed specification of the model (4), which includes all the control variables previously described. In the subsequent columns to the right, from "Model 2" to "Model 5," the control variables are gradually eliminated until the specification in which only the nationality of capital and net worth are considered.

Table 5
Second stage estimates[5]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.83410***	0.83388***	0.84655***	0.83136***	0.84427***
National	-0.26310***	-0.24967***	-0.24671***	-0.22601***	-0.22484***
Net Worth	0.01535***	0.01550***	0.01317***	0.01566***	0.00973***
Intangible assets	-0.10694	-0.11282*	-0.13754**	-0.11992*	
Total transactions	0.00742*	0.00724	0.00422		
Large size	-0.29225	-0.27815			
Public	0.04902				
R^2	0.4496	0.4441	0.4235	0.4101	0.3691
N	57	57	57	57	57

Note: The dependent variable in all models is the efficiency coefficient $E^{(h)}$ obtained in the first stage. *It is statistically significant at 10%; ** statistically significant at 5%; and *** statistically significant at 1%.

The results in Table 5 show that the capital nationality variable has a negative and significant effect for all model specifications, with an estimated coefficient ranging from -26.31 to -22.48, which

[3]Expressed in thousands for better interpretation of estimation results.
[4]Scaled in hundreds of thousands for better interpretation of estimation results
[5]In relation to the observed levels of the R^2 for each model specification, it can be noted that these are not particularly high. To this end, the considerations made by other authors in relation to the fact that a possible low value does not necessarily imply an alteration of the explanatory level of the model (Easton & Harris, 1991; Ramesh & Thiagarajan, 1993; Lys *et al.*, 1998) are shared, also considering that a very limited number of explanatory variables are available.

means that for the first specification, a public bank is 26.31% less efficient than one whose capital origin is private.

Net worth (NP) appears with positive and equally significant effects in all model specifications, although its effect on bank efficiency is small. Nevertheless, this result indicates that the equity structure impacts the efficiency levels achieved by banks.

Moreover, the number of Total Transactions has a very slight positive effect and is only significant in the fullest specification of the model.

Regarding Intangible Assets, which could be considered a proxy for the level of market confidence in the structure of each bank, they appear with a negative sign, which is significant when the variable indicating whether the entity is publicly or privately managed is excluded. This could indicate that investment in this type of asset reduces the efficiency levels that banks can achieve. One possible reason is that these intangible assets compete with others in each bank's resource allocation decision and that other types of assets—especially physical or capital assets—can generate higher profitability or confidence in the market due to their greater solvency capacity.

Finally, it should be noted that the fact of the bank being in the large group or being publicly managed is not significant in the specifications presented.

Conclusions

The methodology, combining DEA and parametric estimation in a two-stage model, is useful for determining the most relevant variables in the efficiency levels of banks. The parametric approach followed in the second stage makes it possible to quantify the part of efficiency explained by the decision units' characteristics, which the data envelopment analysis cannot capture.

In a first stage, the relative technical efficiency of Argentina's 57 banking financial institutions is evaluated based on the information available as of December 2018. A classical DEA model is applied, with variable returns, oriented output that explains the outputs considered, Financial income, Income from services and Investments through three inputs, which represent the funds taken (Deposits), the physical goods (Fixed assets), and the remuneration of employees, and expenses necessary for the functioning of the bank (Operating expenses).

The results of this first stage show 20 efficient and 37 inefficient banks; nevertheless, measuring efficiency simply by applying DEA does not make it possible to identify the factors that determine bank efficiency.

These efficiency measures will be explained in a second stage in terms of a series of factors specific to the banking activity but not considered in the DEA model applied.

Regarding the variables used in the second stage, the origin of capital is one of the most relevant factors concerning its effect on efficiency. On the one hand, capital of national origin has a negative impact on the efficiency levels achieved by the entities analyzed. On the other hand, surprisingly, the fact that the bank's management is public is not significant.

These results show that the composition of capital has an effect on the level of efficiency that banks can achieve; in particular, nationality matters more than the public/private nature.

Regarding the equity structure, the results show, on the one hand, that Equity has a positive effect on the efficiency levels achieved by banks and, on the other hand, that Intangible Assets worsen the performance of the entities. In both cases, it is evident that decisions related to the composition and structure of equity can determine Argentinian banks' efficiency. This is particularly relevant because these variables are those over which decision-makers would have more control within the DMUs, compared to the rest of the variables included in the second stage, and were found to be significant. In other words, the origin of capital (domestic/foreign or public/private) cannot be modified in the short term, while the composition of its equity would be more flexible.

Future developments of this work could incorporate new environmental or economic variables and generate a complementary estimation strategy, such as using panel data to improve the estimates and recover fixed effects.

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