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Pre-evaluating Efficiency Gains from Mergers and Acquisitions: Evidence from the Spanish Banking Sector

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***Abstract*— Data Envelopment Analysis (DEA) is a non-parametric method used to calculate the relative efficiency of decision-making units. DEA has recently been used as a pre-merger tool to help decision-makers select the most appropriate target and increase M&As success chances. The aim of this paper is to pre-estimate and decompose the potential gains from hypothetical mergers of Spanish banks using Data Envelopment Analysis to know whether these operations would result in efficiency improvements. Following Bogettof and Wang** [1]**, we estimate the overall potential gains and decompose them into learning effect, harmony effect, and size effect. Our results reveal that mergers between the Spanish banks of our sample would result in substantial potential gains for the hypothetically merged banks. We conclude that on average, these hypothetical mergers result in improved efficiency through economies of scope, and also through economies of scale. Although our results revealed some cases where the size effect worked against the merger, the overall size effect is positive and enhances the efficiency of the merged banks.**

***Keywords*— Data Envelopment Analysis, DEA, Mergers and acquisitions, M&As, banking, potential efficiency gains.**

I. Introduction

The Spanish banking sector is witnessing major changes as many of its largest banks are under high pressure for consolidation through mergers and acquisitions. This pressure comes mainly from the need to cope with historically low-interest rates and the negative economic impact of the actual Coronavirus pandemic. In such a context, mergers and acquisitions have become indispensable for survival. According to "El Pais", The Spanish banking sector is undergoing the biggest restructuring process in Europe as in just 12 years, it has closed 50% of its branches and fired 37% of its workforce. The largest banks in Spain such as BBVA, la Caixa, and Santander are the result of multiple mergers and acquisitions during this last decade and many mergers involving the most important Spanish banks are currently under process.

Mergers and acquisitions (M&As) represent, alongside strategic alliances, two alternative governance structures available to companies when they decide to combine their resources to achieve common strategic objectives. A merger is an external growth strategy, as opposed to an internal growth strategy, in which two companies come together by pooling all their resources to form a single entity to achieve common strategic objectives. However, there is consensus in the extant literature that despite their success and the increased number of firms involved in these operations, M&As exhibit high failure rates and lead to shareholder value destruction. This paradox gave rise to prolific literature and many studies have highlighted the need to develop pre-merger planning approaches in order to lower the failure rate of these operations through a rigorous selection of the target. In this sense, recent studies have used Data Envelopment Analysis (DEA) as a pre-merger tool in order to estimate the potential gains from hypothetical mergers, which can help decision-makers to select the most appropriate target and increase the success chances of these strategies.

Prior studies have used different methods to compare the overall performance of banks before and after M&As. When evaluating efficiency gains, scholars have mainly used Stochastic Frontier Analysis (SFA), a parametric approach using regression, and Data Envelopment Analysis which is a non-parametric approach using linear programming. However, DEA is undoubtedly the most commonly used method to evaluate the efficiency gains in the banking sector.

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The aim of this study is to contribute to the extant literature by answering the following questions;

- ***Are there efficiency gains from merging the most important Spanish banks?***
- ***What are the sources of these efficiencies (or inefficiencies)?***

To answer these questions, we follow Bogettof and Wang [1] by applying Data Envelopment Analysis to pre-evaluate the potential merger gains resulting from mergers between Spanish banks. We decompose these overall gains into learning effects, harmony effects, and size effects and reveal the most promising mergers leading to an improvement in the efficiency scores of these banks. To the best knowledge of the author, no previous study has applied DEA as a pre-merger tool to pre-evaluate the potential gains from hypothetical mergers and acquisitions of the Spanish banks and only scant efforts in this sense have been found at the European level. Furthermore, this study is timely as the Spanish banking sector is going through many simultaneous merger processes, and our results have the potential to show whether or not these mergers are justified by efficiency gains and performance improvement. The novelty of this study also lies in the inclusion of the most important European banks in our sample so that we are able to evaluate how potential mergers between Spanish banks would affect their efficiency with reference to their European counterparts.

The structure of the paper runs as follows. Section 2 reviews the main empirical and methodological research on efficiency evaluation in M&As using DEA. Section 3 provides a detailed description of the methodology used in this paper, section 4 presents the data and the variable definition. Section 5 shows empirical results and discussion. The final section concludes the paper.

II. LITERATURE REVIEW

Evaluating the efficiency of M&As has been a hot topic in management these recent years as many papers have been published to evaluate the efficiency of mergers following two main approaches. The first approach is an ex-post efficiency evaluation that examines whether a merger has improved the efficiency of the involved entities by comparing their efficiency before and after the merger has taken place. This approach is the most commonly used in the literature as the majority of the published studies in the M&A efficiency evaluation literature focused on ex-post efficiency analysis. Under this approach, DEA has been applied as a post-merger analysis tool. The second approach, less common, is to evaluate pre-merger potential gains in order to determine beforehand which mergers and promising in terms of efficiency gains. This approach uses DEA as a strategic tool for policy-makers to pre-evaluate possible M&As decisions based on performance criteria that are measured in terms of technical efficiency gains [2]. In this paper, we are following this second approach as we believe that potential production and economic effects should be investigated before merger decisions are made [3], in order to make the best decision when selecting a target.

To evaluate pre-merger potential gains, many methods have been used in previous studies. Reference [2] used a Bootstrapped DEA-based procedure to estimate the short-run operating efficiency gains of potential M&As in the Greek banking industry. The results showed that in the majority of cases, these potential M&As would not result in improved efficiency. Also, acquisitions between efficient banks do not ensure an efficient bank M&A. This method was also used by [2] to analyze potential M&As in the Japanese regional banking sector. Their results reveal that potential M&As involving smaller banks performed better than those involving larger banks. Inverse DEA which is a method that determines the level of inputs and/or outputs required to reach a given efficiency target has also been widely used in order to pre-evaluate mergers gains [4],[5].

Reference [1] proposed an economic production model to estimate the potential efficiency gains from merger and their decomposition into learning effect, harmony effect, and size effect. Some authors followed this model to quantify the effects of a merger in terms of efficiency gain. Reference [6] used this model to examine the hospital mergers in Denmark. More recently, [3] analyzed the potential efficiency effects of merging the Swedish district courts. They used Data Envelopment Analysis (DEA) to compute a production frontier where the conducted mergers are incorporated to identify the potential ex-ante gains. The results showed diverse potential gains as some mergers had the potential to gain substantially while others did not.

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In the banking sector, [7] used the work of Bogettof and Wang as a platform to develop an alternative approach. They decompose the potential overall gains from mergers using strongly efficient projections and calculate radial input-based measures for these three effects based on the pre-merger aggregated inputs. They analyze the top 20 City Commercial Banks (CCBs) in China and find that the technical effect and harmony effect favor mergers, whereas the size effect work against most mergers. These results are supported by [8] who develop a novel two-stage cost efficiency model to estimate and decompose the potential gains from Mergers and Acquisitions.

Our screening of the extant literature suggests that there are very limited studies trying to assess potential merger gains using DEA in the banking sector in Europe and absolutely no effort in this sense has been found in the Spanish context. Reference [9] evaluated the ex-post effects of mergers and acquisitions on the long-run productivity of 17 mergers and acquisitions in Spanish savings banks between 1986 and 2004. To perform this analysis, the authors calculate the distance to the frontier, changes in productivity, and conduct event analysis to determine the impact of the merger on the firm's share prices. Their results show that productivity improvements have only been achieved in half of the mergers analyzed. Our review of the DEA-related literature in the banking system failed to find any effort trying to assess the potential gains from the consolidation of the Spanish sector using DEA. The primary goal of this paper is to fill this gap by estimating and decomposing the potential merger gains from hypothetical mergers between the most important Spanish banks in order to evaluate the implications of each merger on the efficiency of the involved banks with reference to their Spanish and European counterparts,

III. METHODOLOGY:

In reference [1], Bogettof and Wang develop a framework where they estimate the potential gains from the horizontal integration of two similar firms. They show how the effects of mergers can be captured and decomposed by DEA models. This approach is first used by the authors to estimate the potential overall gains from mergers. Afterward, they decompose these potential gains into learning effects, harmony effects, and size effects in order to identify three sources of improvement.

A. Data Envelopment Analysis (DEA)**:**

Data Envelopment Analysis is mathematical programming used to calculate the relative efficiency of decision-making units with common inputs and outputs. DEA was proposed in 1978 by Charnes, Cooper, & Rhodes and is referred to in the academic literature as the CCR model. It assumes that each entity operates with constant returns-to-scale. The BCC model (after Banker, Charnes, and Cooper, 1984) brought some improvements to the original model by allowing for variable returns to scale (VRS).

DEA is a non-parametric approach that does not require the definition of the production function. It constructs the best practice production frontier only on the basis of observed data and therefore it is not possible to miss specify the production technology [10]. DEA determines the relatively efficient production frontier, based on the inputs and outputs of a number of entities, called Decision Making Units (DMUs). It identifies reference points (relatively efficient DMUs) that define the efficient frontier (best practice production technology). All the DMUs that are below that frontier are relatively inefficient.

Following DEA literature, We assume that there are n peer DMUs that consume m inputs $X^j = (x_1, x_{mj})^T$ to produce s outputs $Y^j = (y_{1j},\ldots, y_{sj})^T$. The technical efficiency score of DMUd (d = 1,…, n) can be calculated by the following model (1):

$$\begin{aligned} &\theta_d^* = \operatorname{Min} \theta_d \\ &\text{s.t.} \sum_{j=1}^{n} \lambda_j X_j \le \theta_d X_d \\ &\quad \sum_{j=1}^{n} \lambda_j Y_j \ge Y_d \\ &\quad \lambda_j \ge 0, \lambda_j \in \Omega, j = 1, \ldots, n. \end{aligned}$$

The optimal solution of θ_d is the efficiency score of DMU_d (d = 1,…, n), and represents the maximal proportional contraction in inputs while keeping outputs unchanged. DMU_d (d = 1,…, n) is identified as DEA efficient if its score reaches the maximum of one, otherwise, it is inefficient.

B. Overall Gains from Merger:

Let us assume that J-DMUs with indexes $j \in J \subseteq \{1, 2,...,n\}$ are merged to create a new entity denoted DMU^J that uses $\Sigma\, j\in J\, x^j$ to produce $\Sigma j\in J\, y^j$. A radial input-based measure of the potential overall gains from the merger could be obtained by E^J, which is the maximal proportional reduction

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in the aggregated inputs $\Sigma\, j\in J\ x^j$ that allows the production of the aggregated output profile $\Sigma j\in J\ y^j$

$$E^J = \text{Min}\left\{ E\in\Re_0 \middle| \left(E\left[\sum_{j\in J} x^j\right], \sum_{j\in J} y^j\right)\in T\right\}$$

if $E^J < 1$, the merger is advantageous and produces savings equal to $1- E^J$ in the inputs needed to produce the aggregate outputs. if $E^J >1$, the merger is costly as the production of the aggregate output would require $E^J - 1$ more input. Hence, a score of $E^J =0.6$ suggests 40% savings in input, whereas a score $E^J =1.6$ suggests that the merged unit will need 60% more resources in order to keep the aggregate output.

Similarly, an output-based measure of the potential overall gains from merging the J-DMUs represents the maximal proportional expansion of the aggregate output $\Sigma j\in J\ y^j$ that is feasible in a (merged) unit with aggregate input $\Sigma\, j\in J\ x^j$.

$$F^J = \text{Min}\left\{ F\in\Re_0 \middle| \left(\sum_{j\in J} x^j, F\left[\sum_{j\in J} y^j\right]\right)\in T\right\}$$

If $F^J>1$, we can gain by merging. If $F^J <1$, the merger is costly. The output-oriented calculations and decompositions of the overall merger gains are similar to the input-oriented. Therefore, we shall restrict ourselves to input-based measures from hereon.

Bogettof and Wang [1] highlight that the obtained overall gains measure of the above model is optimistic because a part of the gains could possibly be obtained individually and it would be inaccurate to associate them entirely with the merger. Therefore, they propose to decompose the overall gains into learning, scope, and scale effects to account for this. Additionally, one could be skeptical about the assumption that the merged entity will be technically efficient as even highly competitive firms show inefficiencies.

C. Decomposition of Merger Gains:

Bogetoft and Wang [1] suggested decomposing the potential overall gains (E^J) into technical effect (T^J), harmony effect (H^J), and size effect (S^J).

$$\boldsymbol{E^J = T^J \cdot H^J \cdot S^J} \qquad (1)$$

Technical efficiency or learning $\boldsymbol{T^J}$ is associated with the ability to learn from best practices. The authors contend that a great part of these effects could have been attained on an individual basis if the merged units had optimized their businesses, and therefore they could not completely be associated with the merger. To adjust the overall merger gains for the learning effect, Bogettof and Wang start by projecting the original firms to the production possibility frontier and use the projected plans as the basis for evaluating the remaining gains from the merger. Size effect and harmony effect are thought of as the pure potential gains from mergers.

Accordingly, (x^j, y^j) is projected into $(E^j x^j, y^j)$ for all $j \in J$, where $E^j=E^{\{j\}}$ is the standard efficiency score for the single DMUj, and use the projected plans $(E^j x^j, y^j)$, $j\in J$, as the basis for calculating the adjusted overall gains from the merger

$$E^{*J} = \text{Min}\left\{ E\in\Re_0 \middle| \left(E\left[\sum_{j\in J} E^j\, x^j\right], \sum_{j\in J} y^j\right)\in T\right\}$$

$$\boldsymbol{E^{*J} = H^J \cdot S^J} \qquad \textbf{(2)}$$

Harmony or scope effects H^J are associated with the mix of resources used and the mix of services provided. They represent the input reduction achieved through input reallocation and input mixture among the DMUs of the new entity.

According to the formula (1) and (2), the learning effect is calculated by

$$\mathbf{T^j = E^J \,/\, E^{*J}}$$
$$\mathbf{E^J = T^J * E^{*J}}$$

where $T^J \in [0, 1]$ indicates what can be saved by individual adjustments in the different units in J.

After the technical efficiency or learning effects have been eliminated from the overall potential gains, we are left with the pure gains from the merger, i.e harmony or scope effects and scale effects. Harmony effects H^J represent the input reduction achieved through input reallocation and input mixture among the DMUs of the new entity. These effects are captured by examining how much of the average input could be saved in the production of the average output.

$$H^J = \text{Min}\left\{ H\in\Re_0 \middle| \left(H\left[|J|^{-1}\sum_{j\in J} E^j x^j\right], |J|^{-1}\sum_{j\in J} y^j\right)\in T\right\},$$

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Where /J/ is the number of DMUs. H^J <1 indicates a savings potential due to improved harmony, while H^J >1 indicates a cost of harmonizing the inputs and outputs ;

The increased size attained through a merger allows the merged entity to produce at lower average costs. This size effect is calculated by asking how much could have been saved by operating at full scale rather than average scale. But this effect depends on the returns to scale property of the underlying technology, i.e whether it is favorable for an increase in scale or not. The size effect could be measured by S^J ;

$$S^J = \text{Min}\left\{ S \in \Re_0 \middle| \left(S\left[H^J \sum_{j \in J} E^j x^j \right], \sum_{j \in J} y^j \right) \in T \right\}$$

If S^J< 1, there are economies of scale and the rescaling is advantageous. If S^J > 1 rescaling is costly. This could happen if the returns to scale property do not favor larger firms. This may be the case in DRS, VRS, and FDH models.

IV. DATA AND VARIABLE DEFINITION:

In this section, the DEA approach presented so far is exemplified through a data set composed of 27 European commercial banks, out of which 7 are Spanish and the remainder represents the top 20 European banks. The data were extracted from the Eikon Datastream database and cover the year 2019. The aim of our analysis is to estimate potential efficiency gains from mergers of Spanish banks. The objective pursued by including European banks is twofold. First, the data needed to perform our analysis was only available for 7 Spanish banks in the database we used. Conducting our analysis on such a small number would have yielded unacceptable results and thus, we had to expand the size of our sample. Second, we think that including European banks would enrich our analysis as the efficiency frontier is no longer determined by efficient Spanish banks, but by efficient European banks. This permits us to estimate how mergers between Spanish banks would affect their efficiency with reference to their European counterparts.

The definition of the variables is one of the biggest challenges facing bank efficiency-based studies, as improper variable selection can substantially distort the results' reliability [11]. There are three main approaches to define the inputs and outputs in the extant DEA literature, namely the intermediation approach, the production approach, and the profitability approach. In the intermediation approach, banks are thought of as intermediaries between savers and investors. In this case, deposits, labor, and capital are treated as inputs whereas loans are treated as outputs. In the production approach, labor and capital are used as inputs to produce banking products, mainly deposits, and loans which are treated as outputs. Finally, the profitability approach uses more profit-oriented outputs such as interest income and non-interest income.

In our analysis, we follow the DEA-related literature that prioritizes the intermediation approach, considering that financial institutions act as intermediates between depositors and borrowers. In reference [12], the authors contend that the intermediation approach may be more appropriate for evaluating entire financial institutions, whereas The production approach is more appropriate for branches. Therefore, we define our DEA formulation based on previous studies by using total deposits, labor, and fixed assets as inputs, and loans and non-interest income as outputs. Table 01 gives summary statistics of our selected inputs and outputs

TABLE *1: SUMMARY STATISTICS OF INPUTS AND OUTPUTS*

Variable	Obs	Mean	Std. Dev.	Min	Max
Deposits	27	500551,8	362683,3	30687	1531800
Labor	27	7212,407	5295,547	111	18002
Fixed Assets	27	8853,63	9163,879	353	34262
Loans	27	434104,2	366759,2	25096	1840022
Non-Interest Income	27	19132,81	19686,52	331	72389

For illustration purposes, we conducted a Data Envelopment Analysis under the assumption of variable returns to scale (VRS) [13]. Further, for convenience of analysis, we consider only mergers between two Spanish banks. We identified all possible combinations in our sub-sample of Spanish banks with a total of 21 (C^2 = 21) hypothetical mergers. 7

V. RESULTS AND DISCUSSION:

Efficiency is measured on a scale of 0 to 1, where a value of 1 indicates the DMU is relatively efficient, and a value less than 1 indicates the DMU is inefficient. To investigate the

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efficiency of the individual banks, a VRS technology DEA was performed in R studio software using the package "Benchmarking". The efficiency distributions in VRS technology are reported in Table 2. The results show 8 fully efficient banks with an efficiency score of 1, meaning that these banks are on the efficiency frontier and represent the benchmark for other relatively inefficient banks below the frontier with scores lower than 1.

Among Spanish banks, Bankinter and Liberbank are fully efficient. Caixa Bank has an efficiency score of 0.6408, meaning that it should reduce its input consumption by (1-0.6408) while keeping its outputs constant in order to become efficient. Based on the current production set constructed by these 27 European banks, it is now possible to estimate potential merger gains for all potential mergers involving Spanish banks.

TABLE 2: TECHNICAL EFFICIENCY SCORES

BANK	Technical Efficiency	BANK	Technical Efficiency
Caixa Bank	0.6408	**Groupe BPCE**	1.0000
BBVA	0.5630	**Lloyds Banking Group**	1.0000
Sabadell	0.6225	**ING Group**	0.9203
Bankia	0.6973	**UniCredit**	0.6299
Bankinter	1.0000	**Intesa Sanpaolo**	0.9651
Liberbank	1.0000	**UBS Group**	0.6118
Banco Santander	0.6435	**Credit Suisse**	0.5872
HSBC	0.5324	**Banco Bilbao**	0.5630
BNP-Paribas	0.6494	**Rabobank**	0.8283
Credit Agricole	1.0000	**Nordea Bank**	1.0000
Deutsche Bank	0.5441	**Standard Chartered**	0.4195
Barclays	0.6001	**Danske Bank**	1.0000
Société Générale	0.5953	**Commerzbank AG**	0.5263
		Cassa depositi e prestiti	1.0000

In order to estimate the overall and decomposed potential gains from Spanish mergers, we start by calculating the overall potential efficiency of the new entities resulting from the direct pooling of inputs and outputs. These overall potentials should be adjusted for the learning effects that could have been realized individually by the involved banks simply by learning the best practices in their sector. After the individual inefficiencies have been dealt with, we are left with pure merger gains that could be decomposed now into

learning effect, harmony effect and size effect. All the aforementioned calculations can be done in R software using the command "dea.merge" from the package "Benchmarking". Table 3 shows the distribution of merger efficiency gains and their decomposition into learning effect, harmony effect, and size effect, for all 21 feasible mergers of Spanish banks.

TABLE 3: MERGER EFFICIENCY GAINS AND THEIR DECOMPOSITION

	Hypothetical mergers	Overall potential efficiency E^J	Pure potential gains	Learning effects T^J	Harmony effects H^J	Size effects S^J
1	**Caixa/BBVA**	0.5612	0,9480	0,5920	0,9859	0,9616
2	**Caixa/Sabadell**	0.5797	0,9156	0,6332	0,9697	0,9442
3	**Caixa/Bankia**	0.5973	0,9071	0,6585	0,9474	0,9575
4	**Caixa/Bankinter**	0.6375	0,8934	0,7137	0,9607	0,9299
5	**Caixa/Liberbank**	0.6256	0,9208	0,6794	1,0000	0,9208
6	**Caixa/Santander**	0.6432	1,0004	0,6430	0,9711	1,0301
7	**BBVA/Sabadell**	0.5640	0,9707	0,5811	1,0000	0,9707
8	**BBVA/Bankia**	0.5756	0,9683	0,5945	0,9997	0,9686
9	**BBVA/Bankinter**	0.5809	0,9409	0,6174	0,9755	0,9645
10	**BBVA/Liberbank**	0.5666	0,9611	0,5896	1,0000	0,9611
11	**BBVA/Santander**	0.6180	0,9966	0,6202	0,9845	1,0124
12	**Sabadell/Bankia**	0.6201	0,9492	0,6534	0,9996	0,9496
13	**Sabadell /Bankinter**	0.6432	0,8991	0,7155	0,9582	0,9383
14	**Sabadell /Liberbank**	0.6225	0,9272	0,6714	1,0000	0,9272
15	**Sabadell/Santander**	0.6386	0,9973	0,6403	0,9832	1,0143
16	**BANKIA/Bankinter**	0.6998	0,8822	0,7933	0,9509	0,9278
17	**BANKIA/Liberbank**	0.6847	0,9129	0,7501	1,0000	0,9129
18	**BANKIA/Santander**	0.6477	0,9972	0,6495	0,9826	1,0148
19	**Bankinter/Liberbank**	0.7985	0,7985	1,0000	1,0000	0,7985
20	**Bankinter/Santander**	0.6488	0,9785	0,6631	0,9663	1,0126
21	**Liberbank /Santander**	0.6446	0,9877	0,6527	0,9752	1,0128

These results suggest that there exist considerable potential gains from mergers of Spanish banks as all of these feasible hypothetical mergers are assigned a merger efficiency score

EJ < 1. The estimated average potential gains from mergers between Spanish banks are equal to 36.85%, which means that 63.15 % of the aggregate inputs would be sufficient to maintain the same level of aggregate outputs.

The hypothetical merger between Caixa Bank and Bankia is advantageous as it will result in huge savings equal to 42.43% (1- 0.5756644) in the inputs needed to produce the aggregate outputs. The most promising merger (lowest efficiency score) is Caixa Bank/BBVA with 43.88% of input savings.

However, once we adjust for individual inefficiencies, the estimated average pure potential gains are now 5.94%, which is considerably less than the overall potential gains. This

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finding is consistent with [1] and suggests that a substantial part of the gains from mergers could be achieved by Spanish banks on an individual basis without any merger, just by eliminating their technical inefficiencies through learning from best practices.

TABLE 4 : THE FIVE MOST PROMISING MERGERS

	Pure potential gains	Learning effects	Harmony effects	Size effects
Bankinter/Liberbank	0,7985	1,0000	1,0000	0,7985
Bankia/Bankinter	0,8822	0,7933	0,9509	0,9278
Caixa/Bankinter	0,8934	0,7137	0,9607	0,9299
Sabadell/Bankinter	0,8991	0,7155	0,9582	0,9383
Caixa/Bankia	0,9071	0,6585	0,9474	0,9575

Table 4 shows the 5 most promising mergers in terms of pure potential gains. The most promising merger involves Bankinter and Liberbank. Even though these two banks were originally efficient, 10.86% of input savings are still possible. Caixa/SANTANDER is no longer advantageous after eliminating individual inefficiencies as the efficiency score is higher than one. This merger is costly as it will require more inputs to keep producing the aggregate outputs.

When decomposing the pure potential gains into, harmony effects and size effects, we get an average efficiency score for the harmony effect equalling 0,9815, which suggests that mergers between Spanish banks would result in some economies of scope through input reallocation and mixture. The estimated average efficiency score for the size effect equals 0,9586, suggesting that mergers would create economies of scale that would improve the efficiency of the merged banks. The merger between Caixa bank and Bankia, which is now under process, seems to be justified in terms of efficiency gains as it would result in 9.29% input savings. The results show that these efficiency gains come from both harmony effects and size effects. The efficiency improvement from the merger of Bankinter and Liberbank is mainly caused by size effects as there are no harmony effects and no learning effects given that both banks are individually efficient. It is noteworthy that in 6 hypothetical mergers involving Banco Santander, rescaling is not advantageous as the efficiency score is higher than one. Banco Santander is the largest Spanish bank and one of the top 20 European banks. In cases like these, size works against mergers because the merging banks are so large that they lose the favor of returns to scale properties [7].

IV. Conclusions

The aim of this paper was to pre-estimate and decompose the potential gains from hypothetical mergers of Spanish banks using Data Envelopment Analysis to judge whether consolidation of the Spanish banking sector would result in efficiency improvements. Following Bogettof and Wang (2005), we estimated the overall potential gains then we decomposed them into learning effect, harmony effect, and size effect. Our results showed that the consolidation of the Spanish banks of our sample would result in substantial potential gains for the hypothetically merged banks. However, the majority of these gains derive from the technical effect as after eliminating individual inefficiencies, a considerable part of these gains disappeared. We concluded that on average, these hypothetical mergers result in improved efficiency through economies of scope, and also through economies of scale. Although our results revealed some cases where the size effect worked against the merger, the overall size effect is positive and enhances the efficiency of the merged banks.

The results of our study have important practical implications for managers as they provide relevant information regarding the performance outcome of the hypothetical mergers. The Spanish banking sector is clearly going through an important consolidation and DEA has the potential to assist decision-makers in the selection of the most appropriate target to achieve efficiency improvement. However, the results of our study should be interpreted in light of some limitations. The main limit of our study is related to the number of Spanish banks included in our sample. Further studies could try to expand the size to the whole Spanish banking sector to get a more accurate estimation of the impact of consolidation on the efficiency of the Spanish banks.

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