Banks in Portugal: service producers or financial intermediaries?

Bancos em Portugal: produtores de serviços ou intermediários financeiros?

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Abstract

Financial and monetary intermediation have always been the core competencies of banks. However, to balance for the significant reduction in bank intermediation margins in recent years, institutions have promoted the increase of their charges, through the supply of banking services and cross-selling techniques. DEA methodology was applied to the data of the 37 major banks operating in Portugal in 2007, according to the production and intermediation approaches, in order to identify best practices and the main causes of inefficiency. The main contribution of this study is the incorporation of new variables in the models that reflect, besides profitability, value creation and opportunity cost to shareholders. The efficiency is analyzed using a global perspective (including all banks) and by groups, based on homogeneity and risk factors. Separate frontiers are estimated and the inefficiencies intra-groups as differences among groups are also analyzed. The results show a tendency for banks to focus on certain skills. Overall, the average efficiency levels are low and significant waste of resources and inefficiencies of scale were registered.

Keywords

Data Envelopment Analysis; efficiency models; bank efficiency; context-dependent efficiency; shareholder value creation

Resumo

Actividades de intermediação financeira e monetária sempre foram as principais competências dos bancos. No entanto, a fim de compensar a significativa quebra nas margens de intermediação bancária registada nos últimos anos, as instituições têm promovido o aumento das suas comissões, por via da oferta de serviços bancários e de técnicas de cross-selling. Foi aplicada a metodologia DEA aos dados dos 37 principais bancos a operar em Portugal em 2007, de acordo com as abordagens de produção e intermediação, a fim de identificar as melhores práticas e as principais causas de ineficiência. A principal contribuição deste estudo é a incorporação de novas variáveis nos modelos que reflectem, além da rentabilidade, a criação de valor e o custo de oportunidade do capital para os accionistas. A eficiência é analisada sob uma perspectiva global (incluindo todos os bancos) e por grupos, segundo factores de homogeneidade e risco. São estimadas fronteiras separadas e analisadas as ineficiências intra-grupos bem como as diferenças entre os grupos. Os resultados evidenciam uma tendência para os bancos se concentrarem em determinadas competências. Globalmente, os níveis médios de eficiência são baixos e registam-se consideráveis desperdícios de recursos e ineficiências de escala.

Palavras-chave

Análise Envoltória de Dados; modelos de eficiência; eficiência bancária; eficiência contexto-dependente; criação de valor para o accionista

1. Introduction

Financial intermediation and monetary policy has always been the core competencies of banks. However, in order to balance the significant drop in bank intermediation margins in recent years, institutions have promoted the increase of its committees, multiplying available bank services and cross-selling techniques. Furthermore, it was necessary to adopt policies to restrain operating

costs through a rigorous rationalization of production factors and reengineering of resources, giving priority to increasing efficiency.

Freedom of establishment and provision of services within the European Union, established by Directive 2000/12/EC, overthrew the most important barrier to entry and internationalization, increasing the level of competition, boosted by the fact that institutions that are non-banks are now able to provide financial intermediation banking services, previously exclusive to banks, by removing regulatory restrictions. Participation in the euro area, and the resulting financial integration in an enlarged monetary union, conditioned decisively the latest developments in the banking system and the behavior of the Portuguese economy in general. Taking into account global trends, characterized by strategies of concentration, diversification, innovation and modernization, it is expected for the banking sector an increasing competitive pressure that may lead to further narrow margins and increased efficiency in order to maintain market share. Moreover, banks will have to optimize its risk profile, reducing the weighted average assets and increasing capital ratios.

There is a growing trend of studies on the productive efficiency of the financial sector, but a large proportion of them focus only on traditional problems related to economies of scale and scope. It has not yet been adequately explored the deviations from efficiency frontiers, also known in the literature by X-inefficiencies. The empirical evidence suggests that X-inefficiencies caused by the inability of managers to control costs or maximize revenues are greater than the costs associated with a poor choice of scale or product range. X-inefficiencies are responsible, at least about 20% of production costs in the banking sector, while the inefficiencies of scale and scope, when properly estimated, are responsible no more than about 5% of the costs (Berger *et al.*, 1993).

There are several techniques used in the study of efficiency. The Data Envelopment Analysis (DEA) has been widely used in many different sectors, given its mathematical simplicity and its non-parametric features. We can evaluate this extension through the studies of Emrounejad and Thanassoulis (2001).

This study evaluates the efficiency of the major banks operating in Portugal, through the application of DEA methodology, according to the main approaches usually applied to the banking sector, namely: Production vs. Intermediation. The main objective is to determine whether there is evidence that banks specialize in certain skills or not and if they are referenced by their peers as mainly producers of services or financial intermediaries. The main contribution of this study is the incorporation of new variables in the models that reflect, besides profitability, value creation and the cost of capital to shareholders to interrelate the approaches mentioned above with the modern approach to banking activities. Efficiency is analyzed from a global perspective (including all banks) and by groups according to risk and homogeneity factors. Separated frontiers are estimated and the inefficiencies intra-group is analyzed, as well as the differences among groups. In addition to this introduction, this study is structured as follows: section 2 discusses the main concepts and methodologies associated to efficiency. Section 3 presents the main aspects of the applied methodology (DEA). Section 4 characterizes the sample, DEA models and input/output variables used. Section 5 presents the main results and section 6 summarizes the main conclusions and presents some suggestions for future research.

2. EVALUATION OF THE EFFICIENCY

The terms "efficiency gains" or "economies" usually stands for all (voluntary or involuntary) reductions of the average cost of production recorded by an economic unit, which can be caused by multiple causes, among which we can distinguish the increase of production and technological progress. Efficiency gains in production derive from cost-based synergies and reflect increases of economies of scale and scope. Economies of scale occur when the expansion of production capacity of a company or industry causes an increase in the total amount produced without a proportional increase in production cost. As a result, the average cost of the product tends to be lower with increased production since fixed or structure costs are distributed over a larger volume of production. Economies of scope reveal the total costs reductions achieved through the production of multiple and/or complementary products. The economies of scope are based on diversification principles and can promote significant strategic and competitive advantages.

The performance of productive units is often measured by productive efficiency indicators. The general concept of efficiency is related to how resources are used in the production process and can be decomposed into two components: technical and

allocation efficiency. Technical efficiency is related to the evaluation of combinations of observed inputs/outputs compared to the best possible technological alternatives. Technical efficiency mainly reflects the efficiency of the production process to convert inputs into outputs. It is said that one company is technical efficient if, from a given set of inputs and existing technology, it can produce the maximum output possible (or for a given level of output and based on available technology, it can produce it with the minimum inputs possible). The evaluation of the allocation efficiency is associated with optimal combinations of inputs to minimize the production costs, compared to their prices. It is said that a company is allocation efficient if it uses inputs according to the optimal structure that minimizes the cost of production. On the other hand, a company is scale efficient (even if it is technical and allocation efficient) only if it produces the amount of output necessary to maximize profit, i.e. if it is working at the optimal production scale (Avkiran, 1999).

Over the past decades multiple methods for estimating efficiency were developed, which can be classified into two main groups: parametric and nonparametric. Berger and Humphrey (1997) reviewed 130 empirical studies about efficiency in financial institutions from 21 countries and identify the most common used ones[1], according to two major groups of methods: parametric (Stochastic Frontier Approach - SFA, Distribution Free Approach - DFA, Thick Frontier Approach - TFA) and nonparametric (Data Envelopment Analysis - DEA and Free Disposal Hull - FDH). The authors found that different methods do not produce consistent results. Also Berger *et al.* (1993) analyzed the results of several studies conducted by other researchers, which used SFA, TFA, DFA and DEA methods, and found that there is no rule defining which one is more appropriate to describe the true nature of financial institutions data. Moreover, they point the fact that the choice of the method and related variables significantly influences the efficiency levels results. Berger and Mester (1997) report that although efforts have been made in recent years for developing many empirical studies of the financial and banking sector efficiency, there is no consensus among researchers on the factors explaining the differences obtained in results, which may be, in part, explained by the use of different efficiency notions.

There are, specifically for the banking sector, several approaches to evaluate efficiency, which differ mainly in the basic foundations that support the identification of input and output variables to include in the models. The approaches referred as production, intermediation and modern (developed in section 4) are traditionally applied by the vast majority of authors (Berger and Humphrey, 1997) (Freixas and Rochet, 1997). However approaches based on value added[2], on assets[3] or on user-costs[4] are also applied by several other authors (Berger and Humphrey, 1992) (Canhoto, 1996) (Grigorian and Manole, 2002) (Tortosa-Ausina, 2002) (Hoose, 2010).

From all the studies about the banking efficiency in Portugal, based on parametric methods, we highlight the work carried out by Mendes (1991), Almeida (1994), Barros and Pinho (1994), Mendes and Rebelo (1999; 2003), Pinho (1999; 2001) and Ribeiro (2006); and based on non-parametric methods (DEA) the work of Mendes (1994), Canhoto (1996; 1999), Canhoto and Dermine (2000), Camanho and Dyson (1999; 2005), Portela and Thanassoulis (2007) and Martins (2009).

3. Data Envelopment Analysis (DEA)

According to Amado (2004) the first definition of technical efficiency has been developed by Koopmans (1951), based on the works of Debreu (1951) who proposed the first measure of productive efficiency: the coefficient of resource utilization. These studies led Farrell (1957) to develop a methodology to empirically calculate the relative efficiency of different production units, allowing the decomposition of productive efficiency in technical efficiency and allocation efficiency. Charnes, Cooper and Rhodes (1978) developed the model proposed by Farrell (1957), converting the technical efficiency measure obtained by the initial model (based on a single input/output process) to a multiple inputs/outputs process.

Developed by Charnes *et al.* (1978) (1981) the methodology called Data Envelopment Analysis (DEA) is a mathematical linear programming technique that converts multiple inputs and outputs in efficiency measures. The conversion is performed by comparing the resources (inputs) used and the results (outputs) produced in each Decision Making Unit (DMU) with all the other DMUs under study. The DMUs are organizational units with similar characteristics, in any industry (manufacturing plants, schools, banks, hospitals, businesses, etc.). The application of DEA methodology identifies the

most efficient units in a population and, based on these provide, a measure of inefficiency for all the others, measuring the relative efficiency.

Besides assessing the technical efficiency, DEA also evaluates the economies of scale present in the production process. Since the concept of economies of scale used in DEA is quite similar to concepts in the classical literature on the theory of production, they are incorporated into the DEA methodology through the use of different models. We can identify two main variants: CCR model, which considers the lack of a significant relationship between the operations scale and the efficiency level, assuming constant returns to scale, that is, the model assumes that an increase in output is proportional to the increase in inputs at any scale of production (Charnes, Cooper and Rhodes, 1978) and BCC model, which considers variable returns to scale and does not assume proportionality between inputs and outputs (Banker, Charnes and Cooper, 1984).

The DEA methodology is classified as non-parametric since it does not use a predefined production function identically to all organizations for the analysis of the relationship among input - output – efficiency factors. Through linear programming techniques, DEA determines an efficient frontier based on the "best practice" companies. Companies located below the frontier are considered inefficient. Its main objective is to identify the efficient DMUs and to evaluate the necessary adjustments of the amount of inputs and/or outputs from inefficient DMUs, in order to promote their efficiency levels. The main point is that DEA methodology allows calculating quantitatively the relative efficiency of DMUs, identifying the sources and amounts of each DMU relative inefficiency and maximizing the efficiency of each DMU.

For each inefficient DMU, DEA identifies the efficient DMUs marked as a reference to them and their contribution to the calculation of their (in) efficiency ratio. The contribution of each efficient reference DMU is given by the lambda indicator (λ) also known as peer weight. The DMU with the highest lambda (or highest weight in the set of reference units) is the most similar to the inefficient DMU. The DMU mostly referred as reference unit for the others, is considered to be the global leader DMU (Boussofiane *et al.*, 1991) (Avkiran, 1999).

The DEA models can be applied to minimize the level of inputs to achieve a given level of output target (input oriented) or to maximize the level of output given a certain fixed level of input (output oriented) (Thanassoulis, 2003) and derive from the linear programming problems, for the model type BCC, expressed in Table 1.

Table 1: Input and Output oriented BCC DEA Models

Input oriented	Output oriented
$Min\ \theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$	$Max\ \phi + \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$
$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{io}$	$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io}$
$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro}$	$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi\, y_{ro}$
$\sum_{j=1}^{n} \lambda_j = 1$	$\sum_{j=1}^{n} \lambda_j = 1$
$i = 1,\ldots,m;$ $r = 1,\ldots,s;$ $\lambda_j \geq 0;$ $j = 1,\ldots,n$	

Source: Zhu (2009: 13).

Where: x_{ij}: i^{th} input from j^{th} DMU

y_{rj}: r^{th} output produced by j^{th} DMU

s^- and s^+: inputs and outputs slacks

4. METHODOLOGY

Financial data from the 37 major banks operating in Portugal in 2007 was selected and collected from the annual banks reports and accounts, and from the Newsletter of the Portuguese Association of Banks. Extra-accounting information was also collected, in particular the rating assigned by the worldwide financial consultants (Standard & Poors, Moodys and Fitch).

Whereas DEA performs an analysis of efficiency in relative terms, it is important to ensure uniformity among the DMUs in the sample under study. In this context, in order to obtain relatively homogeneous groups, the initial sample was divided into two, based on the size/business and risk factors. The sample which comprises the Group 1 includes the 18 larger banks (number of branches > 15) and the sample composing Group 2 includes the remaining 19 smaller banks, specialized in certain market segments or business areas. From the initial sample, another two groups of banks were created under a risk factor, evaluated on the basis of solvency and long-term rating assigned by the main financial consultants. Group 3 includes 17 banks with the lowest risk index and Group 4 the remaining 20 banks with higher risk.

A careful selection of input/output variables for inclusion in the DEA model is particularly relevant in the banking sector, since two major approaches coexist, associated to the main type of activity inherent to the business: the intermediation approach where banks are regarded as financial intermediaries whose primary business is the gathering of resources from savers (savings/deposits) and the mobilization of these funds to others for investment activities in the form of loans, by carrying out a income (interest, commissions, etc.); and the production approach where banks are considered institutions that use capital and labor to provide services, or to provide loans and manage deposits. In this context, the main problem surrounds the deposits classification, since in the intermediation approach deposits are considered inputs and in the production approach are considered outputs.

The modern approach, which incorporates the specificities of banking activities (such as risk management and information processing) into the classical theory of the firm, taking into account some problems arising from agency theory, namely, the conflict of interests between managers and shareholders, has led several authors to mention the need to incorporate in the banks evaluation performance models, variables that reflect, besides the profitability, value creation, risk and opportunity costs for shareholders (Fiordelisi and Molyneux, 2004; 2006) (Tabak *et al.*, 2005).

In order to connect the classical production and intermediation approaches with the modern approach of banking activities, new variables were created and incorporated into the classical models. These variables reflect, besides profitability, value creation and the cost of capital to shareholders. The variable value created for shareholders, which corresponds to the intrinsic value added, was calculated from the equity perspective, based on the concept of Tabak *et al.* (2005). For the calculation of the value creation measures, it was necessary to estimate a proxy variable for the cost of equity due to the lack of published information on it. The latter was estimated based on the real rate of return on risk-free assets, the average annual rate of inflation and the risk premium associated with the bank (estimated based on the rating assigned by the major world financial consultants) according with the alternative approach of Martins (2010).

Performance is evaluated trough two models denominated Production Model and Intermediation Model, based on the model created by Seiford and Zhu (1999) and innovated by Martins (2009)[5]. The Production Model incorporates as input variables equity (CP), number of employees (NEMP) and number of branches (NB) and as output variable the amount of deposits (DEP). The Intermediation Model incorporates deposits (DEP) as input variable and as output variables loans (LN), gross value added (GVA) and shareholder value created (SVC). To complement these approaches the Profitability Model was created to evaluate the bank ability to create results from the income generators and the available structure. This model incorporates as input variables the cost of structure (CS) and the amount of liquid financial assets (LFA) and as outputs the interest margin (IM) and the net operating income (NOI) (see Table 2).

Table 3 resumes the hypotheses tested. For example: hypothesis 2.2 tests the hypothesis of equality in the central tendency of the production efficiency levels distributions in the main frontier, for group 3 versus group 4, for a confidence level of 95%; hypothesis 6.1 tests the hypothesis of equality in the central tendency of the intermediation efficiency

Table 2: BCC DEA Models applied in the study

	Production Model	Intermediation Model	Profitability Model
Orientation	Input	Output	Output
Inputs	Equity (CP) Nº of Employees (NEMP) Nº of Branches (NB)	Deposits (DEP)	Cost of structure (CS) Liquid Financial Assets (LFA)
Outputs	Deposits (DEP)	Loans (LN) Gross Value Added (GVA) Shareholder Value Creation (SVC)	Interest Margin (IM) Net Operating Income (NOI)

Source: Compiled by author.

Table 3: Hypotheses tested and statistical tests applied in the study

Ref	Hypotheses: equality in the central tendency of distributions			Statistical Test (significance)	Conclusion
	Efficiency Model	Frontier	Group		
Hip 1	Production Intermediation Profitability	Main	-	Friedman (0,000)	Profitability efficiency present the highest values and Intermediation efficiency present the lowest
Hip 2.1	Production	Main	Group 1 vs 2	Mann-Whitney (0,443)	Do not reject H_0
Hip 2.2	Production	Main	Group 3 vs 4	Mann-Whitney (0,357)	Do not reject H_0
Hip 3.1	Intermediation	Main	Group 1 vs 2	Mann-Whitney (0,004)	Group 1 presents higher efficiency
Hip 3.2	Intermediation	Main	Group 3 vs 4	Mann-Whitney (0,015)	Group 3 presents higher efficiency
Hip 4.1	Profitability	Main	Group 1 vs 2	Mann-Whitney (0,039)	Group 1 presents higher efficiency
Hip 4.2	Profitability	Main	Group 3 vs 4	Mann-Whitney (0,167)	Do not reject H_0
Hip 5.1	Production	Group	Group 1 vs 2	Mann-Whitney (0,039)	Group 1 presents higher efficiency
Hip 5.2	Production	Group	Group 3 vs 4	Mann-Whitney (0,270)	Do not reject H_0
Hip 6.1	Intermediation	Group	Group 1 vs 2	Mann-Whitney (0,001)	Group 1 presents higher efficiency
Hip 6.2	Intermediation	Group	Group 3 vs 4	Mann-Whitney (0,478)	Do not reject H_0
Hip 7.1	Profitability	Group	Group 1 vs 2	Mann-Whitney (0,046)	Group 1 presents higher efficiency
Hip 7.2	Profitability	Group	Group 3 vs 4	Mann-Whitney (0,117)	Do not reject H_0

Source: Compiled by author.

levels distributions in the group frontier, for group 1 versus group 2, for a confidence level of 95%, etc.

Relatively to the nature of returns to scale, the hypothesis of variable returns to scale was considered as a more consistent alternative. Most of the empirical studies record variable returns to scale in the banking sector (Mendes, 1991; 1994) (Mendes and Rebelo, 1999; 2003) (Almeida, 1994) (Barros and Pinho, 1994) (Canhoto, 1996; 1999) (Camanho and Dyson, 1999; 2005) (Pinho, 1999; 2001) (Seiford and Zhu, 1999) (Camanho and Dermine, 2000) (Lo and Lu, 2006) (Ribeiro, 2006) (Portela and Thanassoulis, 2007) (Martins, 2009).

5. Main results

Table 4 summarizes the statistical results obtained by the DEA models. We highlight the following facts: the profitability model notes higher average efficiency indicators and lower standard deviation measures; the intermediation model notes lower average efficiency measures and higher standard deviation measures; in 8 of 12 cases the standard deviation of efficiency decreases as we divide the whole group in smaller and more homogeneous ones; in 9 of 12 cases the average efficiency increases when we divide the whole group in smaller and more homogeneous ones.

Table 4: DEA Models summary statistics

	Main Group	Group 1	Group 2	Group 3	Group 4
PRODUCTION MODEL					
Average efficiency	0,606	0,772	0,555	0,800	0,649
Standard deviation	0,310	0,226	0,305	0,231	0,315
Minimum efficiency	0,087	0,382	0,134	0,294	0,087
N° efficient banks	7	6	4	5	6
INTERMEDIATION MODEL					
Average efficiency	0,507	0,750	0,369	0,652	0,561
Standard deviation	0,344	0,271	0,342	0,345	0,373
Minimum efficiency	0,032	0,165	0,032	0,062	0,042
N° efficient banks	7	7	3	7	6
PROFITABILITY MODEL					
Average efficiency	0,819	0,915	0,773	0,935	0,835
Standard deviation	0,189	0,151	0,193	0,132	0,176
Minimum efficiency	0,452	0,467	0,491	0,507	0,484
N° efficient banks	10	9	5	12	9

Source: Compiled by author

Table 5: Number of banks by Returns to Scale

	Production Model			Intermediation Model			Profitability Model		
RTS	Efficient	Estimated	Total	Efficient	Estimated	Total	Efficient	Estimated	Total
n° IRS	1	20	21	0	0	0	1	10	11
n° CRS	4	1	5	2	0	2	3	2	5
n° DRS	2	9	11	5	30	35	6	15	21
Total	7	30	37	7	30	37	10	27	37

Source: Compiled by author

Differences among efficiency levels from the DEA models were analyzed based on the nonparametric Friedman test, since the requirement for normality failed. The significance of the Friedman test (sig. 0,000) rejects the hypothesis of equality in the central tendency of distributions of the various models efficiencies, for a confidence level of 95% (see Table 3: Hip 1). The efficiencies of different models are considered to be statistically different, with the profitability model presenting the highest efficiency levels and the intermediation model the lowest.

Table 5 records the number of banks by returns to scale (RTS) nature, according to the DEASolver software. For inefficient banks features of return to scale refer to their projection on the efficient frontier. For each model efficient banks are accounted with characteristics of increasing (IRS), constant (CRS) or decreasing returns to scale (DRS). The results differ greatly among models. While in the production model most (56,8%) of banks present increasing returns to scale, the same number of banks present decreasing returns to scale in the profitability model. The intermediation model present 94,6% of banks with features of decreasing returns to scale, not recording any bank with increasing returns. There are several banks with variable returns to scale in all models, which explain, in part, the choice of DEA BCC model.

When analyzed by groups, it can be seen in Table 6 that in the production and in the profitability models, most of the larger banks (group 1) present decreasing returns to scale, while most smaller banks (group 2) present increasing returns to scale. These results are consistent with the results of Berg *et al.* (1991), Canhoto (1996), Seiford and Zhu

Table 6: Returns to Scale by group (factor: size)

	Production Model			Intermediation Model			Profitability Model		
RTS	G1	G2	Total	G1	G2	Total	G1	G2	Total
nº IRS	6	15	21	0	0	0	1	10	11
nº CRS	1	4	5	1	2	3	0	5	5
nº DRS	11	0	11	17	17	34	17	4	21
Total	18	19	37	18	19	37	18	19	37

Source: Compiled by author.

(1999), Drake and Hall (2003), Lo and Lu (2006) and Martins (2009).

The production model has an average efficiency of 60,6%. Since the model is input oriented, we can conclude that, on average, banks could produce the same level of output with less 39,4% of resources. The efficient frontier is composed by 7 banks, namely: CGD, BAI, BPI, Banco BPI, BEST, Barclays and BSN, which report the maximum efficiency level (100%). Banks DB (99%), BES (94,4%) and BPG (92,3%) also account for very high levels of efficiency. The banks with the lowest levels of efficiency are Banco Mais (8,7%), Finantia (11,5%) and Santander Consumer (13,4%). The efficiency levels of inefficient banks are widely dispersed, where 63,3% of them (19 out of 30) report efficiency levels between 20% and 70% (see Figure 1).

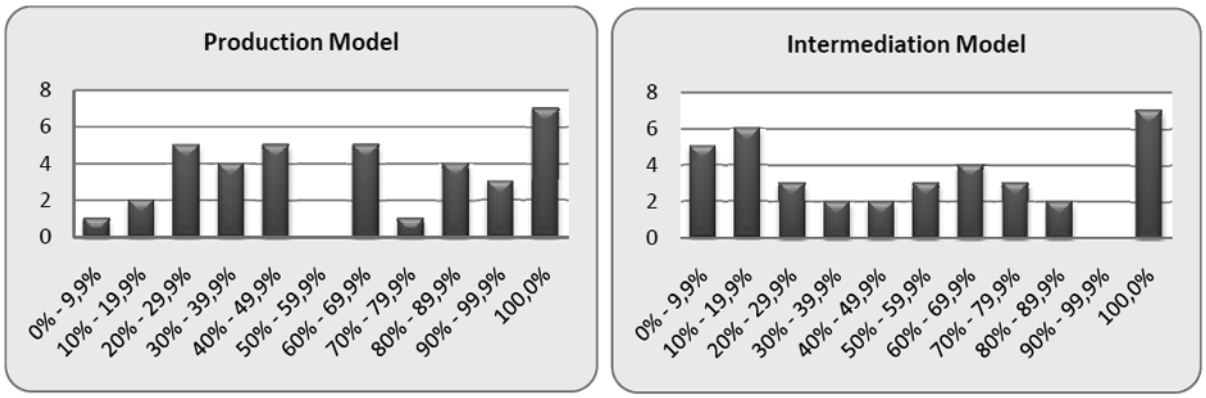
Intermediation model has an average efficiency of 50,7%. Since the model is output oriented, we can conclude that, on average, banks could produce more 49,3% of results with the same level of inputs (deposits). The efficient frontier is also composed by 7 banks, namely: BCP, BCPI, BES, BESI, BII, BST and CGD, which get the maximum efficiency level (100%). The efficiency levels of inefficient banks are widely dispersed, where 66,7% of them (20 out of 30) report efficiency levels between 10% and 70% (see Figure 1). There are no banks with efficiency levels from 90% to 99% which remarks a significant gap between global efficient banks and inefficient banks. Among the inefficient banks, Finantia and Banco Mais present the highest levels of efficiency (87,9% and 85,4% respectively). The banks with the lowest levels of efficiency are BAI (3,2%), BPG (5,7%), Activo Bank (6,2%), BEST (7,0%) and Banco Invest (9,5%).

Profitability model has the highest average efficiency of 81,9% in the main group and even higher when analyzed by groups. Group 3 composed by the banks with lower risk indicators present an average efficiency of 93,5%. Since the model is output oriented, we can conclude that, on average in group 3, banks could produce more 6,5% of results with the same level of inputs. When analyzed by groups, we can report that in all groups, several banks are global efficient (maximum efficiency level of 100%).

According to Boussofiane *et al.* (1991) the frequency with which the DMUs are considered as a reference DMUs (peer-group) is a good indicator of good practice. Efficient DMUs which present a low frequency as peer-group are considered self-evaluators, i.e. do not represent units of good practice to be followed by other DMUs. For each bank under study the respective peer-group (composed by efficient banks) is identified in addition to the individual contribution to the calculation of efficiency levels[6]. In Figure 2 we can see that in the production model, the bank mostly referenced as an efficient unit for the others is BPI (28%), followed by BAI (24%) and BEST (17%). In the intermediation model the bank mostly referenced as an efficient unit for others is bank BST (32%), followed by BCPI (29%) and BII (24%).

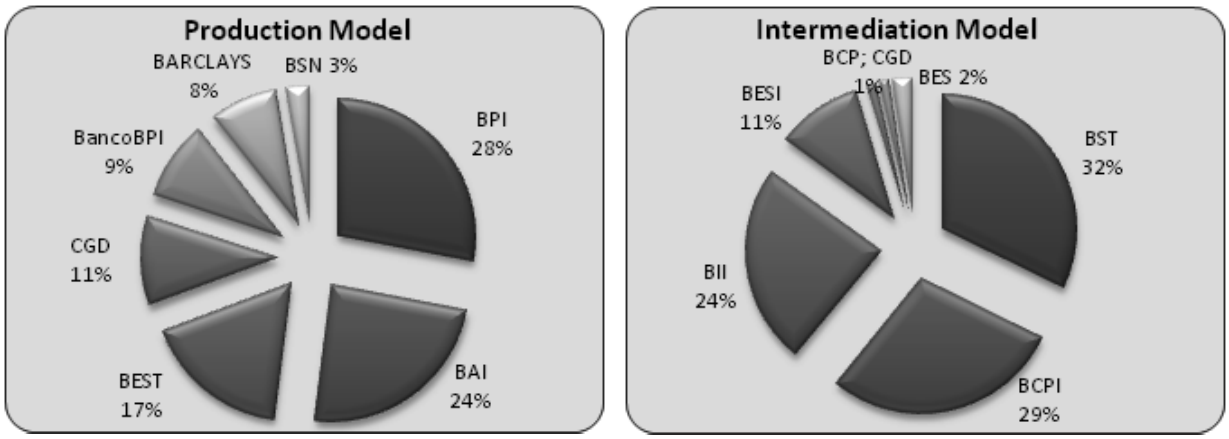
In order to characterize and evaluate the type of existing inefficiencies, CCR and SBM models were estimated[7]. The efficiency ratio obtained by the CCR model (to which is imposed the condition of constant returns to scale) represents the overall technical efficiency (OTE), which measures the inefficiencies related to the configuration of inputs/outputs, as well as the scale of operations. The efficiency ratio obtained by the BCC model represents the pure technical efficiency (PTE), which reflects the waste of resources. Thus, the index of scale efficiency (S), which measures the ability of the bank to decide on the optimal scale of production (i.e. the presence of constant returns to scale) can be obtained through the two earlier indicators, since: OTE = PTE x S. Only four banks are globally efficient, namely: Barclays, BEST, BPI and BSN. These banks use the resources in the

Figure 1: Efficiency levels frequency histograms



Source: Compiled by author

Figure 2: Most referenced banks



Source: Compiled by author.

proper proportions (PTE = 1) and operate on an efficient scale of production (S = 1), i.e. they present constant returns to scale. The overall technical efficiency average is very low (31,7%). Besides DB which reports an OTE of 77,1%, the other banks (which represent 86,5% of the sample) present OTE lower than 44%. It seems that banks BAI, BPI and CGD are technologically efficient (PTE = 1) but do not operate on the most efficient production scale, achieving very low levels of overall efficiency (32,2%, 35,1% and 38,7% respectively). The pure technical efficiency average (60,6%) is higher than the overall (31,7%), which reveals inefficiencies of scale in many banks. As a matter of fact, 70,3% of the banks present scale efficiency levels below 65%. In contrast, banks BESI, Finibanco, BBVA, Finantia, BCA and BPP report high scale efficiency but high inefficiencies in managing its resources (too low PTE levels). All these banks register increasing returns to scale, except BESI (by projection on the efficient frontier) which reveals constant returns to scale. The measure of non-radial efficiency shows that Barclays, BEST, BSN and BPI, besides being global efficient, do not record the existence of any gaps (or slacks) in the variables. The levels of non-radial efficiency are on average very low (23,4%), which reveals the existence of high levels of slacks in resources.

For inefficient banks it is very important to analyze the target values defined by the model, in order to promote their efficiency levels and to identify the banks that serve to them as reference (peer-group). Table 7 illustrates the type of information that can be produced in order to compare the performance achieved by an inefficient bank, with the efficient banks in its peer-group. Therefore it is possible to identify the areas where the bank is weaker relatively to others and improve their efficiency by setting achievable targets. In this example, CGD and Banco BPI contributed 55,7% and 44,3%, respectively, for calculating BCP efficiency level. Thus, CGD is the most similar bank to BCP, as it presents the highest lambda (λ) in its peer-group. We can see in Table 7 that BCP presents more 36,1% of branches, but less 27,4% of deposits than CGD; BCP has more than doubled of number of employees (123,8%) and branches (103,6%), but just 90,3% more of deposits

Table 7: BCP performance relatively to its peer-group

Indicators	Bank BCP		Peer-group			
	Inefficient	Output Input	Banco BPI	Output Input	CGD	Output Input
Efficiency	80,3%		100%		100%	
λ			44,3%		55,7%	
Input: CP	4.899.255	8,0	1.905.459	10,8	5.541.096	9,8
Input: NEMP	20.783	1.888,4	9.285	2.221,0	20.562	2.628,1
Input: NB	1.629	24.092,5	800	25.777,3	1.197	45.145,2
Output: DEP	39.246.611		20.621.866		54.038.767	

Source: Compiled by author.

Table 8: BCP target-values

n°	Bank / Variables	Score Value	Target	Adjustment	%
12	BCP	0,803			
	Input: CP	4.899.255	3.931.763	- 967.492	-19,8%
	Input: NEMP	20.783	15.570	- 5.213	-25,1%
	Input: NB	1.629	1.021	- 608	-37,3%
	Output: DEP	39.246.611	39.246.611	-	0,0%

Source: Compiled by author.

than Banco BPI. In other words: Banco BPI and CGD present higher productivity ratio (output/input) over the analyzed variables.

From Table 8 we can remark that BCP could get the same level of deposits and, simultaneously, promote its level of relative efficiency by adjusting the input to the target values defined by the DEA model, namely: reduce equity by 19,8%, 25,1% in the number of employees and 37,3% in the number of branches. As we can see through this example, the results produced by the model need careful attention, since some of its objectives may be very difficult to achieve in practice. Moreover, beyond the set of established target values it is possible to find several alternatives, which could also increase the efficiency levels of the bank under study, without jeopardizing its normal functioning, through a staged objectives plan, for example. It will also be necessary to complement this kind of analysis with the bank strategic actions needed to successfully achieve the objectives.

A context-dependent analysis can complement such studies, since it defines the degree of attractiveness or progress of a particular bank in relation to other similar banks, evaluated within a given context. The levels of attractiveness and progress of all banks in the study are listed in Table 9.

We obtained five levels, corresponding to five efficiency frontiers. All indicators listed in Table 9 were calculated for the level immediately posterior or anterior. Thus, the performance indicators[8] of level 1 correspond to the degree of attractiveness of banks considered efficient in the classical frontier (level 1) relatively to the banks that compose the 2nd level efficient frontier. Note that these values are similar to the super-efficiency indicators . Beyond level 2 indicators reflect the progress needed for each bank in order to achieve the efficient frontier of its peer-group. Note, for example, that the performance indicators of level 2 correspond to the values obtained in the classical model, since it reflects the effort required to inefficient banks at level 1, to increase their efficiency toward the good practice frontier. For example, bank BB has an efficiency level of 43,5% in the classical model (level 1). By excluding banks considered efficient at level 1, its level of efficiency increases to 78,7% at level 3, i.e. on the frontier formed by the banks considered efficient at level 2, namely: DB, BES, BPG, etc.

Table 9: Production Model context-dependent attractiveness/progress

Level 1		Level 2		Level 3		Level 4		Level 5	
BEST	+∞	DB	0,990	BPN	0,944	BIG	0,988	Itaú	0,954
CGD	+∞	BES	0,944	BAC	0,844	Finantia	0,958	BII	0,931
BPI	8,173	BPG	0,923	BB	0,787	BBVA	0,920	SantanderCons	0,692
BSN	2,808	MG	0,872	BPP	0,777	BancoInvest	0,892	BancoMais	0,325
BAI	2,080	CCCAM	0,866	BST	0,744	Finibanco	0,834		
Barclays	1,407	BCP	0,803	BANIF	0,705	CBI	0,614		
BancoBPI	1,270	ActivoBank	0,791	BANIFInv	0,631				
		FortisBank	0,695	BCA	0,594				
		Efisa	0,675	Popular	0,397				
		BCPI	0,443						
		BESI	0,439						

Source: Compiled by author.

The banks considered the least attractive in terms of efficiency, and therefore at the last context-dependent level, are Banco Mais, Santander Consumer, BII and Itaú. Banco Mais, which has an efficiency of only 8,7% in the classical model (level 1), has an efficiency of 32,5% at level 5, i.e., on the frontier formed by the banks considered efficient in level 4, such as BIG, Finantia and BBVA. The target values set for Banco Mais at the classical frontier, in order to achieve the efficient frontier, will certainly be very difficult to achieve in practice (changes required nearly 95%).

The mathematical characteristics of the BCC model allows DMUs with the lowest value in one of the inputs (or the highest value in one of the outputs) to be considered efficient, even if the other variables do not exhibit the best relationships (Ali, 1993). These DMUs are called false efficient or efficient by default. This fact promotes the need to analyze the context in which banks as BAI, BEST or CGD reached the status of efficiency, since BAI has the lowest values in the sample for variables CP and NEMP, BEST has the lowest value for variable NB and CGD has the highest value of deposits. The analysis to several additional indicators reveals that the efficiency level obtained by CGD and Barclays may be false efficiencies, since they also get the maximum level of inefficiency in the inverted frontier[9] and a low compound efficiency[10] (51,6%). Among the efficient banks, BAI is the only one that obtains maximum efficiency in the compound index, showing a good performance in areas where it is better (high standard efficiency) and acceptable performance in areas where it is worse (low reversed efficiency). Also BPI (96,6%), BEST (92,0%) and BSN (90,9%) report quite high levels of compound efficiency. Among the inefficient banks in the standard frontier, we highlight that BPG and DB report high levels of compound efficiency (96,4% and 92,0% respectively), contrary to BES that presents an acceptable level of technical efficiency (94,4%) but a low compound efficiency (51,6%) since BES belongs to the inefficient frontier. The reversed or inefficient frontier is composed by the 12 banks with the worst practices in the sample. In addition to those already identified (CGD, Barclays and BES) the banks CCCAM, BPN, BCP, BST, BCPI, Finibanco, BII, Itaú and Banco Mais also belong to this frontier.

The efficiency levels achieved in the global frontier for each model were discriminated by a size/business factor (group 1 and 2) and risk (group 3 and 4). Differences were evaluated using the non-parametric Mann-Whitney test. The hypothesis of equality in the central tendency of the efficiency levels distributions for the various groups was tested for a confidence level of 95%. There is no evidence, in the production model, of differences between the levels of efficiency of banks belonging to group 1 and 2 (sig. 0,443), i.e., the size/business factor does not seem to influence the levels of production efficiency (see Table 3: Hip 2.1). There also no evidence of differences between the levels of efficiency of banks belonging to group 3 and 4 (sig. 0,357), i.e., the risk factor also seems to have no influence on the levels of production efficiency (see Table 3: Hip 2.2).

In the intermediation model the significance test (sig. 0,004) shows that efficiency levels in groups 1 and 2 are considered to be statistically different, with group 1 (larger banks) recording higher levels of efficiency. Thus, it seems to be evidence that the size/business factor influences intermediation efficiency levels (see Table 3: Hip 3.1). Also in relation to the risk factor, the significance test (sig. 0,015) shows that

efficiency levels in groups 3 and 4 are considered to be statistically different, with group 3 (banks with lower risk levels) recording higher efficiency levels. Thus, it seems to be evidence that the risk factor influences the intermediation efficiency levels (see Table 3: Hip 3.2).

In the profitability model the significance test (sig. 0,039) shows that efficiency levels in groups 1 and 2 are considered to be statistically different, with group 1 (larger banks) recording higher levels of efficiency. Thus, it seems to be evidence that the size/business factor influences profitability efficiency levels (see Table 3: Hip 4.1). In relation to the risk factor, the significance test shows that there is no evidence of differences between the levels of efficiency of banks belonging to group 3 and 4 (sig. 0,167), i.e., the risk factor seems to have no influence on the levels of profitability efficiency (see Table 3: Hip 4.2).

Separate frontiers for each group were estimated to analyze differences among groups. The hypothesis of equality in the central tendency of the efficiency levels distributions of the various groups was tested for a confidence level of 95% using the non-parametric Mann-Whitney test. In all models the significance tests show that efficiency levels in groups 1 and 2 frontiers are considered to be statistically different, with group 1 (larger banks) recording higher levels of efficiency (see Table 3: Hip 5.1; 6.1; 7.1). In the other hand, in all models the significance tests show that there is no evidence of differences in efficiency levels in groups 3 and 4 frontiers (see Table 3: Hip 5.2; 6.2; 7.2).

6. Conclusions and suggestions for future research

The model that shows the highest average efficiency levels is the profitability model (81,9%) and the lowest average efficiency levels the intermediation model (50,7%). There are a large number of banks with variable returns to scale in all models, which justifies, in part, the choice of BCC DEA model. In the production and profitability models most large banks experience decreasing returns to scale, while most of the smaller banks experience increasing returns to scale. These results are consistent with the results of Canhoto (1996), Seiford and Zhu (1999), Lo and Lu (2006) and Martins (2009). Many models present technological efficient bank not operating on the most efficient scale of production, achieving very low overall efficiency levels. The pure technical efficiency average is generally higher than the global efficiency, revealing the existence of scale inefficiencies in many banks. M&A transactions may lead to potential increases in efficiency in these cases. On the other hand, there are banks with high scale efficiency but with high inefficiencies managing its resources. Overall, we conclude that most banks have very low efficiency levels, which reflects the need for a major effort to improve the use of resources. It also seems that larger banks have higher profitability efficiency levels. Several banks present a higher level of efficiency when analyzed in a context of homogeneous groups. There seems to be evidence that banks are recognized by their peers according to certain skills. While banks such as BAI, BPI, CGD, BEST, DB, Barclays and BPI are cited most often as reference banks in the Production Model, banks such as BST, BCPI, BII, BESI, BBVA and Banco Mais record higher frequency of references in the Intermediation Model.

There is a need to complement this study with an extra DEA analysis to better understand the results. Moreover, the application of regression techniques may help identify the variables with greatest influence on performance indicators. Additional studies that might prove to be useful would be the inclusion of weight restrictions and new variables related to technology, quality or not controllable by managers. We intend to continue this study to evaluate the impact of M&A transactions in several performance indicators through the application of complementary models (such as the two-stage or in a network) and its application to a single bank to conduct the study at branch level.

Endnotes

1- DEA is the most popular method, used in about 48% of the empirical studies.

2- According to the value-added approach bank's outputs are identified as banking functions which are associated with a substantial labor or physical capital expenditure to produce a (noninterest) flow of banking services. In this method most key types of loans (such as commercial and industrial loans, installment loans, and real estate loans) are bank outputs. Labor, physical capital, and purchased funds typically are classified as bank inputs (Hoose, 2010: 29).

3- According to the assets approach, bank's assets are outputs and deposits, purchased funds, and other liabilities are financial inputs. Real resources such as labor and capital are considered as real inputs (Hoose, 2010: 29).

4- According to the cost approach the user cost of a financial good is defined as the net effective cost of holding one unit of services per time period. All bank balance-sheet items with negative user costs (including all categories of loans and transactions deposits) are considered as outputs and items with positive user costs (such as savings, time deposits and purchased funds) are considered as inputs along with labor, raw materials, and physical capital (Hoose, 2010: 29).

5- Based on this model, Martins (2009) evaluates the efficiency based on a two-stage DEA model enlightening the importance of the intermediate variable (Deposits), which represent the main connection between savers and investors and circumvent, simultaneously, the main problem associated with the application of the production and intermediation approaches.

6- The reference group for efficient banks is composed by the bank itself.

7- The Slack Based Model (SBM) reflects all types of existing inefficiencies, allowing characterizing the inefficiencies of technically efficient DMUs with gaps or slacks in the input/output variables.

8- In super-efficiency models DMUs in examination are taken out of the set of comparators. Therefore levels of super-efficiency obtained can be above 100%, allowing ranking efficient DMUs. The level of super-efficiency identifies the increase in inputs and/or reduction of outputs that efficient DMUs can support without ceasing to be efficient. When infeasibility of calculating the level of super-efficiency is registered, it represents that the level of efficiency of that DMU is stable for any variation of resources in an input orientated model (and stable for any variation in production in an output orientated model). These cases are identified by the symbol $+\infty$ and represent the highest level of efficiency (Seiford and Zhu, 1999).

9- The model of the inverted frontier allows the identification of falsely efficient DMUs in BCC models. The inverted frontier (or inefficient frontier) is composed by the DMUs with the worst management practices.

10- The level of compound efficiency represents the arithmetic mean between the efficiency in relation to the classic (standard) DEA frontier and the complement of efficiency in relation to the reversed border. Usually the level of standard compound efficiency is used, which is obtained by dividing the values of the compound efficiency of each DMU by the greatest amount of compound efficiency achieved in sample. The level of standard compound efficiency requires that an efficient DMU hold for a good performance in areas where there it is better (high standard efficiency levels) and sustain an acceptable performance in areas where it is worse (low reversed efficiency levels).

Acronyms

ActivoBank	Banco Activobank (Portugal)	BPI	Banco Português de Investimento
BAC	Banco Espírito Santo dos Açores	BancoBPI	Banco BPI
BAI	Banco Africano de Investimento Europa	BPN	Banco Português de Negócios
BancoInvest	Banco Invest	BPP	Banco Privado Português
BancoMais	Banco Mais	BSN	Banco Santander de Negócios Portugal
Banif	Banco Internacional do Funchal	BST	Banco Santander Totta
Banif Inv	BANIF - Banco de Investimento	CBI	Caixa - Banco de Investimento
Barclays	Barclays Bank (Sucursal)	CCCAM	Caixa Central de Crédito Agrícola Mútuo
BB	Banco do Brasil (Sucursal)	CGD	Caixa Geral de Depósitos
BBVA	Banco Bilbao Vizcaya Argentaria (Portugal)	DB	Deutsche Bank (Portugal)
BCA	Banco Comercial dos Açores	Efisa	Banco Efisa
BCP	Banco Comercial Português (Millennium bcp)	Finantia	Banco Finantia
BCPI	Banco Millennium bcp Investimento	Finibanco	Finibanco
BES	Banco Espírito Santo	FortisBank	Fortis Bank (Sucursal)
BESI	Banco Espírito Santo de Investimento	Itaú	Banco Itaú Europa
BEST	BEST - Banco Electrónico de Serviço Total	MG	Montepio Geral (Caixa Económica)
BIG	Banco de Investimento Global	Popular	Banco Popular Portugal
BII	Banco de Investimento Imobiliário	SantanderCons	Banco Santander Consumer Portugal
BPG	Banco Português de Gestão		

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