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Branch banking networks assessment using DEA: A benchmarking analysis

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Abstract : This paper presents a benchmarking analysis of the branches and regional banks of a large French banking group. The analysis focuses on the operational performance. Starting from an "individual" diagnostic at the branch level, a "network" diagnostic is developed at the regional banks level. The variations of performance are discussed within each regional bank and from one regional bank to another by using a DEA ("Data Envelopment Analysis") approach. This approach allows to develop a synthetic index called the technical inefficiency score. Results reveal that 30% of these branches are efficient. Special emphasis is placed on quantifying the productive gains at the regional banks level and on practicing intra- and inter regional banks benchmarking.

Keywords : productivity, benchmarking, aggregate measure, branches, banking network.

JEL Classification : G21, M19

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1. INTRODUCTION

The purpose of this study is to illustrate a DEA ("Data Envelopment Analysis) approach to assess bank branches network performance and benchmarking practices. Operational performance evaluation is the core of management activities as far as bank networks are concerned. Although performance improvement is widely recognized as essential to get competitive advantages, managers often do not have the best evaluation techniques, the main objective being generally to avoid wasting resources.

Output-to-input ratios – productivity ratios – are the most current approaches to estimate operational performance. Despite their popularity, they have several drawbacks (Kamakura et al. 1996, Schaffnit et al. 1997, Donthu and Yoo 1998, Halkos and Salamouris 2004). In this paper we would highlight the fact that they are not appropriate in decision making processes. How could managers benchmark branches according to their productivity if it is evaluated by too larger sets of ratios? Indeed, simultaneously the production process of branches takes into account multiple inputs and outputs. However it is difficult to take decisions regarding the improvement of branch productivity and also to classify them following several productivity ratios[1]. DEA can evaluate the operational performance of the branches and provide a single global index which considers all the facets of the branches activity. This approach is especially well adapted to benchmarking because it performs a relative measure to the best observed practices.

This study has two closely linked objectives. The first one is to estimate the technical inefficiency of the branches, in terms of their ability to avoid wasting resources allocated by the top branch management. Here an evaluation procedure is adopted; it allows to neutralize the uncontrollable effects of localization on branches activity (Charnes et al. 1981, Banker and Morey 1986, Athanassopoulos 1998). The second objective is to estimate the productivity gains at the regional bank level. This is obtained through an aggregation of the technical inefficiency score using a directional measure (Chambers et al. 1996, Briec 1997, Briec et al. 2003).

[1] A multitude of partial productivity is generally used. The input factor is usually the number of employees and the output factor can vary according to the various facets of the branches activity – traditional and non traditional banking products-.

The results of this research allow the implementation of both individual and aggregate benchmarking procedures. Specifically, one has to answer four questions: (Q1) How can one estimate the technical inefficiency of branches, considering only the elements under their control? (Q2) What are the best branches practices? (Q3) What are the best networks practices? (Q4) What are the mix-products orientations to maximise operational gains?

The paper is organized as follows. Section 2 discusses some already published DEA studies and describes the production process of bank branches. Section 3 introduces a linear program used to evaluate the technical inefficiency of the 1611 branches and the sixteen networks of a French bank. Section 4 presents our empirical results and proposes both individual and aggregate benchmarking analyses. Finally, section 5 gives some concluding remarks.

2. ASSESSING OPERATIONAL PERFORMANCE OF BANK BRANCHES NETWORK: AN INDIVIDUAL PERSPECTIVE AND AN AGGREGATE PERSPECTIVE

DEA is a well-known framework introduced by Farell (1957) and developed by Charnes et al. (1978) and Banker et al. (1984). This approach determines an empirical frontier of the production set called the "efficiency frontier". Thanks to the efficiency frontier, the efficient decision making units under evaluation can be distinguished from the non-efficient ones. If they are located on the efficiency frontier, they are considered technically efficient. The empirical application of a DEA approach requires the qualification of resources (inputs) and results (outputs) specifying the production process of the assessed decision units: each decision unit evaluated is represented by its consumption of inputs and production of outputs. The inefficiency score measures the difference between the production process of each decision unit and the efficiency frontier. If this difference is null, the decision unit is technically efficient.

2.1. Technical inefficiency of bank branches using DEA

DEA has been used numerous times to evaluate the performance of financial institutions (several studies have been discussed by Berger and Humphrey (1997) and Berger et al. (1997)). Although bank branches networks are the main production channel in banking activity, Athanassopoulos (1998) and MacEachern and Paradi (2007) emphasize that there is less attention in the literature on branch performance evaluation in comparison with bank performance evaluation. The main reason is the lack of data at branch levels. So, most of this kind of research has limited empirical and managerial implications because the models are applied to a low branch population (less than 50 branches) [2]. Athanassopoulos (1998)[3] includes a consideration of the commercial environment of the bank branches into the procedure of the performance evaluation. He neutralizes the commercial environment of the bank branches by using a Factor Analysis. In this way, the branches are split "*into homogenous clusters in order to increase the validity of the comparison between efficient and inefficient branches*". Our performance analysis follows Athanassopoulos (1998) but jointly in a branches perspective (individual level) and in a network perspective (aggregate level).

2.2. Production process of the branches

The DEA approach is based on a concept of production technology developed by Shephard (1970). It allows representing the entity activities under study (in this case, bank branches) using the relationship connecting all the employed resources to all the provided services. In the case of our analysis, the branches do not decide on the amount of resources, it is the top bank management which allocates the branch resources. So as to evaluate branches performance, we answer the following question: (Q1a) Does *a branch have the possibility of improving its results (outputs) given the allocated resources (inputs)?* Figure 1 provides a representation of the production process of the branches. On the inputs side, top regional bank management allocated three types of resources: human resources, operational resources and customer capital is a specificity of the banking activity. The bank branch contributes directly to the role of financial intermediary of the bank: it collects the deposits that comprise the liabilities on the bank's income statement and it grants loans that comprise the assets on the bank's income statement. The branch's customer capital can be considered as business funds. On the output side, branches sell six types of products to their customers: cash savings products, personal and business loans, access to services related to the management of demand accounts, damage insurance products and financial savings products. Some of them result from classical banking intermediation activity (cash savings products, personal and business loans); the others are off-balance sheet activities. In addition, some factors which are

[2] DEA has been used several times to evaluate the performance of the branches (see Tulkens 1993, Soteriou and Zenios 1999, Schaffnit et al. 1997). The first study was published by Sherman and Gold (1985).

[3] We highlight that in the banking efficiency literature there are several papers (Dietsch and Lozano-Vivas 2000, Lozano-Vivas and al. 2002) about environmental conditions and performance, but these studies are at the bank level. The papers about environment and branches performance are rarer because of the difficulty in obtaining specific environmental data for each branch.

"uncontrollable" by the branches influence its performance. As emphasized by Athanassopoulos (1998) some of these factors are the trade environment of the branches. Then to propose a *fair*[4] performance measure of the branches, we answer the question (Q1b): *Has a branch the possibility of improving its results (outputs) given the allocated resources (inputs) and its localization?*

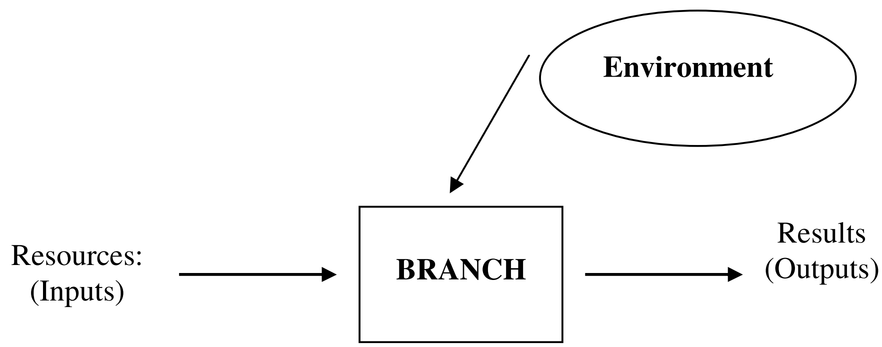

Figure 1: The production process of the branches

2.3. Mathematical framework for evaluating banking networks efficiency

The standard DEA approach is derived from the work of Shephard (1970) who developed a theoretical framework showing that distance functions are a perfect representation of production technology. Traditionally the traditional distance functions measurement is generally a radial measurement of the technical inefficiency (notably for the application of the DEA approach in the banking sector). However this radial measurement does not allow for the technical inefficiency scores to be aggregated as each evaluated unit is its own referential. Given this, we use the recent work of Luenberger (1992), Chambers et al. (1996) who have generalized Shephard's distance functions and shown that they have a particular case of directional distance functions. The use of directional distance functions is particularly interesting as it enables us to aggregate indicators such as inefficiency scores (Briec et al. 2003). Directional distance functions are managerially advantageous as they do not develop just an analysis of the technical inefficiency of the individual banking branches but also of one of the regional banks. Moreover using a radial versus a directional measure of the efficiency depends on three levels of analysis:

[4] We use the word '*fair*" because the efficiency measure proposed in this study respects, as much as possible, the well-known controllability principle.

(1) when adopting a branch – individual- point of view, a radial measurement is the most appropriate one because it indicates a percentage in comparison with itself;

(2) when adopting a regional bank – network – point of view, a directional measurement which is specific to each regional bank, is the most appropriate because it allows for a comparison of the branches inside each regional bank[5];

(3) when adopting a broad – banking group – point of view, a directional measure is once again the more appropriate one, but now the direction will be the same for all the regional banks. This direction allows us to compare each regional banking group with the others and each branch with one another[6].

We are looking to evaluate the performance of a population of branches a, $a = 1...U$. They are distributed within G_n integrated distribution networks, $n = 1...N$. Each of them consists of a top regional bank management and a network of branches a. The branch under evaluation is noted u. All branches uses inputs $x = (x_1,...,x_R) \in \Re_+^R$ to produce outputs $y = (y_1,..., y_P) \in \Re_+^P$.

The first objective is to obtain an operational performance evaluation of the branches. This is typical of many DEA studies, both within and outside the financial service sector (Lovell and Pastor, 1997). The second objective is to obtain an operational performance evaluation of the regional banks. This is new. To achieve these two objectives we use an output directional measure of the technical inefficiency noted i in PML1.

The inefficiency score i gives an answer to question (Q1b) by estimating the potential effort that each non-efficient branch has to achieve to become efficient (when $i = 0$, the branch is a benchmark). Moreover, the specificity of the directional measurement of the technical efficiency allows a correct and easy aggregation of the efficiency score[7], and then we can match our managerial objective which is to practice intra-and inter- regional banks benchmarking.

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[5] In this case the radial measurement is at the regional bank level, and the directional one at the branch level.
[6] In this case the radial measurement is at the banking group level, and the directional one at the regional bank level and at the branch level.
[7] In the linear program developed by Charnes et al. (1978), the inefficiency score is multiplied by the individual observed production of each entity under evaluation. Then, we can't aggregate the calculated scores because they are not expressed in a same unity of measurement (in a same base). Therefore, we use the new approach developed by Luenberger (it is a generalisation of Shephard's distance functions).

$$\max_{\{i^u, t^a\}} \quad i^u \qquad \text{[LMP1]}$$

With constraints:

$$\sum_{a \in e(u)} t^a y_p^a \geq i^u \; b + y_p^u \qquad \forall p = 1 \ldots P$$

$$\sum_{a \in e(u)} t^a x_r^a \leq \; x_r^u \qquad \forall r = 1 \ldots R$$

$$\sum_{a \in e(u)} t^a = 1$$

$$t^a \geq 0$$

$$b = \sum_{u \in G_n} y_p^u$$

$$\forall a \in e(u)$$

LMP 1

Linear mathematical program used to calculate the technical inefficiency scores of branches

The inefficiency score calculated by PML1 assesses three significant managerial interests:

(1) Branches do not control their size neither their resource allocation so a production technology characterized by the variable returns to scale is inferred. In the mathematical program LMP1, the constraint $\sum t^a = 1$ indicates the hypothesis of variable returns to scale, with t^a being a technical coefficient defining the production process of branches.

(2) The localization of the branches can be different and have a favourable or an unfavourable impact on the branches' performance. Therefore, the program PML1 indicates that a referential specific to each type of localization exists. In other words, a branch is compared only to other branches confronted with the same market constraints. An efficient frontier is defined for each environment: each branch is assessed only in comparison to other branches faced with the same environment. Index e indicates the environment in the LMP1.

(3) From a methodological point of view, the choice of the direction is completely free. We choose a direction which is consistent with our managerial objectives. The direction chosen has to allow for the comparison of the individual inefficiency score and the aggregate inefficiency score. We select a common base to express the inefficiency score for all the 1611

branches (the objective is to employ benchmarking among all the branches evaluated and among the entire regional bank analyzed). In the program PML1, the common referent is indicated by the notation b and $b=\sum_{u\in G_n} y_p^u$.

3. Data and Empirical results

The performance of the banking network is analyzed both at the branch level and at the network level. The technical inefficiency of all branches is evaluated. Although these 1611 branches operate under the same trade name (a large French banking group), they are distributed among sixteen regional banks. Each one is an independent regional bank with its own top management which decides the product-mix strategy, branches localization, and branches resources allocation.

Using the LMP1, we calculate the inefficiency score that will allow the banking groups' general manager to practice internal benchmarking. Before presenting the results obtained and the population of branches studied, we indicate the input and output variables used to describe the production process of branches as well as the measurements retained.

3.1. Data and descriptive statistics

Detailed data on 1611 anonymous branches of an unnamed French mutual bank for 2004 were collected. Table 1 gives summarized information on the proxies used in the production process of the branches.

Tableau 1: Proxies to estimate the selected inputs and outputs and summary statistics

	Proxies	Mean
Output 1	Value of cash savings portfolio in k€	38 950
Output 2	Value of personal loans portfolio in k€	33 023
Output 3	Value of business loans portfolio in k€	9 232
Output 4	Commissions on services in k€	331
Output 5	Amount of damage insurance products in k€	819
Output 6	Amount of financial savings products in k€	27448
Input 1	Number of full-time equivalent employees	12

Input 2	Operating expenses in €	741
Input 3	Number of active current accounts	3 494

They are distributed within sixteen regional banks with a general management and a network of branches. The general management of the regional banks decides independently on the location of their branches, their allocation of resources and the choice of their product assortment. Table 2 shows the distribution of the 1611 branches within the sixteen regional banks (noted RB in table 2). The size of the sixteen regional groups varies greatly (the smallest comprised of a network of 19 branches and the largest of 380). In addition to belonging to different regional banks, the branches are distributed according to the characteristics of their local commercial environment. They are hence classified into six distinct environments: (1) rural areas with a high rate of employee assets working in the agricultural field and a high rate of retirees, (2) residential areas with a high rate of businesses, retirees and secondary residences, (3) areas with average profiles, (4) urban areas with a high rate of unemployment, (5) peripheral areas with a high rate of population growth, a significant portion of large dwellings and homeowners, (6) urban areas with a high rate of executives. These environments are respectively represented by E1 to E6. The number of branches per environment is also variable. Each network is present in at least four different environments. Indeed, in order to meet the commercial strategy needs, the general managers of the regional banks choose to be present in all types of environments.

Tableau 2: Distribution of the 1611 branches by regional bank (RBG) and by environment (E)

Regional Banks	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**	**Total**
RB1	23		5	6	3		37
RB2	17	2	12	7	29	6	73
RB3	119	16	38	13	39	2	227
RB4	16	2	5	9	22	2	56
RB5	1			3	14	1	19
RB6	29	11	7		5		52
RB7	38	2	7		14	2	63
RB8	20	4	20	11	104	6	165
RB9	11	2	20	6	33	21	93

RB10	2	6	2	5	40	1	56
RB11	42	9	45	19	30		145
RB12	39		18	6	14	5	82
RB13			4	4	15	40	63
RB14	56	1	150	30	137	6	380
RB15	4	4	9	13	32	1	63
RB16	9		3	4	19	2	37
Total	426	59	345	136	550	95	1611

3.2. The empirical results

The PML1 code calculates an inefficiency score for each individual branch. This score allows us to answer question: (Q2) What are the benchmarks of the network? The branches that obtain an inefficiency score of 0% are technically efficient, given their location and allocation of resources. Within the population studied, 31% of the branches are technically efficient (501 branches). These 501 branches are the best practices of the studied population. They are indicated in table 3. From this table, managers of the regional bank can quickly identify their best practices according to the characteristics of their commercial environment. So the technical inefficiency score as it is calculated in this study makes implementing benchmarking easier. With table 3, question (Q2) is answered; the branches benchmarks are identified for each regional bank and for each environment.

Table 3: Individual benchmarking practices

Regional Banks	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**	**Total**
RB1	5		1	4			**10**
RB2	1		3		3	1	**8**
RB3	24	8	11	7	11	2	**63**
RB4	8	2	3	6	15	2	**36**
RB5	1			2	2		**5**
RB6	5	9	1		1		**16**
RB7	8		1			1	**10**
RB8	9	2	5	4	16	4	**40**

RB9	7	2	13	6	14	14	**56**
RB10		5	1	4	9	1	**20**
RB11	1	2	3	6	4		**16**
RB12	18		7	1	2	4	**32**
RB13			4	4	7	20	**35**
RB14	24	1	47	14	42	5	**133**
RB15		3	1	5	5	1	**15**
RB16				3	2	1	**6**
Total	**111**	**34**	**101**	**66**	**133**	**56**	**501**

The identification of the best practices is the first result of this analysis. The second lies in the aggregate inefficiency score which allows to compare the sixteen regional banks.

3.2.1. Evaluation of the regional banks

Using the Gini index, we assess, for the entire banking group and for each regional bank, the concentration of the technical inefficiency of branches. The Gini index for the entire French group (the sixteen regional banks together) is 58%, this indicates that the technical inefficiency of branches is moderately concentrated. The analysis of the Gini index at the French bank group reveals that 40% of the technical inefficiency is grouped within 80% of branches.

Table 4 presents the summarized results for each regional bank: in the third column the “aggregate inefficiency scores”, in the fourth the “Gini index”, and in the last one the “over/under representation of the inefficiency index”.

Three profiles of the concentration of technical inefficiency can be distinguished:

- Profile 1: the technical inefficiency is very concentrated

  Regional banks RB4, RB9 and RB13 display Gini indexes close to 1 which means that the technical inefficiency is very concentrated; relatively few branches are very inefficient. Regional banks RB12 and RB14 can be classified in Profile 1.
- Profile 2: the technical inefficiency is moderately concentrated

Regional banks RB15 and RB8 display a Gini score of about 50% which means that the technical inefficiency is moderately distributed throughout the branch network. Groups RB1, RB3, RB5, RB6, RB10 and RB16 can be classified in Profile 2.

- Profile 3: the technical inefficiency is slightly concentrated

  Regional banks RB2, RB7 and RB11 display a Gini index of 40% which means that the technical inefficiency is distributed throughout the network, in other words, several branches are slightly inefficient.

Table 4: Aggregate benchmarking practice

	Number of employees	**Aggregate inefficiency scores**	**Gini Index**	**Over/under-representation of the inefficiency index**
Regional bank	18 602	**9,45490%**[8]	**58%**	
RB1	445	**0,16125%**	**49%**	**0,71**
RB2	615	0,65860%	40%	2,11
RB3	2 612	1,29618%	58%	0,98
RB4	365	0,06397%	78%	0,35
RB5	148	**0,19798%**	**48%**	**2,64**
RB6	1 012	0,54748%	48%	1,06
RB7	1 085	0,67725%	42%	1,23
RB8	1 997	0,98787%	51%	0,97
RB9	792	**0,15544%**	**78%**	**0,39**
RB10	550	0,30591%	56%	1,09
RB11	1 257	1,21090%	40%	1,89
RB12	863	0,31099%	64%	0,71
RB13	848	0,19652%	75%	0,46
RB14	5 258	**2,07549%**	**61%**	**0,78**
RB15	446	0,30811%	50%	1,36
RB16	309	**0,30095%**	**47%**	**1,92**

[8] The technical inefficiency of branches across the all banking group represents 9.455%. In other words, the operational performance of all the 1611 branches could increase by 9.455%.

The comparison of the branches technical inefficiency score could be biased by a size effect. In fact, groups GR3, GR11 and GR14 account for the highest percentage of inefficiencies; they are also the groups that manage the largest number of branches. A regional bank having 19 branches will be less inefficient that a group having 380 ones since the indicator is the sum of the individual technical inefficiencies of the branches. These results have be refined in order to perform a "network" diagnostic using the individual technical inefficiency scores of the branches and it will be described in next paragraph.

Before comparing the network of branches with the technical inefficiency criteria of the branches, the results are presented taking into account the size of each regional bank. The number of employees is used as a parameter to estimate the size of a regional bank (this number is indicated on table 4). An index of under/over-representation is derived as follows: for each regional group, the percentage of inefficiency of the branches is divided by the proportion of employees. The regional banks which obtain an under-representation of inefficiency (index < 1) can be considered as the best practices. The ones which obtain an over-representation of the inefficiency (index > 1) have to make a productive effort to become efficient. For example, the regional bank RB5 has the worst results and presents an over inefficiency of 2.64 (*i.e.* the inefficiency in % is 2.64 larger than the number of employees in percentage). The regional bank RB9 has the best results. We can note that the bigger regional bank RB14 obtain good results too and can be considered as a benchmark.

3.2.2. Analysis of the efficiency gains

A technically inefficient branch can increase its volume of sales due to its allocation of resources and location. For these branches, potential gains in efficiency exist. Multiplying the technical inefficiency scores of the branches by the real values observed for the volume of sales realized within each regional bank, potential realizable gains can be estimated at the "regional bank" level.

Table 5 presents the potential productive gains in % which will allow the general managers of the branches to compare the networks among themselves. The potential gains are not the same according to regional banks and according to products. They provide information on the abilities of each regional bank to sell one product rather than another and also on the capacity of the groups to optimize their resources and location as best they can.

Table 5: Potential achievable gains expressed in %

Regional bank	Interest-bearing deposits	Personal loans	Business loans	Commissions on services	Damage insurance	Financial savings
RB1	7%	8%	5%	5%	8%	8%
RB2	**29%**	**23%**	**35%**	**46%**	**18%**	**23%**
RB3	8%	9%	7%	7%	15%	5%
RB4	3%	5%	2%	3%	3%	7%
RB5	**40%**	**33%**	**34%**	**30%**	**48%**	**23%**
RB6	9%	10%	6%	8%	14%	11%
RB7	**11%**	**15%**	**11%**	**10%**	**9%**	**12%**
RB8	9%	13%	11%	8%	12%	10%
RB9	4%	4%	3%	3%	3%	6%
RB10	10%	11%	13%	8%	14%	12%
RB11	**17%**	**20%**	**26%**	**16%**	**19%**	**20%**
RB12	6%	8%	6%	6%	9%	11%
RB13	4%	3%	10%	4%	5%	4%
RB14	6%	6%	8%	7%	5%	8%
RB15	**16%**	**14%**	**16%**	**11%**	**11%**	**21%**
RB16	**15%**	**28%**	**19%**	**15%**	**45%**	**16%**

5. Conclusion

In this paper we performed an application of DEA to a French banking group by using an original inefficiency score. This analysis has generated two sets of findings. The first concerns the ability of the branches to avoid the waste of the allocated resources for a given environment and the second concerns the managerial perspective of an intra- and inter-regional banks benchmarking analysis

We have discussed the methodological and managerial interests of such a measurement when assessing a distribution network compared to the radial measurement traditionally employed. The "individual" diagnostic makes it possible to assess the effort necessary for each inefficient branch in terms of volume of sales of banking and non banking products given a branch's location and allocation of resources. The "network" diagnostic makes it possible to compare the different regional banks, in order to study the concentration of the technical inefficiency within each network and to assess the productive gains of the regional bank. The latter elements constitute major managerial interests for use of a directional measurement of technical inefficiency.

Benchmarking remains a powerful decision-making tool. It is a complex practice to implement, particularly with a retail network, since it is based on the measurement of performance that must identify the best practices, compare the assessed units fairly and classify them. We show that the DEA approach is useful in developing an indicator for total productivity that meets the requirements of the implementation of rigorous benchmarking.

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