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Full Length Research Paper

Efficiency analysis and classification of bank by using data envelopment analysis (DEA) Model: Evidence of Iranian Bank

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Data envelopment analysis is the most practical nonparametric methods to compute efficiency and to rank decision- making units. This method is based on a series of optimizing and using the technique of linear programming. Using this method, this paper evaluates the efficiency of Industrial and Mine Bank in Iran. Using this method, the rank of each branch has been measured according to the types of efficiency (technical efficiency, management efficiency and scale efficiency). Further, kind of returning to scale has been evaluated in each branch (ascending, descending or constant productivity). Then, efficient and inefficient units have been recognized, optimal quantity of inputs in the inefficient units have been evaluated, surplus of production factors have been computed, the pattern or reference branches and weight of each for inefficient branches have been introduced too, and finally based on the average of efficiency, type of returning to scale, frequency of each branch as a pattern and efficiency and inefficiency, all of the branches have been ranked and a ranking system have been developed. Using this system branches are classified to six levels as: superior, excellent and degrees from 1 to 4.

Key words: Data envelopment analysis (DEA), Banker, Charnes and Copper (BCC), Charnes, Cooper and Rhodes (CCR), management efficiency, scale efficiency, technical efficiency.

INTRODUCTION

Lack of strategic management system on operation, lack of efficient evaluation system of operation, lack of authority of economical viewpoint and low rate of efficiency and effectiveness are considered as evident features of Iran's official system (Namazi and Salehi, 2010). Active institutions and organizations are less productive in such a system due to the mentioned characteristics. The primary step in resisting such a management method necessitates trying to balance inputs and outputs of organizations by procedure of scientific-practical effective ways, and to internalize productivity by frequently evaluating operations. Clearly, access to the aforementioned necessities, and what this proposal is looking for, will be possible throughout measuring activities, using scientific and quantitative instruments, and finally formulating and creating a system of evaluating operations. This measurement is so important that it can increase productivity from 5 to 10% by only introducing, basing and performing a system of evaluating operations, even without any change in organizations and investments. This fact is based on the experiences of industrial countries (Charns, 2008).

Thus, in our period of time, efficiency and effectiveness should be the greatest for managers and the most valuable purpose of every organization. Attempt to increase productivity is considered as the most serious goal of managements on the threshold of 21st century (Salehi and Rostami, 2010). Hence, more products with the same cost or the same quantity of products with less cost will be beneficial for the society. It may affect positively life levels in the society (Salehi and Ghorbani, 2011). In the recent years, there has been a fairly appropriate approach to productivity mentally, culturally and socially. In fact, nowadays productivity is not strange and unfamiliar, at least in the society's manner of thinking

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and believes.

The aim of current study is determining banking system efficiency in Iran by using DATA envelopment analysis (DEA). Regarding this system, it can be said that productivity, intellectual use of facilities and access to the greatest result and the most valuable purpose, requires a scientific view so that the productivity circle in four processes of measurement, analysis, programming, and performance can be established in this system. Shaping scientifically and particularly quantitative determinants are considered as the most important features of this circle.

In this process increasing efficiency and productivity requires recognition. Recognition itself requires measurement. Productivity measurement leads to the advantages below in every organization including the banking systems:

(i) Recognizing effective potentials to improve productivity
(ii) Helping priorities and decisions making
(iii) Assisting management to recognize problematic areas inclusively and effectively.
(iv) Letting managers have access to valuable information to evaluate the effects of changes and to lead sources (Salehi and Yousefi, 2011).

All of these advantages can be considered in DEA model. Referring to these advantages of DEA model in performance evaluation, in this paper we introduced an efficient way for Industrial and Mine Bank branches classification. Branches classification is an effective way for managerial and organizational performance that can be used in budget evaluation, reward system and so on.

THEORETICAL ISSUES AND REVIEW OF THE LITERATURE

DEA models are classified with respect to the type of envelopment surface, the efficiency measurement and the orientation (input or output). There are two basic types of envelopment surfaces in DEA. Charnes et al. (1978) introduced the constant returns-to-scale (CRS) and Banker et al. (1984) introduced the variable returns-to-scale (VRS) model. DEA models are also classified as radial input oriented, radial output oriented or additive (both inputs and outputs are optimized) based on the direction of the projection of the inefficient unit onto the frontier. Although we utilize both the radial input and output oriented VRS models in our study of commercial bank branches, we will not present the mathematical formulation here; instead direct the reader to the complete mathematical presentation of the applicable DEA models in Cook et al. (2000). DEA is a framework well suited for performance analysis and it offers many advantages over traditional methods such as performance ratios and regression analysis. Largely the result of multi-disciplinary research during the last two decades in economics, engineering and management, DEA is best described as an effective way of visualizing and analyzing performance data. Technically, it represents the set of non-parametric, linear programming techniques used to construct empirical production frontiers and to evaluate the relative efficiency of production units.

DEA is particularly effective in handling complex processes, where these DMUs use multiple inputs to produce multiple outputs. There has been a significant interest in evaluating bank branch activities, both by practitioners and academics. Traditionally based on profitability measures, the banks assessment of their branch networks has started to change towards more comprehensive benchmarking programs. Academics have used frontier analysis as a sophisticated way to evaluate the relative performance of production units, assessing how close the financial units are to a best-practice frontier. The first of these applications using DEA was by Sherman and Gold (1985); they defined the broad approach to DEA applications when used in bank branch productivity measurements. Schaffnit et al. (1997) contain a review of the DEA studies of bank branches published prior to 1995. Then, a comprehensive paper by Berger and Humphrey (1997) reviewed the literature concerning the efficiency of financial institutions, including bank branches, using non-parametric (DEA and variations) and parametric frontier analysis. Lovell and Pastor (1997) looked at setting targets for bank branches; Camanho and Dyson (1999) evaluated Portuguese bank branches; Kantor and Maital (1999) examined activity based accounting in bank branches; Soteriou and Zenios (1999) focused on operations, quality and profitability in banking services; and Golany and Storbeck (1999) examined operational efficiencies in bank branches. There are other studies too many to cite here, but there are a few that resulted in an adaptation of DEA by the bank on an on-going basis. Oral and Yolalan (1990) examined 20 branches of a Turkish Commercial Bank where DEA was used to reallocate resources between branches. Building on the previous work by Sherman and Gold (1985), Sherman and Ladino (1995) reported on the implementation of DEA results in the restructuring process of 36 US branches of a bank that led to actual annual savings of over $6 million. Zenios et al. (1999) studied the Bank of Cyprus where the bank adopted their model and findings to establish policy guidelines and provide operational support for productivity improvements. Then, Athanassopoulos and Giokas (2000) examined 47 branches of the Commercial Bank of Greece and the DEA results were used to implement the proposed changes in the bank's performance measurement system.

Closer to home is the study by Cook et al. (2000) when they applied DEA to a large Canadian Banks branches and the bank accepted their new performance rating system based on DEA. This work builds on the previous studies and emphasises the importance of obtaining results of direct relevance to the bank's management (Sherman and Ladino, 1995; Golany and Storbeck, 1999). Two models are analysed here, with the choice of inputs and outputs aimed at addressing particular managerial needs. Also, from a technical perspective, we apply advanced DEA models enabling us to move from technical to overall efficiency. Banker and Morey (1986) applied DEA in a fast food environment where exogenously fixed variables were introduced. Ray (1991) examined resource use efficiency in a public school environment where they regressed DEA results against socio-economic factors. Ruggiero (1996) also worked in the public-sector and suggested that environmental variables need to be used in DEA analyses because otherwise technical efficiencies will be over estimated. The papers all dealt with non-discretionary variables in real situations. Unrestricted DEA can yield quite unrealistic results from a managerial point of view and there are situations where additional information is available that allows the analyst to impose conditions on the components of the multiplier vectors. Thompson et al. (1986) introduced the technology they referred to as the ‘‘assurance region’’ and then, Charnes et al. (1990) published their ‘‘cone ratio’’ approach. Joseph and Schaffnit (2004) developed an applied model to commercial branch performance evaluation. Recently Chansarn (2008) conducted a survey that called “the relationship between efficiency for commercial banks in Thailand: an application of data envelopment analysis”. He considered the efficiency for 13 commercial banks in Thailand between 2003 and 2006, using data envelopment analysis. In this study, there were one input, referred to the number of the personnel, and two outputs, referred to the incomes for DEA functions and it used a constant return to scale to measure efficiency. The results of the study indicate that the efficiency for the banks with functional approaches, although growing gradually, is very high. In fact, the average of their efficiency has been more than 90%, yearly. The experienced banks compete with the new-founded institutions and averagely they seem more efficient. Fotio et al. (2007) presented a paper entitled "estimating and analyzing the cost efficiency for Greek cooperative banks: an application of two stage data envelopment analysis". In this paper, they estimated the efficiency for 16 Greek cooperative banks from 2000 until 2004. First, they estimated cost, specialized, technical, and management efficiency, using DEA method. Then, they recognized internal and external factors affecting the aforementioned kinds of efficiency, using Tobit regression method. The results of their study revealed that the banks were inefficient 17.7% in average. Richardo (2008) presented a paper in Brazil entitled "using data envelopment analysis estimation approach for banks in brazil". Working on 50 Brazilian superior banks ad using their balance sheet variables, they evaluated their efficiencies and made a comparison. The results of the study indicated that compared to the present approach, DEA approach was more efficient to rank the bank branches. For this reason in this paper we have used CCR and BCC model to classify the various branch of industrial and mine bank of Iran.

METHODOLOGY

DEA is one of the nonparametric methods to measure economical units' efficiency and productivity. This method was initiated by Rhodes' PhD thesis under Cooper supervisory. Then, Banker et al. (1984) developed data envelopment analysis concepts and versions with new versions in 1984. In fact, data envelopment analysis is a linear programming version for observed data, and is considered as a new version in the estimation of efficiency frontier experimentally.

DEA is a mathematical programming version to evaluate the performance of decision making units. Data envelopment analysis refers to an organizational unit or individual organization handling by a manager, boss, or supervisor, provided that the organization enjoys a systematic process. That is, a number of production factors are used to get a number of products. Experimental nature and loss of troublesome assumptions is why data envelopment analysis is used to estimate efficiency frontier. DEA theoretical versions are considered in two methods: Charnes, Cooper and Rhodes (CCR), Banker, Charnes and Copper (BCC).

CCR versions (Charnes et al., 1978)

In order to construct a virtual unit, Farell focused on units' set of weights to measure efficiency for units relatively. He suggested the below relationship as a means of measuring technical efficiency:

Efficiency = (weighted sum of outputs) / (weighted sum of inputs)

Regarding efficiency for n units enjoying m inputs and s outputs, the efficiency for unit j (j = 1,2,…n) can be computed as below:

$$\text{Unit efficiency} = : \frac{\sum_{r=1}^{s} U_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}$$

X ij = the amount of input i for unit j (i=1,2,…m), Y rj = the amount of output r for unit j (r=1,2,…s)
V i = weight of input I, U r =weight of output r

Refereeing to this definition, Charnes et al. (1978) developed CCR model with the mathematical version is as follow:

$$MaxZ_0 = \frac{\sum_r^s u_r y_{ro}}{\sum^m v_i x_{i0}}$$

$S.t:$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{s} v_i x_{ij}} \leq 1$$

$$u_i, v_j > 0$$

BCC version (Banker et al., 1984)

The formulation of CCR version assumes that the relationship between inputs and outputs follows the constant returns to scales assumption. For instance, if inputs get twice as much, outputs get twice as much too. If inputs increase more than or less than twice as much, the returns are assumed increasing and decreasing, respectively. In many organizations, constant returns to scale assumption are not acceptable. This assumption is appropriate when every institution acts in optimal level. However, various problems, such as competitive effects, constraints, managements' week operations, and so on, cause institutions not to act in optimal scales. Therefore, Banker et al. extended BCC version in 1984 so that varying returns to scale (VRS) are considered. This version was known as BCC, taken by their names' the first letters.

The mathematical version is as follow:

$$MaxZ_0 = \frac{\sum_{r=1}^{s} u_r y_{r0} + w}{\sum_{i=1}^{m} v_i x_{i0}}$$

$s.t$

$$\frac{\sum_{r=1}^{s} u_r y_{rj} + w}{\sum_{i=t}^{m} v_i x_{ij}} \leq 1$$

$$j = 1, 2 ...., n$$

$$u_r v_r \geq 0, w : free \ in \ Sign$$

Equaling the denominator of the objective function to 1, the non-linear version can be converted to a linear one. As you see, the W free variable is the difference between CCR and BCC versions. The W variable in BCC can determine returns to scale for every unit.

If W < 0, kind of return to scale is decreasing, If W = 0, return to scale is constant. If W > 0, return to scale is increasing.

Banker et al. (1984) developed the last version (CCR) so as to include the varying return to scale. Using the constant return to scale will derange the computed amounts for technical efficiency of analysis when all the institutions do not act into optimal scale. Using the varying return to scale leads to a very precise analysis, computing technical efficiency based on the amounts of scale efficiency and management efficiency.

Formulating the dual problem in the linear programming with the constant return assumption is accomplished by adding the constraint $\sum_{k=1}^{N} \lambda_k = 1$ (convex restraint) to the linear programming of computations with the varying return assumption.

$$\text{Min } H_k = \theta_k - \varepsilon \left(\sum_{i=1}^{m} S_{ik}^- + \sum_{r=1}^{n} S_{rk}^+ \right)$$

$$\text{subject to } \sum_{k=1}^{N} \lambda_k \chi_{ik} - \theta_k \chi_{ik} + S_{ik}^- = 0$$

$$\sum_{k=1}^{N} \lambda_k = 1$$

$$\sum_{k=1}^{N} \lambda_k \chi_{ik} - S_{rk}^+ = y_{rk}$$

$$\varepsilon, \lambda_k, S_{ik}^-, S_{rk}^+ \geq 0; i=1,\cdots,m; r=1,\cdots,n; k=1,\cdots,N, \theta \text{ unconstrained}$$

The last version with the varying return to scale does not determine whether institutions act in the region of increasing return or decreasing one. It is accomplished by comparing the restraint of non-increasing returns to scale ($\sum_{k=1}^{N} \lambda_k \leq 1$). That is:

$$\text{Min } H_k = \theta_k - \varepsilon \left(\sum_{i=1}^{m} S_{ik}^- + \sum_{r=1}^{n} S_{rk}^+ \right)$$

$$\text{subject to } \sum_{k=1}^{N} \lambda_k \chi_{ik} - \theta_k \chi_{ik} + S_{ik}^- = 0$$

$$\sum_{k=1}^{N} \lambda_k \leq 1$$

$$\sum_{k=1}^{N} \lambda_k \chi_{ik} - S_{rk}^+ = y_{rk}$$

$$\sum_{k=1}^{N} \lambda_k \chi_{ik} - S_{rk}^+ = y_{rk}$$

$$\varepsilon, \lambda_k, S_{ik}^-, S_{rk}^+ \geq 0; i=1,\cdots,m; r=1,\cdots,n; k=1,\cdots,N, \theta \text{ unconstrained}$$

In the other words, the nature of the kind of return in scale inefficiency for a special institution is determined by comparing the amount of technical efficiency in the varying return to scale. That is, if the both are equal, the institution falls into the decreasing return to scale.

Data analysis

In institutions such as banks, insurances and financial institutions that production factors are considered as decision making variables, the appropriate version to evaluate efficiency is based on production factors. Optimizing based on minimizing production factors and inputs results in optimizing and maximizing outputs automatically. This paper considering branches of Industrial and Mine Bank all over the Iran analyze the data, evaluate efficiency, and rank the units based on minimizing the production factors and by the way of the varying returns to scale. The results of the varying returns to scale are more precise and authentic because constant returns to scale is operational only if institutions act in optimal level. However, institutions never act in optimal scale in the real world because of various problems such as competitive markets, legal and juridical constraints and so on.

In addition, because there is a difference between input-oriented and output-oriented results in the varying returns to scale, data analysis in this paper is based on the production factors' input-orienting. In the approach of minimizing production factors, the software can compute three types of efficiency: management efficiency, scale efficiency, and technical efficiency. In this paper, the inputs refer to the number of the personnel, operational and non-operational costs in the various branches. The outputs refer to the given facilities and payments, operational and non-operational incomes in the various branches. DEAP, the specialized software of DEA method, has been used in this study.

Measuring the branches' efficiency and types of their returns

In the version of the varying returns to scale, the efficiency was divided into three types: technical, management and scale efficiency, and was presented with the types of the returns (decreasing, constant, and increasing) in the units.

According to Table 1, the Branches 7, 13, 29, 33, and 38 obtained the average efficiency of 100%, hence, they are categorized in completely efficient branches. The Branches 1, 21, 24, 25, and 30 obtained high and acceptable average efficiency (80%). At most, their inefficiencies are 20% that they will convert to efficient branches if they act a little more precisely. Also, the following branches act as the weakest: the Branch 15 with an inefficiency score of 73%, the Branch 10 with inefficiency of 52%, the Branch 16 with inefficiency of 51%, the Branch 28 with an inefficiency score of 55%, and the Branch 36 with an inefficiency score of 51%. In fact, except 5 completely efficient branches, 5 branches with a fairly good efficiency, and 5 branches with the weak efficiency, the remaining branches of Industrial and Mine Bank all over the country enjoyed an average efficiency operation (with the average rate of efficiency from 50 to 80%).

The results also indicate the average scale, management, and technical efficiencies for all the bank branches all over the country as 0.590, 0.839, and 0.713, respectively. That is, sum of the branches encounter scale inefficiency rate of 41%, management inefficiency rate of 17%, and technical inefficiency rate of 29%. Because the management efficiency score in the total bank exceeds 80%, it can be claimed that the bank is in a fairly good situation.

With regard to the technical efficiency, the bank situation is between average and good. It does not have a very appropriate situation concerning the scale efficiency.

Finally, the (numeral) average rate of total efficiency (scale, management, and technical) in the total branches is 0.709, illustrating the total bank's rather good operation concerning efficiency. Of course, Industrial and Mine Bank can increase its efficiency up to 30%, including the research strategies and suggestions and attempting to optimize the system.

Analyzing surplus of production factors in the branches of Industrial and Mine Bank

Reducing a unit's surplus of production factors does not result in reducing amounts of its production. Rather, the unit, whether efficient or inefficient, still retains the same efficiency. Thus, the unit's surplus of production factors can be led to the branches encountering input slacks. It will improve the efficiency for the total organization. The surplus amounts of the three inputs are illustrated in Table 2.

Analyzing the surplus of production factors computed in Table 2 is actually so that the Branch 5 (Ardebil), for example, enjoys 118379 as a surplus operational costs and 1.2 as a surplus personnel. That is, the branch can attain the same efficiency even if loosing the surpluses. Thus, in order to improve the efficiency of the total organization, the surplus personnel can be shifted to the branches of increasing returns to scale.

Reference groups and their weight for inefficient branches

Inefficient units can attain to the efficiency frontier, following the similar reference units regarding inputs and outputs. In Table 3 you can find the reference units and their weights in the varying returns to scale for all the branches of Industrial and Mine bank all over the country.

The analysis of Table 3 is so that the reference branches for the Unit 34, for instant, as an inefficient unit are as follows: 36, 21, and 35.

Table 1. Types of the branches' efficiency and types of the return in the varying returns to scale.

No.	Name of branch	Efficiency scale	Management efficiency	Technical efficiency	Efficiency average	Type of return
1	Tehran	883.0	000.1	883.0	921.0	DRS
2	Tabriz	573.0	642.0	894.0	693.0	IRS
3	Sari	606.0	698.0	868.0	718.0	IRS
4	Zanjan	701.0	766.0	914.0	791.0	IRS
5	Ardebil	384.0	686.0	560.0	532.0	IRS
6	Ahvaz	618.0	681.0	0/907	728.0	IRS
7	Kermanshah	000.1	000.1	000.1	000.1	Constant
8	Qom	615.0	900.0	683.0	725.0	IRS
9	Yazd	497.0	686.0	725.0	631.0	IRS
10	Boushehr	336.0	879.0	382.0	487.0	IRS
11	Mashhad	712.0	751.0	948.0	799.0	IRS
12	Tehran-karimkhan	398.0	535.0	745.0	545.0	IRS
13	Tehran-hafez	000.1	000.1	000.1	000.1	IRS
14	Arak	420.0	692.0	607.0	564.0	Constant
15	Qazvin	143.0	000.1	143.0	277.0	IRS
16	Kerman	342.0	618.0	554.0	493.0	IRS
17	Bandarabas	546.0	000.1	546.0	671.0	IRS
18	Zahedan	359.0	884.0	407.0	509.0	IRS
19	Semnan	712.0	763.0	933.0	799.0	IRS
20	Shahrkord	396.0	912.0	434.0	543.0	IRS
21	Yasuj	836.0	000.1	836.0	888.0	DRS
22	Rasht	562.0	573.0	981.0	684.0	IRS
23	Gorgan	382.0	997.0	383.0	530.0	IRS
24	Hamedan	806.0	844.0	955.0	867.0	IRS
25	Oroumiyaeh	880.0	882.0	997.0	919.0	IRS
26	Khoramabad	518.0	758.0	684.0	648.0	IRS
27	Sanandaj	461.0	000.1	461.0	600.0	IRS
28	Eilam	300.0	000.1	300.0	452.0	IRS
29	Esfahan	000.1	000.1	000.1	000.1	Constant
30	Shiraz	741.0	827.0	896.0	820.0	IRS
31	Qaem karaj	535.0	633.0	845.0	662.0	IRS
32	Tehran-sanat	451.0	000.1	707.0	592.0	IRS
33	Tehran-bazar	000.1	624.0	000.1	000.1	Constant
34	Foolad	306.0	000.1	490.0	458.0	IRS
35	Kish	576.0	000.1	576.0	695.0	IRS
36	Bojnord	341.0	000.1	341.0	492.0	IRS
37	Birjand	499.0	000.1	499.0	632.0	IRS
38	Alborz	000.1	000.1	000.1	000.1	Constant
	Average	590.0	839.0	713.0	709.0	

Computing optimal amounts of inputs

Amounts of 3 variable inputs for the individual branches are shown in Table 4. Presenting and computing optimal inputs or targets are considered as the most important results of the DEA-based measuring version. For example, concerning the Branch 2 (Tabriz) as an inefficient unit, DEA method has determined 8 people as the optimal number of personnel, 259,031,000 Rials as the optimal rate of the operational costs and 745,532,000 Rials as the optimal rate of the non-operational costs.

Referring to the branches statistics, it can be seen that the current input average of these 3 variables in Tabriz branch are as follow: 14 participants as the number of personnel, 403,738,000 Rials as the rate of the operational costs and 1,162,019,000 Rials as the rate of the non-operational costs.

Hence it can be seen that the branch Tabriz, categorized

Table 2. Surplus of production factors with the varying returns to scale.

No.	Name of the branch	Number of the personnel	Operational costs (1000 Rials)	Non-operational costs (1000 Rials)
1	Tehran	000.0	000.0	000.0
2	Tabriz	745.0	000.0	000.0
3	Sari	000.0	000.0	000.0
4	Zanjan	365.0	000.0	000.0
5	Ardebil	294.1	578.118379	000.0
6	Ahvaz	000.0	000.0	000.0
7	Kermanshah	000.0	000.0	000.0
8	Qom	149.2	626.12947	000.0
9	Yazd	000.0	000.0	000.0
10	Buoshehr	000.0	000.0	000.0
11	Mashhad	588.0	882.538946	000.0
12	Tehran-karimkhan	000.0	871.417912	426.44752
13	Tehran-hafez	000.0	000.0	000.0
14	Arak	000.0	871.417912	231.89.69
15	Qazvin	000.0	000.0	000.0
16	Kerman	265.1	000.0	000.0
17	Bandarabas	000.0	000.0	000.
18	Zahedan	757.0	000.0	000.0
19	Semnan	017.0	000.0	000.0
20	Shahrkord	887.0	000.0	000.0
21	Yasuj	000.0	000.0	000.0
22	Rasht	000.0	000.0	370.19840
23	Gorgan	000.0	000.0	000.0
24	Hamedan	000.0	000.0	000.0
25	Oroumiyaeh	185.0	000.0	000.0
26	Khoramabad	618.0	000.0	000.0
27	Sanandaj	000.0	000.0	000.0
28	Eilam	000.0	000.0	000.0
29	Esfahan	000.0	000.0	000.0
30	Shiraz	000.0	000.0	000.0
31	Qaem karaj	563.0	000.0	000.0
32	Tehran-sanat	305.0	886.3520950	000.0
33	Tehran-bazar	000.0	000.0	000.0
34	Foolad	000.0	591.6803244	851.257249
35	Kish	000.0	000.0	000.0
36	Bojnord	000.0	000.0	000.0
37	Birjand	000.0	000.0	000.0
38	Alborz	000.0	000.0	000.0

into the inefficient branches, it cab obtain the same level of efficiency through less quantities of the production factors sources. According to the computations, this branch can reduce the number of the personnel to 8 people, the operational costs to 144,707,000 Rials, and the non-operational costs to 416,487,000 Rials. In the other words, the branch of Tabriz will be able to retain the same level of efficiency, reducing 42% of the number of the personnel, 35% of the operational costs, and 35% of the non-operational costs.

The bank management will be able to develop the branches and services all over the country through adopting appropriate strategies if regarding each inefficient branch enjoy almost the same quantities of extra sources. Clearly, collecting the sources obtained by the aforementioned reductions and thrifts (in employees and investment, as two main and basic parameters of productivity in every organization) results in a significant quantity of extra sources for any organization. Organizations can follow an ascendant course and lead to more

Table 3. Reference (pattern) units and their weight for inefficient units.

No.	Name of branch	Pattern and reference unit					Weight of reference unit				
1	Tehran	1					00.1				
2	Tabriz	33	7	13	29	21	130.0	342.0	024.0	061.0	443.0
3	Sari	38	13	21	29	35	180.0	065.0	212.0	039.0	014.0
4	Zanjan	38	13	7	29	33	222.0	021.0	283.0	030.0	444.0
5	Ardebil	29	13	21	28		120.0	018.0	760.0	210.0	
6	Ahvaz	13	21	33	35		87.0	742.0	113.0	058.0	
7	Kermanshah	7					000.1				
8	Qom	29	28				442.0	558.0			
9	Yazd	29	13	28	21	36	142.0	051.0	366.0	384.0	057.0
10	Boushehr	28	29	13	21	36	562.0	014.0	012.0	002.0	41.0
11	Mashhad	7	29	21			497	236.0	266.0		
12	Tehran-karimkhan	13	7	21			302.0	023.0	675.0		
13	Tehran-hafez	13					000.1				
14	Arak	29	13	21	35		134.0	024.0	663.0	179.0	
15	Qazvin	15					000.1				
16	Kerman	29	13	28	33	21	053.0	053.0	800.0	037.0	058.0
17	Bandarabas	17					000.1				
18	Zahedan	33	29	28			009.0	050.0	941.0		
19	Semnan	33	29	7	21		272.0	292.0	204.0	232.0	
20	Shahrkord	21	13	28			336.0	012.0	652.0		
21	Yasuj	21					000.1				
22	Rasht	13	38	7	33		089.0	040.0	039.0	832.0	
23	Gorgan	29	13	28	35		139.0	024.0	825.0	012.0	
24	Hamedan	38	13	33	35	29	159.0	120.0	698.0	014.0	008.0
25	Oroumiyaeh	38	33	7	13		641.0	314.0	033.0	12.0	
26	Khoramabad	33	13	28	29		393.0	108.0	452.0	047.0	
27	Sanandaj	27					000.0				
28	eilam	28					000.1				
29	Esfahan	29					000.1				
30	shiraz	33	29	13	28		594.0	348.0	014.0	042.0	
31	Qaem karaj	29	21	33	28		351.0	196.0	130.0	323.0	
32	Tehran-sanat	29	13	28	35		425.0	065.0	445.0	065.0	
33	Tehran-bazar	33					000.1				
34	Foolad	36	21	35			065.0	866.0	069.0		
35	Kish	35					000.0				
36	Bojnord	36					000.1				
37	Birjand	37					000.1				
38	Alborz	38					000.1				

efficiency through optimal use of the extra sources.

Formulating the branches ranking and grading

Branches ranking on the basis of efficiency

One of the most important findings and results of this study is to formulate ranking and grading version for branches. At present, banks rank and grade their own branches because of different reasons. For example, Eghtesad-e-novin Bank has divided the branches to four groups: superior, first degree, second degree, third degree. Also, Melli Bank has divided branches to the six groups: superior, very excellent, excellent, very good, good, and average. Of course, based on nature of work or type of activity, every bank has chosen a special method of ranking (as BSC or balanced score cards, econometrics, OR, EFQM, hierarchical analysis method, TOPSIS method, ELECTER method, and so on) although in our country there is not this process scientifically and incomplete and unscientific determinants are selected to

Table 4. Input targets for the bank branches.

No.	Name of the branch	Number of the personnel	Operational costs (1000 Rials)	Non-operational costs (1000 Rials)
1	Tehran	21	21841464	00070.2098110
2	Tabriz	237.8	929.259.31	696.745532
3	Sari	078.9	622.252458	015.0798160
4	Zanjan	597.0	359.182304	336.834014
5	Ardebil	941.6	123.214751	995.628640
6	Ahvaz	490.7	566.265686	077.739211
7	kermanshah	000.9	873.147835	000.829623
8	Qom	651.8	358.836384	731.855760
9	Yazd	543.7	810.463670	064.715589
10	Bushehr	154.6	961.247169	693.662656
11	mashhad	177.9	507.496094	305.867705
12	Tehran-karimkhan	557.8	042.589955	983.737118
13	Tehran-hafez	000.12	042.1588872	000.974588
14	Arak	611.7	363.382666	263.954043
15	Qazvin	000.8	307.568092	000.573706
16	Kerman	764.6	621.357927	401.6315333
17	bandarabas	000.7	210.50572	000.688358
18	Zahedan	317.6	682.291691	489.602319
19	Semnan	141.9	863.543780	585.851149
20	shahrkord	409.6	773.218391	142.593692
21	Yasuj	000.7	483.157484	000.627673
22	Rasht	597.8	913.175888	508.716115
23	Gorgan	979.6	421.448914	149.685431
24	Hamedan	281.9	807.257231	796.796191
25	oromiyaeh	285.11	479.170367	626.962179
26	khoramabad	715.7	201.357727	282.680451
27	Sanandaj	000.7	906.87487	000.618761
28	Eilam	000.6	749.224336	000.569116
29	Esfahan	000.12	063.1609663	000.1217916
30	Shiraz	362.9	762.606525	301.856887
31	Qaem karaj	562.8	469.671513	503.820641
32	Tehran-sanat	942.8	030.896592	304.961372
33	Tehran-bazar	000.8	978.23515	000.663652
34	Foolad	866.6	247.158523	463.728868
35	Kish	000.6	690.136979	000.1963961
36	Bojnord	000.6	109.195224	000.763572
37	Birjand	000.7	216.89299	000.642377
38	Alborz	000.13	138.216842	000.1115181

grade. Because DEA method computes and measures efficiency, formulating ranking system by the use of this method is more scientific and efficient than other present methods.

There is something that necessitates formulating system of branches ranking and grading, of the important results of this study, in Industrial and Mine Bank more than every other banks: there is no system of branches ranking and grading in Industrial and Mine Bank, at present. Thus, a system is suggested here to rank the bank branches in any time.

Ranking by the use of DEA in this study is so that the efficient branches are ranked in the first step. Although the software may introduce several branches as efficient and even pattern and reference ones, it does not mean that all the branches have the same efficiency ranks. In order to rank the efficient branches, a set of references are considered. As seen earlier, one or more branches are introduced as patterns for inefficient branches. Every unit which is introduced more frequently as the pattern unit for other inefficient branches obtains the first, second, ... and finally last rank of all the branches, respectively.

The method of ranking of efficient branches was mentioned. However, inefficient branches should also be ranked in order to determine 'the least efficient and productive' branches and finally to specify position of each branch in ranking. To rank inefficient branches, types of efficiency (management, scale, and technical) average are considered in the varying returns to scale. Each branch obtaining a higher efficiency average receives a higher degree too. Of course, inefficient branches are ranked after efficient ones.

According to the mechanism described earlier, degree of each 38 branches was assigned. In ranking, if two branches are introduced equally as patterns that branch enjoying a higher efficiency average receives a higher rank. Also, if two branches obtain equal efficiency averages, that branch enjoying increasing returns to scale receives a higher rank than the other enjoying constant returns to scale. Then, one enjoying constant returns to scale receives a higher rank than the other enjoying decreasing returns to scale. Finally, if two branches are equal in all the aforementioned items, they will receive the same rank.

Formulating branches grading system based on computed rank

Banks decide and act on the basis of ranks and degrees of branches. Hence, all the branches are motivated to promote to a higher degree so as to receive higher rewards and premiums. It is considered as one of the most important incentives and motivations to promote operation and efficiency and to create a safe competition between branches and personnel.

According to Table 5, branches of Esfahan and Tehran-Hafez are introduced as the first rank of 38 branches available. The efficiency average of the aforementioned branches is 100%. Also, their frequency as patter and reference branches for inefficient ones is 18. Then, branch of Yasouj obtained the second rank, enjoying efficiency average up to 38% and frequency of patterns and references up to 14 times. This process still continues to the last one.

The final step to formulate a ranking system refers to using assigned rank of each branch. Based on the last corresponding studies, this study suggests that all the branches be divided to the 6 levels, regarding the received ranks: superior, excellent, first degree, second degree, third degree, and fourth degree.

Therefore, regarding the earlier explanations and the results of the raking, the suggested six-level ranking of Industrial and Mine Bank all over the country is as follows:

(a) Superior branches: The branches introduced more than once as reference for other ones are categorized in this rank. Of the 38 branches available, the followings received the superior rank: Kermanshah, Tehran- Hafez, Yasouj, Ilam, Esfahan, Tehran- Bazar, Kish, Bojnourd, and Alborz.

Excellent branches: the branches introduced once as a pattern are categorized here.

(b) Of the 38 branches of Industrial and Mine Bank, the followings are considered as excellent branches: Tehran-Markazi, Qazvin, Bandarabbas, Sanandaj, and Birjand.

(c) First-degree branches: According to the suggested pattern, the branches which are not placed in the patterns group and whose (numeral) average of efficiency is computed as more than 90% are considered as the first-degree branches. Of the 38 branches of Industrial and Mine bank, Oroumiye was introduced as a first-degree branch.

(d) Second-degree branches: According to the suggested pattern, the branches which are not placed in the patterns group and whose (numeral) average of efficiency is computed as between 70 and 90% are considered as the second-degree branches. Of the 38 branches of Industrial and Mine bank, Sari, Zanjan, Ahvaz, Qom, Mashhad, Semnan, Hamedan and Shiraz are introduced as a second-degree branch.

(e) Third-degree branches: According to the suggested pattern, the branches which are not placed in the patterns group and whose (numeral) average of efficiency is computed as between 50 and 70% are considered as the third-degree branches. Out of the 38 branches of Industrial and Mine bank, Tabriz, Ardebil, Yazd, Tehran-Karimkhan, Arak, Zahedan, Shahre Kord, Rasht, Gorgan, Khoram Abad, Qaem karaj and Tehran-sanat are introduced as a third-degree branch.

f) Fourth-degree branches: According to the suggested pattern, the branches which are not placed in the patterns group and whose (numeral) average of efficiency is computed as less than 50% are considered as the fourth-degree branches. Out of the 38 branches of Industrial and Mine bank, Boushehr, Kerman and Foolad are introduced as a fourth-degree branch.

SUMMARY AND CONCLUSION

There are many methods to compute and evaluate efficiency and productivity. However, the method of data envelop analysis is considered more significantly because it envelops all data and statistics of units, it determines components of productivity, and computes efficiency in three forms of management, scale, and technical. This method estimates a production standard limit based on the operation of pattern institutions, using total information about the final products and all the effective factors and inputs used in the production process or servicing. On the support of linear programming method, the relative efficiency of other units is measured in a comparison to the production standard

Table 5. Efficiency ranking of the branches of Industrial and Mine Bank all over the country.

No.	Name of branch	Frequency as in reference group	Average efficiency	Rank and degree
1	Tehran	1	921.0	8
2	Tabriz	0	693.0	21
3	Sari	0	718.0	20
4	Zanjan	0	791.0	17
5	Ardebil	0	532.0	30
6	Ahvaz	0	728.0	18
7	Kermanshah	7	000.1	5
8	Qom	0	725.0	19
9	Yazd	0	631.0	25
10	Boushehr	0	487.0	34
11	Mashhad	0	799.0	16
12	Tehran-karimkhan	0	545.0	28
13	Tehran-hafez	18	000.1	1
14	Arak	0	564.0	27
15	Qazvin	1	277.0	12
16	Kerman	0	493.0	33
17	Bandarabas	1	671.0	9
18	Zahedan	0	509.0	32
19	Semnan	0	799.0	16
20	Shahrkord	0	543.0	29
21	Yasuj	14	888.0	2
22	Rasht	0	684.0	22
23	Gorgan	0	530.0	31
24	Hamedan	0	867.0	14
25	Oruomiyaeh	0	919.0	13
26	Khoramabad	0	648.0	24
27	Sanandaj	1	600.0	11
28	Eilam	12	452.0	4
29	Esfahan	18	000.1	1
30	Shiraz	0	820.0	15
31	Qaem karaj	0	662.0	23
32	Tehran-sanat	0	592.0	26
33	Tehran-bazar	13	000.1	3
34	Foolad	0	458.0	35
35	Kish	7	695.0	5
36	Bojnord	3	492.0	7
37	Birjand	1	632.0	10
38	Alborz	5	000.0	6

limit. Computing efficiency types and their average in the branches of Industrial and Mine Bank reveals that the organization enjoys a pretty good situation concerning technical and management efficiency. However, the scale efficiency is low. The organization's board of management can play a prominent role to increase efficiency for the organization in the following ways: adopting strategies to optimize investment and human sources, specializing sources optimally, improving quality of services, satisfying clients, and so on. Finally, the most important results of this paper is to use DEA method in rankings and to formulate branches grading system based on efficiency.

SUGGESTIONS

The first suggestion is related to the threefold type of efficiency and their average in the individual branches and in the total institution. As the results indicate, the scale, management, and technical efficiency are computed here as 0.590, 0.839, and 0.713, respectively. Thus, it can be concluded that Industrial and Mine Bank totally enjoys a good board of management all over the country. Its facilities, type of services, cost of activities and income and financial and non-financial determinants indicating the bank's technical efficiency situation enjoys a pretty good status. However; scale efficiency does not enjoy a good situation. That is, it is necessitated to establish new branches, to develop the branches physically and virtually and activities of the bank all over the country, and to develop mass of activities. Thus, it is suggested that, utilizing optimal and appropriate strategies, at first the bank managers improve scale efficiency so as to develop quantity of activities and physical quantity of branches. Then, they accomplish activities to improve technical and management efficiency. Management inefficiency can be eliminated by the following decisions: developing training courses for the managers, establishing a rewarding system based on the managers' merits, reviewing skillful personnel and managers retaining system, formulating employment system based on meritocracy, formulating the consistent research proposals, and so on. Also, technical inefficiency is related to the lack of optimal use of technical, technologic, and human sources. It is suggested that the organization management tries to improve these efficiencies so as to make decisions about specializing the sources optimally, improving the quality of services and clients' satisfaction.

Another suggestion is related to "type of returning to scale". One of the practical results of this study is to determine the individual branches' type of returns. The results indicate that among 38 branches of Industrial and Mine Bank, only one branch encounter decreasing return to scale and 5 branches have constant return to scale. In fact, most of the branches enjoy increasing return to scale (IRS), fortunately. It reveals the high potentials for the branches and total bank to improve efficiency and to develop quantity of activities increasingly. That is, injecting and specializing sources to these branches results in more outputs than to the branches encountering constant returns to scale, and more importantly, decreasing returns to scale (DRS). Thus, it is suggested that the banks' major management consider type of returns in the branches while specializing budgets and sources. This study suggests that these branches be given priority, if the organization is going to specialize some budget to the units to increase efficiency in the production factors as investment, new personnel, area, and constant properties and so on. Also, the organization can increase the quantity of activities and develop efficiency in the branches through more effective management and specializing optimal sources.

In order to promote the operation and to improve efficiency and productivity in the total organization, it is suggested that the organization emphasize the surplus factors of production, subtract some input variables computed as the surplus of production factors for 38 branches in this study as presented in Tables 4 to 5 from the related branches and conduct them to the branches with increasing returns to scale or creating new investments and units.

Another strategy is related to the reference groups and their subgroups that are recognized in this study as presented in Tables 2 to 5. Here, it is suggested that the results of the part introducing the pattern and reference branches and their subgroups be used and groups of the units, including reference and following units be related together. The branches which were recognized as pattern and reference for all the branches are placed at the head of the mentioned groups. The inefficient branches, subgroups of the pattern branches, make their subgroups too. Organizing these groups follows very helpful fruits for the organization. The subgroups always try to attain to the efficiency frontier through the continuous patterning of and contact with their own units. The coordinated working and encouraging decisions and actions are made for every group. Thus, the branches in every group will get more coordinated and united, there will be a more precise evaluation and examination, and the organization can have more control over its subgroup branches.

It is suggested that the bank management consider the results of ranking branches, presented in this study, and type of the ranking version in order to develop for other branches in the future, and make the branches group decisions based on their ranks and degrees. Regarding the different working nature of Industrial and Mine Bank due to specializing activities, it is finally suggested that another factors affecting efficiency be recognized as a research project by specializing necessary budget; optimal input and output variables be recognized by the sensitivity analysis and the use of OR professors' opinion; and a specific software for Industrial and Mine Bank be made so that the results of this study are extracted continuously for all the branches so as to accelerate improving productivity and efficiency of the bank through frequent persistent and continuous reforms.

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