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Bank branch operating efficiency: evaluation with data envelopment analysis

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C H R O N I C L E

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Measuring the relative efficiency of similar units has been a popular research especially when the units were mostly non-financial. Even, similar financial units may not be necessarily evaluated based on traditional financial figures such as return of equities, return of assets, etc. In this paper, we present an empirical investigation to measure the relative efficiency of 30 branches of an Iranian bank named Bank Mellat. The study considers four inputs including operating expenses, interest paid, capital expenditures and fixed assets. In addition, we use customers' bank deposit, commissions and loans paid as output parameters. Using three different data envelopment analyses, the study measures the relative efficiencies of all units. The preliminary results indicate that most banks were working under desirable level of efficiency.

1. Introduction

Studying the relative efficiency is one of the concerns in many financial companies such as insurances, banks, etc. (Soltanifar & Farhadi, 2014) Data envelopment analysis (DEA) has been one of the popular techniques for measuring the relative efficiency of similar units such as bank unites, schools, etc. The advantage of using DEA is that one may easily use the non-financial factors along with the financial numbers to caculate a suitable comparison of different units. DEA has become a popular technique because of simple application and interpretation (Charnes et al., 1978; Banker et al., 1984). During the past three decades, there have been many applications of DEA methods for calculating the relative efficiency of banks (Haslem et al., 1999; Mercan et al., 2003; Fallah et al., 2011). Yang et al. (2010) presented an integrated bank performance assessment and management planning by hybrid minimax reference point – DEA approach. Staub et al. (2010) investigated different factors impacting the relative efficiency of Brazilian banks such as costs and technical efficiencies. They reported that Brazilian banks had severly suffered from low levels of efficiency compared with European or North American banks. They reported that state-owned banks were more cost efficient than other foreign units. Nonetheless, they did not give any indication to claim that the differences in economic efficiency were because of the kind of activity and bank size.

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Avkiran (2010) investigated the relationship between the supper-efficiency estimations and some major key financial ratios for Chinese banking sector. The technique provided some opportunity to determine the inefficient units where there was a low correlation between the supper-efficiency and good financial ratios. Lin et al. (2009) applied various DEA models for 117 branches of a certain bank in Taiwan and reported an overall technical efficiency of 54.8 percent for all banks. They also explained that most branches had been relatively inefficient. Thoraneenitiyan and Avkiran (2009) investigated DEA and stochastic frontier analsysis (SFA) to measure the impact of restructuring and country-specific factors on the efficiency of post-crisis east Asian banking systems. They stated that banking system inefficiencies were primarlity due to country-specific conditions, such as high interest rates, concentrated markets and economic development. DEA was also implemented for banking decisions. For example, Che et al. (2010) applied a combination of Fuzzy analytical hierarchy procedure (AHP) and DEA as a decision making facility for making bank loan decisions.

2. The proposed study

The constant return to scale DEA (CCR) was initially proposed by Charnes, et al. (1978, 1994) as a mathematical technique for measuring the relative efficiency of decision making units (DMU). One can easily find out how a given DMU works whenever a production function is available.

$$\max Z_0 = \sum_{r=1}^{s} u_r y_{r0} \ ,$$

subject to

$$\begin{aligned} &\sum_{r=1}^{m} v_i x_{i0} = 1 \\ &\sum_{r=1}^{s} u_r y_{r0} - \sum_{r=1}^{m} v_i x_{i0} \le 0 \\ &(r=1,\cdots,s),(i=1,\cdots,m),(j=1,\cdots,n),u_r,v_i \ge 0 \end{aligned} \tag{1}$$

where x and y represent the input and output vectors, respectively. In addition, u and v are dual variables associated with input/outputs, respectively. The CCR production feasibility set border determines the relative efficiency in which any off-border DMU is considered as inefficient. The CCR model can be detected in two forms of either input or output oriented. The input CCR aims to decrease the maximum input level and can be represented as follows,

$$\max Z_0 = \sum_{r=1}^{s} u_r y_{r0} + W$$

subject to

$$\begin{aligned} &\sum_{r=1}^{m} v_i x_{i0} = 1 \\ &\sum_{r=1}^{s} u_r y_{r1} - \sum_{i=1}^{m} x_{ij} v_i + W \le 0 \\ &(r=1,\cdots,s),(i=1,\cdots,m),(j=1,\cdots,n),u_r,v_i \ge 0 \end{aligned} \tag{2}$$

The difference between Model (1) and Model (2) is associated with the free variable, *W*. When *W>0* The resturn to scale is in the form in deceasing, when *W=0* we have a constant return to scale model and finally when *W<0*, the return is to scale in increasing form. Finally, Model (3) demonstrates the maxmin model as follows,

$$\max Z_0 = M$$

subject to

$$\begin{aligned} &\sum_{r=1}^{m} v_i x_{i0} = 1 \\ &\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} x_{ij} v_i + d_j = 0 \\ &M - d_j \ge 0 \\ &(r=1,\cdots,s),(i=1,\cdots,m),(j=1,\cdots,n),u_r,v_i,d_j \ge 0 \end{aligned} \tag{3}$$

where *M* represents the deviation from the desirable value. One of the issues associated with DEA model is that we may receive more than one efficient unit and to rank the efficient units, Anderson Peterson model can be use.

3. Case study

In this paper, we use the proposed model explained in the previous section to measure the relative efficiency of 30 Iranian banks named Bank Mellat located in city of Tehran, Iran. The proposed DEA model of this paper considers 4 inputs including operating expenses, interest paid, capital expenditures and fixed assets. In addition, we use customers' bank deposit, commissions and loans paid as output parameters. Table 1 demonstrates the results of measuring the relative efficiency of 30 units based on the implementation of model 1 and model 2.

Table 1
The summary of the results of CCR and BCC models introduced in Model (1) and Model (2)

Unit	CCR	BCC	Unit	CCR	BCC
1	0.7576	0.8801	16	1	1
2	1	1	17	0.5137	0.6218
3	0.8603	1	18	1	1
4	1	1	19	0.7286	0.7301
5	1	1	20	1	1
6	1	1	21	1	1
7	1	1	22	0.7917	1
8	0.7627	1	23	0.969	1
9	1	1	24	1	1
10	0.5277	1	25	1	1
11	0.5245	0.8653	26	0.6438	0.6781
12	0.8196	1	27	0.892	0.8934
13	0.4683	1	28	1	1
14	1	1	29	0.7681	0.7912
15	1	1	30	1	1

As we can observe from the results of Table 1, most units are represented as efficient ones and the results somewhat confuses decision maker. Therefore, we use Model (3) to measure the efficiency of various units. Table 3 summarizes the results of our survey.

Table 3
The summary of measuring the relative efficiency of 30 units based on minmax model

Unit	MinMax model	Unit	MinMax model
1	0.6738	16	0.973
2	0.3082	17	0.2792
3	0.5184	18	1
4	0.68	19	0.4779
5	0.9889	20	0.4766
6	0.5144	21	0.7707
7	0.5503	22	0.2367
8	0.526	23	0.3953
9	0.4055	24	0.809
10	0.3008	25	0.7032
11	0.083	26	0.4747
12	0.149	27	0.6389
13	0.2225	28	0.4618
14	0.6217	29	0.3166
15	0.4783	30	0.9874

According to the results of Table 3, only one unit, unit 18, is considered to be efficient and the other units are stated as inefficient. The average efficiencies of model 1, 2 and 3 are 0.87, 0.95 and 0.53,

respectively. In order to have a better insight on the relative efficiency of efficient as well as inefficient units and comparing with the results of maxmin method we apply Anderson Peterson method (Andersen & Petersen 1993) and Table 4 summarizes the results of our investigation.

Table 4
The summary of Anderson Peterson method for measuring super efficiency

	Efficiency			Anderson Peterson		Rank		
Unit	CCR	BCC	MinMax	CCR	BCC	CCR	BCC	MinMax
1	0.7576	0.8801	0.6738	-	-	24	25	9
2	1	1	0.3082	1.01303	1.024	16	22	24
3	0.8603	1	0.5184	-	1.0091	19	23	14
4	1	1	0.68	1.25195	1.2519	11	15	8
5	1	1	0.9889	2.09521	2.5041	4	5	2
6	1	1	0.5144	2.58889	2.5888	2	2	15
7	1	1	0.5503	1.40698	1.4069	9	11	12
8	0.7627	1	0.526	-	1.0742	23	19	13
9	1	1	0.4055	1.05127	1.0529	15	21	21
10	0.5277	1	0.3008	-	2.5293	27	4	25
11	0.5245	0.8653	0.083	-	-	28	26	30
12	0.8196	1	0.149	-	1.5724	20	9	29
13	0.4683	1	0.2225	-	1.1036	30	18	28
14	1	1	0.6217	1.05842	1.2887	14	14	11
15	1	1	0.4783	1.1323	1.4061	13	12	16
16	1	1	0.973	1.4648	1.4648	8	10	4
17	0.5137	0.6218	0.2792	-	-	29	30	26
18	1	1	1	5.5751	5.57513	1	1	1
19	0.7286	0.7301	0.4779	-	-	25	28	17
20	1	1	0.4766	1.33303	1.333	10	13	18
21	1	1	0.7707	1.2292	1.2292	12	16	6
22	0.7917	1	0.2367	-	1.1377	21	17	27
23	0.969	1	0.3953	-	1.06891	17	20	22
24	1	1	0.809	1.59994	1.5999	6	8	5
25	1	1	0.7032	1.6411	1.641	5	7	7
26	0.6438	0.6781	0.4747	-	-	26	29	19
27	0.892	0.8934	0.6389	-	-	18	24	10
28	1	1	0.4618	1.57122	2.5712	7	3	20
29	0.7681	0.7912	0.3166	-	-	22	27	23
30	1	1	0.9874	2.35804	2.358	2	6	3

As we can observe from the results of Table 4, Anderson Peterson method (Andersen & Petersen, 1993; Anderson et al., 2011) yields the same results as the maxmin method.

4. Discussion and Conclusion

In this paper, we have presented an empirical investigation to study the performance of selected banks in city of Tehran, Iran. The proposed study has considered 4 inputs including operating expenses, interest paid, capital expenditures and fixed assets. In addition, the study has used customers' bank deposit, commissions and loans paid as output parameters. Using different DEA techniques, the study has measured the relative efficiency of various 30 branches. The results have indicated that most banks were operating well above the average. In addition, the implementation of minmax method has appeared to present better results in terms of super efficiency. The results of implementation of DEA techniques have been repeatedly used in other applications. Ehsani and Danaei (2014) applied a combination of DEA and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for ranking banks. In their survey, they first used CCR method to rank all different banks and then used TOPSIS technique to rank efficieny units. Shabani and Shams (2014) measured the performance of accepted investment companies in Tehran's stock exchange by value efficiency analysis, which is an extension of data envelopment analysis. Rahimian and Soltanifar

(2013) presented an application of DEA based Malmquist productivity index in university performance analysis.

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