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MEASURING OMAN BANKS EFFICIENCY: DEA METHOD

Faiza Bait Ali Suleiman[1], Veeramani V[2], Prathima Sudhir[3]

[1,2]Assistant Professor, University of Technology and Applied Sciences, Salalah
[3]Lecturer, University of Technology and Applied Sciences, Salalah

Abstract:
The paper aims to examine the performance and effectiveness of selected banks in Oman. The input data were collected from the banking websites for the financial period of 2018-2021. Data Envelopment Analysis Technique was used to measure the effectiveness of banking sector. The empirical finding provides a background for further studies in particular, the efficiency of Oman banks could be analysed in the extended time period. Furthermore, to maintain the surreptitious this analysis done without mentioning bank names and considered only data which are available in the open sources.

Keywords: DEA Analysis, Efficiency, Total Liabilities, Total Equity, Total Revenue, Net Income and Total Assets.

AMS Subject Classification: 49M25, 90C05, 90C08, 90C32

Introduction:
The non-parametric method, Data Envelopment Analysis (DEA) was introduced in late 1970's [1] for computing relative efficiencies for decision making. It is most popular effective analysis method now a days to evaluate efficiency performance and improvements in productivity for various sectors which combines all the input and output data in a single measure. The standard performance takes the range always calculated between 0 and 1.
Note that the system is highly efficient if the measure range is 1 and if measuring is tending to 0, then efficiency is considered as otherwise. The important feature of DEA is able to manage the multiple characteristics of any sector which use several inputs and outputs.
In DEA approach to trace and suggest the productivity of banks and determine their efficiency. The current paper seeks to measure the most popular banks in Oman to measure efficiency on similar units with the similar inputs based on the annual reports published from the respective bank's website and the input data to analysis the effectiveness was considered for the period 2018 to 2021. For this study, the required data of selected Seven Oman Banks based on the availability of reputed data have been taken from the official websites for the considered years.
In general, to evaluate the bank performance ratio analysis technique has been used for many years. But in this paper, DEA approach is implemented to investigate the efficiency for similar input or output as considering total revenue, net income, total assets, total liabilities and total equity.
The Charnes, Cooper and Rhodes model [2][3] was applicable to constant return scale which was categorized. We try to maximize the best possible efficiency by comparing to the banks. Considering the

situations, the efficiency for a bank is to determine with minimum inputs and maximizing the outputs with the consider situations.
In this article, reviewing the literature on the application of DEA, different studies have used different combination of inputs and outputs. For the current study, the researcher considered two input variables as total liabilities and total equity and three output variables Total revenue, net income and total assets to have an elaborate study.

Research Methodology:

Fractional Programming Problem [FPP]

Let there be “N” decision making unit’s (DMU’s) whose efficiencies have to be compared. Let us take one of the DMU’s, say the mth DMU, and maximize its efficiency according to the formula given below.

The mathematical model for the same can be given as

$$Max\ E_m = \frac{\sum_{j=1}^{J} v_{jm}\, y_{jm}}{\sum_{i=1}^{I} u_{im}\, x_{im}}$$

Subject to

$$\frac{\sum_{j=1}^{J} v_{jn}\, y_{jn}}{\sum_{i=1}^{I} u_{in}\, x_{in}} \leq 1; n = 1,2, \dots, m, m+1, .., N$$

$$v_{jm}, u_{im} \geq 0; i = 1,2, \dots, K, K+1, \dots, I; j = 1,2, \dots, K, K+1, \dots, J$$

$$n = 1,2, \dots N$$

General Form of Constant Return to Scale [CRS] Model:

The general form Output Maximization DEA [CRS] model [5][6][7][8] can be exemplified in the form of FPP Model as follows:

Here the general model is constructed to maximize the efficiency of the qth output variable:

$$Max\ \ E_q = \frac{\sum_{j=1}^{m} v_{jq} y_{jq}}{\sum_{i=1}^{s} u_{iq} x_{iq}}$$

Subject to the constraints

$$\frac{\sum_{j=1}^{m} v_{jq} y_{jq}}{\sum_{i=1}^{s} u_{iq} x_{iq}} \leq 1; q = 1,2, \dots, n$$

$$v_{jq}, y_{jq}, u_{iq}, x_{iq} \geq 0, for\ all\ i = 1,2, .. s; j = 1,2, .. m;\ q = 1,2, \dots n$$

Solving this FP Problem directly is so tedious; so, the FP model is changed into regular Linear Programming [LP] model as described below:

$$Max\ \ E_q = \sum_{j=1}^{m} v_{jq} y_{jq}$$

subject to the constraints

$$\sum_{i=1}^{s} u_{iq} x_{iq} = 1$$

$$\sum_{j=1}^{m} v_{jq} y_{jq} - \sum_{i=1}^{s} u_{iq} x_{iq} \leq 0 ; \quad q = 1,2, \dots n$$

$$v_{jq}, y_{jq}, u_{iq}, x_{iq} \geq 0, \ \ for\ all\ i = 1,2,..s; j = 1,2,..m;\ q = 1,2, \dots n$$

General form of Variable Return to Scale [VRS] Model:

The DEA envelopment program for considering VRS model [5][6][7][8] as follows:

$$Min\ \theta_m$$

Subject to the Constraints

$$Y\lambda \ \geq \ Y_m;$$

$$X\,\lambda \ \leq \ \theta X_m$$

$$\sum_{n=1}^{N} \lambda_n = \ 1;$$

$$\lambda \geq \ 0; \quad \theta_m\ free\ variable$$

Algorithm: [4]

Step 1: Select the Decision-Making Units (Industry) [DMUs]

Step 2: Select the Output and Input Variables for the DMUs

Step 3: Collect the Data for the selected variables.

Step 4: Check whether all the variables are correlated with each other.

Step 5: Create the Mathematical Model for CRS & VRS

An Example Problem for CRS Model:

Fractional Programming Model

In order to explain the mathematical modeling aspect, an example model is depicted based on the Oman bank data for the period 2021.

$$Max\ E_{BKA} = \frac{663.48x_1 + 189.62x_2 + 13072.54x_3}{10921.69x_4 + 2150.84x_5}$$

subject to constraints

$$\frac{663.48x_1 + 189.62x_2 + 13072.54x_3}{10921.69x_4 + 2150.84x_5} \leq 1$$

$$\frac{233.2x_1 + 25.12x_2 + 4438.79x_3}{3740.27x_4 + 698.52x_5} \leq 1$$

$$\frac{207.09x_1 + 30.28x_2 + 4081.07x_3}{3525.61x_4 + 555.46x_5} \leq 1$$

$$\frac{181.11x_1 + 28.34x_2 + 4133.98x_3}{3537.41x_4 + 596.58x_5} \leq 1$$

$$\frac{86.37x_1 + 18.33x_2 + 2349.25x_3}{2003.76x_4 + 345.49x_5} \leq 1$$

$$\frac{80.59x_1 + 12.53x_2 + 1404.82x_3}{1164.98x_4 + 239.84x_5} \leq 1$$
$$\frac{159.13x_1 + 27.61x_2 + 3052.56x_3}{2625.56x_4 + 427x_5} \leq 1$$
$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

For evaluation purpose, the fractional programming problem is converted into an equivalent linear programming model.

The corresponding LPP structure is as follow us

$$MaxE_{BKA} = 663.48x_1 + 189.62x_2 + 13072.54x_3$$

Subject to constraints

$$10921.69x_4 + 2150.84x_5 = 1$$
$$663.48x_1 + 189.62x_2 + 13072.54x_3 - 10921.69x_4 - 2150.84x_5 \leq 0$$
$$233.2x_1 + 25.12x_2 + 4438.79x_3 - 3740.27x_4 - 698.52x_5 \leq 0$$
$$207.09x_1 + 30.28x_2 + 4081.07x_3 - 3525.61x_4 - 555.46x_5 \leq 0$$
$$181.11x_1 + 28.34x_2 + 4133.98x_3 - 3537.41x_4 - 596.58x_5 \leq 0$$
$$86.37x_1 + 18.33x_2 + 2349.25x_3 - 2003.76x_4 - 345.49x_5 \leq 0$$
$$80.59x_1 + 12.53x_2 + 1404.82x_3 - 1164.98x_4 - 239.84x_5 \leq 0$$
$$159.13x_1 + 27.61x_2 + 3052.56x_3 - 2625.56x_4 - 427x_5 \leq 0$$
$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

In the similar way, the researcher constructed 27 more mathematical models for CRS Model.

An Example Problem for VRS Model:

$$Min\ Z_{BKA} = x_8 - x_9$$

Subject to constraints

$$663.48x_1 + 233.2x_2 + 207.09x_3 + 181.11x_4 + 86.37x_5 + 80.59x_6 + 159.13x_7 \geq 663.48$$
$$189.62x_1 + 25.12x_2 + 30.28x_3 + 28.34x_4 + 18.33x_5 + 12.53x_6 + 27.61x_7 \geq 189.62$$
$$13072.54x_1 + 4438.79x_2 + 4081.07x_3 + 4133.98x_4 + 2349.25x_5 + 1404.82x_6 + 3052.56x_7 \geq 13072.54$$
$$10921.69x_1 + 3740.27x_2 + 3525.61x_3 + 3537.41x_4 + 2003.76x_5 + 1164.98x_6 + 2625.56x_7 - 10921.69x_8 + 10921.69x_9 \leq 0$$
$$2150.84x_1 + 698.52x_2 + 555.46x_3 + 596.58x_4 + 345.49x_5 + 239.84x_6 + 427x_7 - 2150.84x_8 + 2150.84x_9 \leq 0$$
$$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 = 1$$
$$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9 \geq 0$$

In the similar way, the researcher constructed 27 more mathematical models for CRS Model.

EMPIRICAL RESULTS:

A. The table 4.1 gives the details that the DEA efficiency rating under CRS model, which strongly communicates three banks in Oman has a maximum efficiency score 1 for efficient based on the input oriented in this CRS method for the year 2018-2021 for efficient based input oriented technical efficiency. It has been noted that the banks mean of technical efficiency of Oman banks from 2018 to 2021, is lies between (0.731, 1) out of 7, the remaining another three banks are close to 1 (approximately) that shows very good efficiency based on the given input data.

Table 4.1 shows that, according to the CRS Model, three of the seven banks chosen for the study obtained the highest efficiency score of 1.

Table 4.1: Constant return to scale–efficiency table

Sl. No.	Name of the Bank	2021	2020	2019	2018	Mean	Rank
1	Bank A	1.000	1.000	1.000	1.000	1.000	1
2	Bank B	1.000	1.000	1.000	1.000	1.000	1
3	Bank C	1.000	0.860	0.940	0.965	0.941	2
4	Bank D	0.886	0.730	1.000	1.000	0.904	4
5	Bank E	0.633	0.620	0.797	0.873	0.731	5
6	Bank F	1.000	0.949	0.777	1.000	0.932	3
7	Bank G	1.000	1.000	1.000	1.000	1.000	1

B. The table 4.2 elaborate us by VRS model, the DEA efficiency score-based output oriented technical efficiency. In this analysis, the report states with the very strong note that 4 of the banks out of 7 attained maximum efficiency score 1 for the year 2018-2021. Also, the mean interval for technical efficiency is raised and lies between (0.879, 1) for the stated period.

According to Table 4.2, four of the seven banks chosen for the study obtained the highest efficiency score of 1.

Table 4.2. Variable return to scale–efficiency table

Sl. No.	Name of the Bank	2021	2020	2019	2018	Mean	Rank
1	Bank A	1.000	1.000	1.000	1.000	1.000	1
2	Bank B	1.000	1.000	1.000	1.000	1.000	1
3	Bank C	1.000	0.866	0.967	1.000	0.958	2
4	Bank D	0.934	0.745	1.000	1.000	0.920	3
5	Bank E	0.842	0.672	1.000	1.000	0.879	4
6	Bank F	1.000	1.000	1.000	1.000	1.000	1
7	Bank G	1.000	1.000	1.000	1.000	1.000	1

C. **Overall mean efficiency:** Three banks, namely Bank A, Bank B, and Bank G are very consistent with the efficiency score of 1 and rank top, and the remaining banks overall all averages are approximately 1 as shown in Table 4.3.

Table 4.3. Overall mean efficiency

Sl. No.	Name of the Bank	CRS Mean Efficient	VRS Mean Efficient	Overall Mean	Rank
1	Bank A	1.000	1.000	1.000	1
2	Bank B	1.000	1.000	1.000	1
3	Bank C	0.941	0.958	0.950	3
4	Bank D	0.904	0.920	0.912	4
5	Bank E	0.731	0.879	0.805	5
6	Bank F	0.932	1.000	0.966	2
7	Bank G	1.000	1.000	1.000	1

5. Conclusion

The analysis based on Constant Returns to Scale reveals that three banks Bank A, Bank B and Bank G are first, while the analysis based on Variable Return to Scale reveals that four banks Bank A, Bank B, Bank F and Bank G. By comparing the two analyses, it is possible to infer that Bank A, Bank B and Bank G are performing very well.

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