Integrated DEA and Promethee II Method to Measure Efficiency and Complete Ranking of Islamic Banks in Malaysia

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Introduction

Data Envelopment Analysis (DEA) approach is a method of assessing efficiency and defining sources and estimating input and output inefficiencies. One of the strengths in DEA is its ability to handle multiple inputs and outputs. It can also identify the best practices among the Decision Making Units (DMUs). The method has been applied extensively in many industries such as insurance, health, education, and banking. However, DEA has some drawbacks and one of them is poor discrimination power where many DMUs are reckoned as efficient units. Standard DEA cannot rank efficient units, hence cannot provide complete ranking of the DMUs. In many situations, fully ranking of DMUs is necessary and important to decision makers. Therefore, a method is required to further discriminate among the efficient units. Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE II) is a Multi-Attribute Decision Making method which is based on a common comparison of each different pair with respect to each of the particular criteria. This paper overcomes the ranking problem identified in DEA and achieves fully ranking of the DMUs under study by integrating DEA and PROMETHEE II. The hybrid method was applied to evaluate the efficiency and ranking of 13 Islamic banks in Malaysia from 2017 to 2019.

Methodology

The data of the inputs and outputs were obtained from the banks' respective annual reports. The model of this study contained three inputs and three outputs. The inputs chosen were deposits, non-interest expenses and interest expenses while the outputs were total loans, non-interest income and interest income. This method involved two stages.

Stage 1: Obtain efficiency scores

In the first stage, DEA was applied to compute efficiency scores for the DMUs.

The DEA-CCR model with input orientation was chosen. The formulation is

$$Max \sum_{j=1}^{3} b_{jm} y_{jm} \qquad (1)$$

Subject to:

$$\sum_{i=1}^{3} a_{im} x_{im} = 1$$

$$\sum_{j=1}^{3} b_{jm} y_{jn} - \sum_{i=1}^{3} a_{im} x_{in} \leq 0 \ ; n = 1, 2, ..13$$

$$b_{jm}, a_{im} \geq 0 \ ; i = 1, 2, 3 \ ; j = 1, 2, 3$$

Phase 2: Obtain Complete Ranking

According to the study of Brans and Vincke (1985), Geldermann, Spengler, and Rentz (2001), there are 7 basic stages in PROMETHEE II. The steps are as follows:

Step 1: Construct the decision matrix.

Step 2: Normalize the decision matrix by using equation (2) and (3) for beneficial criteria and non-beneficial criteria, respectively.

$$R_{ij} = \frac{[\,X_{ij} - (X_{ij})\,]}{[(X_{ij}) - (X_{ij})\,]} \tag{2}$$

$$R_{ij} = \frac{[\,max(X_{ij}) - X_{ij}\,]}{[(X_{ij}) - (X_{ij})\,]} \tag{3}$$

Where $i = 1,2,\ldots,m$ and $j = 1,2,\ldots,n$

Step 3: Calculate the evaluative differences of i^{th} alternative with respect to another alternative, $d_j(a,b)$ by using equation (4).

$$d_j(a,b) = g_j(a) - g_j(b) \tag{4}$$

Step 4: Calculate the preference function, $P_j(a,b)$ using

$$P_j(a,b) = 0 \text{ if } R_{aj} \le R_{bj} \text{ such that } D(M_a - M_b) \le 0$$

$$P_j(a,b) = R_{aj} - R_{bj} \text{ if } R_{aj} > R_{bj} \text{ such that } D(M_a - M_b) > 0 \tag{5}$$

Step 5: Calculate the aggregated preference, $\pi(a,b)$ by using

$$\pi(a,b) = \frac{\sum_{j=1}^{n} W_j P_j(a,b)}{\sum_{j=1}^{n} W_j} \quad \text{where } \sum_{j=1}^{n} W_j = 1 \tag{6}$$

Given that $\sum_{j=1}^{n} W_j$ is the sum of the weight for criteria.

Step 6: Determine the leaving and the entering outranking flow using equation (7) and (8) respectively.

Leaving (positive) flow for a^{th} alternative,

$$\varphi^{+}(a) = \frac{1}{m-1} \sum_{b=1}^{m} \pi(a,b) \quad \text{where } (a \ne b) \tag{7}$$

Entering (negative) flow for a^{th} alternative,

$$\varphi^{-}(a) = \frac{1}{m-1} \sum_{b=1}^{m} \pi(b,a) \quad \text{where } (a \ne b) \tag{8}$$

Step 7: Calculate the net outranking flow for each alternative using equation (9).

$$\varphi(a) = \varphi^{+}(a) - \varphi^{-}(a) \qquad (9)$$

Note that PROMETHEE II determines its outranking relationship based on net-flow with two rules: (1) a outranks b if and only if $\varphi(a) > \varphi(b)$; (2) a is moderate to b if and only if $\varphi(a) = \varphi(b)$. In this method, PROMETHEE II develops a complete outranking relationship so that it is possible to obtain a complete ranking of alternatives.

Results and Discussions

Comparison of rankings obtained via DEA and proposed hybrid DEA PROMETHEE II is shown in Table 1.

Table 1: Comparison of rankings of DMUs obtained using DEA and proposed hybrid DEA PROMETHEE II

DMU	2017		2018		2019	
	Classical DEA	DEA and PROMETHEE II	Classical DEA	DEA and PROMETHEE II	Classical DEA	DEA and PROMETHEE II
DMU1	1	9	1	7	1	8
DMU2	1	4	1	8	12	12
DMU3	1	5	1	4	1	3
DMU4	1	6	1	5	1	4
DMU5	1	2	1	2	1	2
DMU6	10	10	11	11	10	10
DMU7	1	8	1	6	1	7
DMU8	11	11	12	12	11	11
DMU9	13	13	13	13	13	13
DMU10	12	12	9	9	9	9
DMU11	1	7	10	10	1	6
DMU12	1	1	1	1	1	1
DMU13	1	3	1	3	1	5

The results showed that there were 9 efficient banks in 2017, 8 efficient banks in 2018 and 2019. This hybrid method proposed in this paper has successfully ranked the efficient units. The study also revealed that DMU12 was the best performing unit compared to others because it was found consistently efficient and obtained the highest ranking across all three years (2017-2019). Other banks must learn strategies and practices from DMU12 to improve their performance in order to be efficient.

Conclusion

The paper has shown that the hybrid DEA-PROMETHEE II was able to provide complete ranking of the DMUs under study. By using this method, the management of the banks can use the efficiency and ranking results to keep track of its performance and also the rivals' performances so they can make a decision on how to improve their performance. The same method can be applied in other sector like insurances, education and others.

References

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