Efficiency evaluation of the branches of Parsian Bank financing perspective by using data envelopment analysis

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Abstract

DEA (data envelopment analysis) is a non-parametric technique for measuring and evaluating the relative efficiencies of a set of entities with common crisp inputs and outputs. In fact, in a real evaluation problem input and output data of entities evaluated often fluctuate. These fluctuating data can be represented as linguistic variables characterized by fuzzy numbers for reflecting a kind of general feeling or experience of experts. Based on the fundamental CCR model, a fuzzy DEA model is proposed to deal with the efficiency evaluation problem with the given fuzzy input and output data. Using the proposed fuzzy DEA models, Due to evaluate Parsian-bank branches in Tehran district using.

Keywords: Data envelopment analysis (DEA); Fuzzy DEA; Evaluation of bank Parsian.

1 Introduction

Data envelopment analysis (DEA) initially proposed by charnes et al. [3] is a non-parametric technique for measuring and evaluating the relative efficiencies of a set of entities, called decision-making units (DMUs), with the common inputs and outputs. Examples include school, hospital, library and, more recently. Whole economic and society system, in which output and inputs are always multiple in character. Most of DEA papers make an assumption that input and output data are crisp ones without any variation [2, 11]. In fact, inputs and outputs of DMUs are ever-changeful. For example, for evaluating operation efficiencies of airlines, set-kilometers available, cargo –kilometers available, fuel and labor are regarded as the inputs and passenger-kilometers performed as the output [5]. It is common sense that these input and output are easy to change because of weather, season, operating state and so on. Because DEA is a 'boundary' method sensitive to outliers, it is very difficult to evaluate the efficiency of DMU with varying inputs and outputs by conventional.

Some researchers have proposed several models to challenge how to deal with the variation of data in efficiency evaluation problem by stochastic frontier models [1, 7, 10]. On the other hand, in more general cases, the data for evaluation are often collected from investigation by polling where the natural language
such a good, medium and bad are used to reflect a kind general situation of the investigated entities rather than a specific case [8, 9]. In the above example, the expert can make a general conclusion that airline A’s passenger–kilometer is about 200 passenger–kilometers and fuel cost is high based on his rich experience. These fuzzy concepts are used to summarize the general situation of inputs and outputs and reflects the ambiguity of the expert’s judgment. The center of a fuzzy number represents the most general case and the spread reflects some possibilities.

In this paper, fuzzy DEA (FDEA) model is proposed for evaluating of Parsian-bank branches in Tehran’s north. In this work, we used fuzzy DMU with the given fuzzy input and output data.

2 Data envelopment analysis and fuzzy Data envelopment analysis

2.1. DEA model

CCR model is a liner programming (LP)-based method proposed by Charnes et al. [3]. In CCR model the efficiency of entity evaluated is obtained as a ratio of the weighted output to the weighted input subject to the condition that the ratio for every entity is not larger than 1. Mathematically, it is described as follows:

$$\max_{\mu, v} \frac{\mu' y}{\mu' x}$$

s.t. $$\frac{\mu' y_j}{v' x_j} \leq 1 \quad (j = 1, ..., n)$$

$$\mu \geq 0$$

$$v \geq 0$$

(2.1)

2.2. FDEA model

A fuzzy set $A$ defined on the n-dimensional space is called an n-dimensional fuzzy vector, denoted as $A = [A_1, ..., A_n]$ For simplicity, the symmetrical triangular fuzzy vector is considered in this paper where its element $A_j$ is characterized by a symmetric triangular membership function as follows:

$$h_{A_j}(z_j) = \begin{cases} 1 & \text{if } c_j - a_j \leq z_j < a_j + c_j \\ 0 & \text{Otherwise} \end{cases}$$

and its membership function is defined as follows

$$h_A(z) = h_{A_1}(z_1) \land h_{A_2}(z_2) \land ... \land h_{A_n}(z_n),$$

Where $a_j$ and $c_j$ are the center and the spread of $A_j$, respectively, and $z = [z_1, ..., z_n]$.

A can be simply denoted by its center vector as $A = (a, c)$ where $a = [a_1, ..., a_n]$ and $c = [c_1, ..., c_n]$.

Given a symmetrical triangular fuzzy vector $A = (a, c)$, according to the extension principle a fuzzy linear system.

$$Y = A_1 X_1 + ... + A_n X_n,$$

Can be represented as a symmetrical triangular fuzzy variables follows:

$$Y = (x' a, x' c),$$

where $x' = [x_1, ..., x_n]$

2.3. FDEA model based on CCR model

Considering fuzzy input and output data, CCR model (2.1) can be naturally extended to be the following fuzzy DEA model. CCR model with fuzzy data can be regarded as follows where "$\sim$" refers to the phase of the data.
Max: \( \theta = \frac{\sum_{j=1}^{n} u_{rj}y_{r0}}{\sum_{i=1}^{m} v_{ij}x_{i0}} \)

s.t: \( \frac{\sum_{j=1}^{n} u_{rj}y_{rj}}{\sum_{i=1}^{m} v_{ij}x_{ij}} \leq 1, \quad j = 1,2,...,n, \)
\( u_r, v_i \geq 0. \)  \hspace{1cm} (2.2)

If \( y_{rj}, x_{rj} \) be two fuzzy numbers, then by definition for \( \alpha \in (0,1) \) cutting the numbers can be generally represented as follows
\[ [y_{rj}^{\alpha L}, y_{rj}^{\alpha R}] - [x_{ij}^{\alpha L}, x_{ij}^{\alpha R}] \]

This definition refers to the lower bound \( L \) and \( R \) refers to the upper bound. Doubt and uncertainty under the following pair by Zadeh [12] as well as many other researchers to determine the lower and upper bounds suggested performance, the first to get high to get the upper bound \( DMU_0 \) per \( \alpha \in (0,1) \) best \( DMU_0 \) (the highest output and lowest input) against the worst conditions other \( DMU \) (the lowest and highest input output respectively) are evaluated [8]

Max: \( \theta^{R}_0 = \frac{\sum_{j=1}^{n} u_{rj}y_{r0}^{\alpha R}}{\sum_{i=1}^{m} v_{ij}x_{i0}^{\alpha L}} \)

s.t: \( \frac{\sum_{j=1}^{n} u_{rj}y_{rj}^{\alpha R}}{\sum_{i=1}^{m} v_{ij}x_{ij}^{\alpha L}} \leq 1, \quad j = 1,2,...,n; \quad j \neq 0, \quad u_r, v_i \geq 0 \) \hspace{1cm} (2.3)

In the second model to get the lower bound for \( DMU_0 \) performance for a \( \alpha \in (0,1) \) the worst in front of other \( DMU \)'s best will be evaluated.

Max: \( \theta^{L}_0 = \frac{\sum_{j=1}^{n} u_{rj}y_{r0}^{\alpha L}}{\sum_{i=1}^{m} v_{ij}x_{i0}^{\alpha R}} \)

s.t: \( \frac{\sum_{j=1}^{n} u_{rj}y_{rj}^{\alpha L}}{\sum_{i=1}^{m} v_{ij}x_{ij}^{\alpha R}} \leq 1, \quad j = 1,2,...,n; \quad j \neq 0, \quad u_r, v_i \geq 0 \) \hspace{1cm} (2.4)

The accuracy of the models (2.3) and (2.4) for the upper and lower bounds of efficiency, it is clear that the restrictions set used to measure the performance of each \( DMU \) with the rest of them is different. The major drawback of using different constraints on the assessment of the impossibility of comparing the efficiency of \( DMU \) is because in the process of measuring the efficiency of production lines have adopted different.

To avoid such problems and avoid the production of different borders in evaluating the performance of \( DMU \), now a new pair of model range by [8] suggested, offered. Upper and lower bounds for measuring performance \( DMU_0 \), pair programming model is proposed deficit below [8].

Max: \( \theta^{R}_0 = \frac{\sum_{j=1}^{n} u_{rj}y_{rj}^{\alpha R}}{\sum_{i=1}^{m} v_{ij}x_{ij}^{\alpha L}} \)

s.t: \( \frac{\sum_{j=1}^{n} u_{rj}y_{rj}^{\alpha R}}{\sum_{i=1}^{m} v_{ij}x_{ij}^{\alpha L}} \leq 1, j = 1,2,...,n, \)
\( u_r, v_i \geq 0 \) \hspace{1cm} (2.5)

and
\[ \text{Max: } \theta_0^L = \frac{\sum_{r=1}^{s} u_r y_{r0}^L}{\sum_{i=1}^{m} v_i x_{i0}^L} \]
\[ \text{s.t: } \frac{\sum_{r=1}^{s} u_r y_{rj}^R}{\sum_{i=1}^{m} v_i x_{ij}^L} \leq 1, j = 1, 2, \ldots, n, \]
\[ u_r, v_i \geq 0 \]  

(2.6)

Now using a Charnes-Cooper pair is above the planned deficit can be turned to the following linear programming problem.

\[ \text{Max: } \theta_0^R = \sum_{r=1}^{s} u_r y_{r0}^R \]
\[ \text{s.t: } \sum_{i=1}^{m} v_i x_{i0}^L = 1, \]
\[ \sum_{r=1}^{s} u_r y_{rj}^R - \sum_{i=1}^{m} v_i x_{ij}^L \leq 0 \]
\[ j=1, \ldots, n \]
\[ u_r, v_i \geq 0 \]  

(2.7)

\[ \text{Max: } \theta_0^L = \sum_{r=1}^{s} u_r y_{r0}^L \]
\[ \text{s.t: } \sum_{i=1}^{m} v_i x_{i0}^R = 1, \]
\[ \sum_{r=1}^{s} u_r y_{rj}^L - \sum_{i=1}^{m} v_i x_{ij}^L \leq 0 \]
\[ j=1, \ldots, n \]
\[ u_r, v_i \geq 0 \]  

(2.8)

\[ \text{Definition 2.1. Let } \bar{U} = (u^L, u^M, u^R) \text{ and } \bar{V} = (v^L, v^M, v^R) \text{ be two fuzzy numbers. We define that} \]
\[ R(\bar{U}) = \frac{u^L + 2u^M + u^R}{4}. \]

Therefore we have [6]:
1. \( \bar{U} \approx \bar{V} \iff R(\bar{U}) = R(\bar{V}). \)
2. \( \bar{U} < \bar{V} \iff R(\bar{U}) < R(\bar{V}). \)
3. \( \bar{U} > \bar{V} \iff R(\bar{U}) > R(\bar{V}). \)

3 Evaluation of bank branches Parsian

In this paper, to evaluate the input and output of the following bank branches of use:

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Personnel cost</td>
<td>1. Mach deposit</td>
</tr>
<tr>
<td>2. Administrative expenses and depreciation</td>
<td>2. Short-term deposits</td>
</tr>
<tr>
<td>3. Non-current receivables</td>
<td>3. Long-term dep</td>
</tr>
</tbody>
</table>

All inputs and outputs are of this work are fuzzy numbers. By using Tora software, with the above inputs and outputs, we obtain the following conclusions for sample banks:
Table 1: Output table with Tora Software.

<table>
<thead>
<tr>
<th>Bank (Code)</th>
<th>L</th>
<th>M</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1003</td>
<td>0/48</td>
<td>0/56</td>
<td>0/68</td>
</tr>
<tr>
<td>1009</td>
<td>0/59</td>
<td>0/63</td>
<td>0/78</td>
</tr>
<tr>
<td>1012</td>
<td>0/49</td>
<td>0/52</td>
<td>0/64</td>
</tr>
<tr>
<td>1015</td>
<td>0/67</td>
<td>0/72</td>
<td>0/89</td>
</tr>
<tr>
<td>1016</td>
<td>0/62</td>
<td>0/66</td>
<td>0/81</td>
</tr>
<tr>
<td>1024</td>
<td>0/76</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1026</td>
<td>0/51</td>
<td>0/55</td>
<td>0/68</td>
</tr>
<tr>
<td>1030</td>
<td>0/73</td>
<td>0/77</td>
<td>1</td>
</tr>
<tr>
<td>1034</td>
<td>0/54</td>
<td>0/48</td>
<td>0/59</td>
</tr>
<tr>
<td>1048</td>
<td>0/59</td>
<td>0/63</td>
<td>0/78</td>
</tr>
<tr>
<td>1049</td>
<td>0/67</td>
<td>0/71</td>
<td>0/88</td>
</tr>
<tr>
<td>1057</td>
<td>0/37</td>
<td>0/39</td>
<td>0/97</td>
</tr>
<tr>
<td>1060</td>
<td>0/77</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1075</td>
<td>0/62</td>
<td>0/66</td>
<td>0/82</td>
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<tr>
<td>1077</td>
<td>0/68</td>
<td>0/73</td>
<td>0/90</td>
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<tr>
<td>1089</td>
<td>0/72</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1098</td>
<td>0/43</td>
<td>0/46</td>
<td>0/57</td>
</tr>
<tr>
<td>1201</td>
<td>0/57</td>
<td>0/61</td>
<td>0/76</td>
</tr>
<tr>
<td>1211</td>
<td>0/71</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1248</td>
<td>0/76</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1252</td>
<td>0/74</td>
<td>0/81</td>
<td>1</td>
</tr>
<tr>
<td>1253</td>
<td>0/55</td>
<td>0/59</td>
<td>0/73</td>
</tr>
<tr>
<td>1256</td>
<td>0/45</td>
<td>0/48</td>
<td>0/59</td>
</tr>
</tbody>
</table>

The result of Table 1 shows that banks (code) 1024, 1030, 1060, 1089, 1211, 1248 and 1252 are efficient and another banks are not efficient. By means of definition 2.1, for efficiencies banks, we have \( R(1024) = 0.845 \), \( R(1030) = 0.8175 \), \( R(1060) = 0.8475 \), \( R(1089) = 0.835 \), \( R(1211) = 0.8325 \), \( R(1248) = 0.845 \) and \( R(1252) = 0.84 \).

5 Conclusion

In this paper, we used three inputs and three output for this study. Then, we compare twenty three bank branches of Parsian. In this work eight branch’s be efficient and another branches be not efficient. In this work we used FDEA model for evaluation these branches and in the end we obtain rank for efficient branches.

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