APPLICATION OF STEPWISE DATA ENVELOPMENT ANALYSIS AND GREY INCIDENCE ANALYSIS TO EVALUATE THE EFFECTIVENESS OF EXPORT PROMOTION PROGRAMS

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Abstract. Export promotion programs are incentives to increase the participation of companies in international markets. On the other hand, governments try to help exporting companies with developing their goal markets. Therefore, for this purpose, many different programs have been created. To show the effectiveness of these programs, the paper refers to stepwise DEA and grey incidence analysis. Finally, the article determines a unified ranking of the applied programs that can be used by decision makers for resource allocation considering different types of programs based on their effectiveness.

Keywords: Multiple criteria decision making, stepwise DEA, grey incidence analysis, food industry, export promotion programs.

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1. Introduction

Economic scholars believed that export had a major and direct impact on economic conditions and growth of the country. At a micro level, the export of goods and services has become increasingly important for the survival of growth oriented domestic firms. At a macro level, exporting is important for dealing with trade deficit problems experienced by many countries (Julian, Ali 2009). These impacts persuade governments to design and provide some programs in order to promote the magnitude and diversity of export in their countries.

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Export promotion programs (EPPs) are a class of policies that governments make to encourage and reinforce domestic exporters to expand their activities. It can be defined as an incentive program designed for attracting firms into export by offering help with product and market identification and development (Korsakienė, Tvaronavičienė 2012; Travkina, Tvaronavičienė 2011; Valuckaite, Snieska 2007; Zhou et al. 2010), prescription and post-shipment, financing, training, payment guaranty schemes, trade fairs, trade visits, foreign representation, etc. (Shamsuddoha et al. 2009; Lages et al. 2008) used electronic information retrieval methods (Burinskas et al. 2010; Azimi et al. 2011; Büyüközerkan 2004) and systems (Kaklauskas et al. 2002a,b, 2003, 2010; Zavadskas et al. 2005).

Some studies have shown a positive direct impact of EPPs on export performance (Balassa 1978; Kumar Roy 1993; Ramaseshan, Soutar 1996; Billings et al. 2003; Francis, Collins-Dodd 2004; Shamsuddoha, Ali 2006; Zia 2008; Julian, Ali 2009; Larbi, Chymes 2009; Lederman et al. 2010; Freixanet 2011; Argent 2011). Also, Armah and Epperson (1997), Knowles and Mathur (1997), and Onunkwo and Epperson (2000) have tried to measure the global impact of specific promotion interventions. Some studies have indirectly evaluated program effects, considering them among other factors to explain export performance (Crack, Chaudhry 1997; Katsikeas et al. 1996; Walters 1983).

This study is done to determine the effects of EPPs on Iran food industry. A set of different EPPs are proposed to food product exporters in Iran. This diversity in programs and their requested funds forces decision makers to appraise the effects of different EPPs and assign financial resources based on a logical and structured manner. The aim of this study to determine and clarify the effectiveness of EPPs in Iran is satisfied through a hybrid application of stepwise data envelopment analysis (stepwise DEA) and grey incidence analysis (GIA) methods.

The paper is organized as follows: section 2 discusses the concept of stepwise DEA, section 3 briefly introduces the GIA method and section 4 explores the framework of data gathering. The analysis and their results are presented in section 5. Finally, section 6 consists of conclusions and future work.

2. Stepwise data envelopment analysis

Data envelopment analysis was originally proposed by Charnes et al. (1978) as a method to evaluate the relative efficiency of a set of units that consume a set of inputs and transform them into a set of outputs. For more details on DEA refer to Cooper et al. (2002) and Ray (2004). For reviewing applications for DEA see Emrouznejad et al. (2008).

The classic CCR model can be introduced as follows. Suppose there are a set of homogenous units. Each unit, $DMU_j, j=1,2,\ldots,n$, use a set of inputs $X_j=(x_{1j}, x_{2j}, \ldots, x_{mj})$ to produce a set of outputs $Y_j=(y_{1j}, y_{2j}, \ldots, y_{sj})$. The input oriented CCR model to evaluate the relative efficiency of these DMUs for each $DMU_0, 0\in\{1,2,\ldots,n\}$ is developed as follows:
In model (1), $\theta_0$ shows the radial efficiency of $DMU_0$ and $\lambda_j$, $j = 1, 2, \ldots, n$ is a vector of intensity variables. DMU is efficient if its radial efficiency is equal to one and all of its slack variables in optimal solutions of model (1) are zero. Now, suppose that the input vector is segmented into two sub vectors: discretionary inputs $X_{j}^{d} = (x_{1j}^{d}, x_{2j}^{d}, \ldots, x_{kj}^{d})$ and non discretionary inputs $X_{j}^{nd} = (x_{1j}^{nd}, x_{2j}^{nd}, \ldots, x_{lj}^{nd})$. Then, according to Banker and Morey (1986), the input oriented CCR model with non discretionary variables is constructed as

$$\min \theta_0$$
$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta_0 x_{i0}, \quad i = 1, 2, \ldots, m,$$
$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, \quad r = 1, 2, \ldots, s,$$
$$\lambda_j \geq 0, \quad j = 1, 2, \ldots, n. \quad (1)$$

One of the most important aspects of applying DEA is the choice of input and output variables. Golany and Roll (1989), Norman and Stocker (1991), Kittelson (1993), Lovell and Pastor (1997), Salinas-Jimenez and Smith (1996), Jenkins and Anderson (2003), Sigala et al. (2004), and Wagner and Shimshak (2007) examined this problem in the area of DEA following different procedures.

Wagner and Shimshak (2007) proposed stepwise DEA as an approach to variable selection. This method is presented in two forms: backward and forward. Since this paper uses the forward one, it is explained in this section. The forward approach has proposed some simple rules on adding variables in the DEA model – one at a time.

If a “core” model of one input and one output can be determined as a starting point, then, the stepwise method can also be adapted to add variables to the DEA model instead of dropping them. In the forward stepwise approach, the goal is the identification of variables that cause the largest difference in total efficiency scores.

Suppose there are a set of $m$ inputs and $s$ outputs to be considered for efficiency evaluation and the user wants to choose the most effective variables. As for the forward
stepwise method, work is stated considering one input and one output as the core model. In the next step, run a set of \((m-1)+(s-1)\) DEA analysis adding one input variable and one output variable at a time in each run. Then, choose the single input or output to be added by selecting the maximum average difference in efficiency scores resulting from this single variable. The process is repeated until there are not any variables to be added or all units become efficient.

3. Grey incidence analysis

Deng (1982) introduced the grey system theory (GST) as a tool for studying system uncertainty. One of the major components of GST is grey incidence analysis (GIA) dealing with the analysis of complex systems consisting of multiple factors the mutual interactions of which determine the behaviour of the system. It is often the case that among all factors, investigators want to know the ones having dominant effect, whereas the others exert less influence on the development of the system (Liu, Lin 2010). GIA is applied in different studies related to system analysis, for instance, Zhou et al. (2005), Yan-hui et al. (2007), Wang et al. (2008), Lin et al. (2009) and Yue (2009).

Assume that \(X_i\) is a system factor and its observation value at ordinal position \(k\) is \(x_i(k), k = 1, 2, \ldots, n\). Then, \(X_i = (x_i(1), x_i(2), \ldots, x_i(n))\) is referred to as the behavioural sequence of factor \(X_i\).

Different grey incidence degrees are defined between two behavioural sequences \(X_i\) and \(X_0 = (x_0(1), x_0(2), \ldots, x_0(n))\) as follows (Liu, Lin 2010).

Definition 1. Let \(X_i\) and \(X_j\) be two sequences of the same length. Then, \[
\varepsilon_{ij} = \frac{1 + |s_i| + |s_j|}{1 + |s_i| + |s_j| + |s_i - s_j|},
\]
where \[
s_i = \sum_{k=2}^{n-1} x_i^0(k) + \frac{1}{2} x_i^0(n).
\]

In Eq. (4), \(x_i^0(k)\) is defined as \(x_i^0(k) = x_i(k) - x_i(1), k = 1, 2, \ldots, n\) and \(X_i^0\) is called the zero image of sequence \(X_i\). \(s_j\) and \(s_i - s_j\) are defined similarly. Then, \(\varepsilon_{ij}\) is called the absolute degree of grey incidence between \(X_i\) and \(X_j\).

Definition 2. Let \(X_i\) and \(X_j\) be two sequences of the same length with non-zero initial values. Then, \(X_i'\) and \(X_j'\) are the initial image of \(X_i\) and \(X_j\) obtained by dividing all elements of each sequence to its initial value, i.e.
\[
x_i'(k) = \frac{x_i(k)}{x_i(1)}, k = 1, 2, \ldots, n.
\]

Then, the absolute degree of grey incidence of \(X_i'\) and \(X_j'\) is referred to as the relative degree of (grey) incidence of \(X_i\) and \(X_j\), denoted \(r_{ij}\), i.e.
\[
\rho_{ij} = \frac{1 + |s'_{ij}| + |s'_{j}|}{1 + |s'_{ij}| + |s'_{j}| + |s'_{ij} - s'_{j}|},
\]

where
\[
s'_{ij} = \sum_{k=2}^{n-1} x'^0_{i}(k) + \frac{1}{2} x'^0_{j}(n).
\]

Definition 3. Assume that \(X_i\) and \(X_j\) are the sequences of the same length with non-zero initial entries. \(\varepsilon_{ij}\) and \(r_{ij}\) are the absolute degree and relative degree of grey incidence of \(X_i\) and \(X_j\), and \(\theta \in [0,1]\). Then,
\[
\rho_{ij} = \theta \varepsilon_{ij} + (1 - \theta) r_{ij}
\]
is called the synthetic degree of (grey) incidence between \(X_i\) and \(X_j\).

Note that the absolute degree looks at relationships from the angle of absolute magnitude, the relative degree – from the angle of the rates of changes in each observation with respect to their initial point and the synthetic degree – from the combined angle of both.

Now, suppose that \(Y_1, Y_2, \ldots, Y_s\) are the sequences of the characteristic behaviour of the system (output variables), and \(X_1, X_2, \ldots, X_m\) are the behavioural sequence of relevant factors (input variables). Then, the absolute matrix of grey incidences is the \(s \times m\) matrix \(A = [\varepsilon_{ij}]\), the \(ij^{th}\) element of which is the absolute degree of grey incidence between \(Y_i\) and \(X_j\). The relative matrix of grey incidences \(B = [r_{ij}]\) is the \(s \times m\) matrix the \(ij^{th}\) element of which is the relative degree of grey incidence between \(Y_i\) and \(X_j\). The synthetic matrix of grey incidences \(C = [\rho_{ij}]\) is the \(s \times m\) matrix the \(ij^{th}\) element of which is the synthetic degree of grey incidence between \(Y_i\) and \(X_j\).

Considering, for example, matrix \(C\), the favourability characteristics of the factors can be defined as follows:

Definition 4. If \(l\) and \(j \in \{1, 2, \ldots, m\}\) satisfy
\[
\rho_{il} \geq \rho_{ij}
\]
for \(i = 1, 2, \ldots, s\), then factor \(X_i\) is supposed to be more favourable than factor \(X_j\) denoted as \(X_i \succ X_j\); if for \(j = 1, 2, \ldots, m, j \neq l\) we always have \(X_i \succ X_j\), and then \(X_i\) is called the most favourable factor (Liu, Lin 2010).

4. Data gathering framework

This study was done within the period from January 2000 to December 2009. The obtained data are gathered from the existing documents and reports on export performance of food industry in Iran. The study, according to the actual reports, admits six types of EPPs along with an additional factor in the money equivalent considered as an uncontrollable factor. According to the present data, six types of EPPs can be identified: (1) export rewards (ER), (2) international exhibitions (IE), (3) protection of transfer to export (PTE), (4) currency support (CS), (5) training and announcement (TA) and (6)
insurance support (IS). Table 1 shows data obtained considering a time period, export magnitude and money equivalent (ME).

Table 1. EPPs and export data covering the period from January 2000 to December 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Export</th>
<th>ER</th>
<th>IE</th>
<th>PTE</th>
<th>CS</th>
<th>TA</th>
<th>IS</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>207253</td>
<td>10880</td>
<td>3</td>
<td></td>
<td>0.2</td>
<td></td>
<td>1750</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>195634</td>
<td>46658</td>
<td>3</td>
<td></td>
<td>0</td>
<td>7950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>325761</td>
<td>81309</td>
<td>4</td>
<td>620</td>
<td>0.3</td>
<td></td>
<td>8320</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>248755</td>
<td>65223</td>
<td>1</td>
<td>527</td>
<td>0.09</td>
<td></td>
<td>8740</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>4139033</td>
<td>115302</td>
<td>2</td>
<td>1115</td>
<td>68</td>
<td>73</td>
<td>0.2</td>
<td>8500</td>
</tr>
<tr>
<td>2005</td>
<td>6488543</td>
<td>176641</td>
<td>3</td>
<td>1864</td>
<td>72</td>
<td>277</td>
<td>0.2</td>
<td>9000</td>
</tr>
<tr>
<td>2006</td>
<td>8391825</td>
<td>217663</td>
<td>4</td>
<td>4285</td>
<td></td>
<td>1221</td>
<td>0.9</td>
<td>9500</td>
</tr>
<tr>
<td>2007</td>
<td>9008304</td>
<td>235806</td>
<td>3</td>
<td>2603</td>
<td>42135</td>
<td>1859</td>
<td>0.09</td>
<td>8900</td>
</tr>
<tr>
<td>2008</td>
<td>11666950</td>
<td>223130</td>
<td>3</td>
<td>14955</td>
<td>4933</td>
<td>1597</td>
<td>1.4</td>
<td>9500</td>
</tr>
<tr>
<td>2009</td>
<td>14085273</td>
<td>267381</td>
<td>3</td>
<td>22019</td>
<td></td>
<td>817</td>
<td>3.4</td>
<td>9850</td>
</tr>
</tbody>
</table>

5. Data analysis

This section displays the results of analyses conducted with reference to the above data.

5.1. Stepwise DEA

This section points to the method based on the stepwise DEA model where a classic CCR (Charnes et al. 1978) model is applied every year as a DMU. The above introduced models are performed considering ME as non-discretionary input (Banker, Moray 1986).

In a forward stepwise DEA manner, the initial efficiency of DMUs without any input is equal to zero. Now, each EPP is considered as discretionary input and that with ME as non discretionary input. The results of adding new inputs to the model are shown in Table 2.

Table 2. The results of adding one input to DEA with ME as non discretionary input

<table>
<thead>
<tr>
<th>Efficiency Added EPP</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>1</td>
<td>0.23</td>
<td>0.16</td>
<td>0.18</td>
<td>0.72</td>
<td>0.72</td>
<td>0.74</td>
<td>0.73</td>
<td>0.99</td>
<td>1</td>
<td>0.647</td>
</tr>
<tr>
<td>IE</td>
<td>1</td>
<td>0.41</td>
<td>0.28</td>
<td>1</td>
<td>0.86</td>
<td>0.65</td>
<td>0.54</td>
<td>0.80</td>
<td>0.90</td>
<td>1</td>
<td>0.744</td>
</tr>
<tr>
<td>PTE</td>
<td>1</td>
<td>1</td>
<td>0.05</td>
<td>0.02</td>
<td>1</td>
<td>0.98</td>
<td>0.56</td>
<td>1</td>
<td>0.85</td>
<td>1</td>
<td>0.746</td>
</tr>
<tr>
<td>CS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.01</td>
<td>0.01</td>
<td>1</td>
<td>0</td>
<td>0.602</td>
</tr>
<tr>
<td>TA</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9</td>
<td>0.32</td>
<td>0.24</td>
<td>0.40</td>
<td>1</td>
<td>0.786</td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td>1</td>
<td>0.3</td>
<td>0.1</td>
<td>0.24</td>
<td>0.35</td>
<td>0.1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.609</td>
</tr>
</tbody>
</table>

Since the TA variable has the highest impact on average efficiency improvement, it can be chosen in this phase as the most important EPP. In phase 2, the DEA model is
run considering non discretionary variable ME and TA as two discretionary variables. Table 3 shows the received results. In this phase, PTE causes the highest increase in average efficiency and therefore this variable is chosen as the second effective EPP.

Phase 3 begins by considering non discretionary variable ME and two discretionary variables TA and EPP. The obtained efficiency is shown in Table 4 indicating that in this phase the highest increase in average efficiency is obtained by adding the ER variable.

Phase 5 runs considering ME with TA, PTE and ER. Efficiency obtained by adding the remaining EPPs is shown in Table 5 according to which the highest increase in average efficiency is achieved adding the CS variable chosen in this phase. While all DMUs reach full efficiency in this phase, adding more variables do not have any effect on efficiency.

Table 3. The results of adding one input to DEA with ME as non discretionary and TA as discretionary input

<table>
<thead>
<tr>
<th>Efficiency Added EPP</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
<td>0.74</td>
<td>0.73</td>
<td>0.99</td>
<td>1</td>
<td>0.935</td>
</tr>
<tr>
<td>IE</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
<td>0.54</td>
<td>0.80</td>
<td>0.89</td>
<td>1</td>
<td>0.912</td>
</tr>
<tr>
<td>PTE</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.91</td>
<td>1</td>
<td>0.85</td>
<td>1</td>
<td>0.976</td>
</tr>
<tr>
<td>CS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.89</td>
<td>1</td>
<td>0.24</td>
<td>0.39</td>
<td>1</td>
<td>0.852</td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.68</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.968</td>
</tr>
</tbody>
</table>

Table 4. The results of adding one input to DEA with ME as non discretionary and TA and PTE as discretionary inputs

<table>
<thead>
<tr>
<th>Efficiency Added EPP</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.967</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9967</td>
</tr>
<tr>
<td>IE</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.91</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>1</td>
<td>0.987</td>
</tr>
<tr>
<td>CS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.91</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9966</td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.91</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.991</td>
</tr>
</tbody>
</table>

Table 5. The results of adding one input to DEA with ME as non discretionary and TA, PTE and ER as discretionary inputs

<table>
<thead>
<tr>
<th>Efficiency Added EPP</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.996</td>
</tr>
<tr>
<td>CS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.996</td>
</tr>
<tr>
<td>IS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.996</td>
</tr>
</tbody>
</table>

The forward stepwise DEA shows that EPPs can be ordered as follows:

\[ TA \succ PTE \succ ER \succ CS \succ IE = IS \].
5.2. Grey incidence analysis

In this section, data on Table 1 are analyzed employing the GIA method as described in section 3. According to Equations (3) – (8), absolute incidence matrix A, relative incidence matrix B and synthetic incidence matrix C are calculated as follows.

The results in Table 6 show that with reference to Eq. (9), the favourability of EPPs, according to their grey synthetic incidence and matrix C, is as follows:

\[ \text{ER} \succ \text{CS} \succ \text{PTE} \succ \text{TA} \succ \text{IS} \succ \text{IE}. \]

<table>
<thead>
<tr>
<th>EPP</th>
<th>ER</th>
<th>IE</th>
<th>PTE</th>
<th>CS</th>
<th>TA</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.5131</td>
<td>0.500000005</td>
<td>0.50039</td>
<td>0.50053</td>
<td>0.5005</td>
<td>0.50000004</td>
</tr>
<tr>
<td>B</td>
<td>0.500001</td>
<td>0.500000005</td>
<td>0.50002</td>
<td>0.50012</td>
<td>0.50001</td>
<td>0.50000018</td>
</tr>
<tr>
<td>C</td>
<td>0.5065</td>
<td>0.500000005</td>
<td>0.50019</td>
<td>0.50032</td>
<td>0.50036</td>
<td>0.50000011</td>
</tr>
</tbody>
</table>

5.3. Aggregating the results

Sections 5.1 and 5.2 present two distinct rankings obtained for EPPs shown in Table 7.

<table>
<thead>
<tr>
<th>EPP</th>
<th>Ranking obtained by Stepwise DEA</th>
<th>GIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>IE</td>
<td>5.5*</td>
<td>6</td>
</tr>
<tr>
<td>PTE</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CS</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>TA</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>IS</td>
<td>5.5*</td>
<td>5</td>
</tr>
</tbody>
</table>

*Since IE and IS achieved the same rank in the DEA method, this rank is obtained as the average of 5 and 6.

This section displays analysis carried out on the basis of the obtained results. While the achieved ranks of different EPPs are ordinal numbers, their aggregation with averaging is not appropriate. To aggregate the results of two methods, DEA and GIA, the Copeland pair-wise rank aggregation method is used (Copeland 1951; Pomerol, Barba-Romero 2000). The Copeland score is measured for element \( i \) as the difference between the number of alternatives dominated by alternative \( i \) based on different methods (here, DEA and GIA), minus the number of alternatives that dominate this alternative. Table 8 shows the results of the Copeland method where \( M \) means that the element in the row of the table is preferred to the element in the column and \( X \) shows that the element in the row is lost to or is incomparable with the element in the column. For example, the element in row 1 and column 2 of table is \( M \), because ER is preferred to IE in both methods. Also, the numbers presented in the last column and row is the sum of elements.
in associated rows or columns. The final score for each element is the difference between the numbers in the row and column of this element.

<table>
<thead>
<tr>
<th>No. wins</th>
<th>ER</th>
<th>IE</th>
<th>PTE</th>
<th>TA</th>
<th>IS</th>
<th>ER</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>M</td>
<td>X</td>
<td>M</td>
<td>X</td>
<td>X</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>X</td>
<td>–</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>X</td>
<td>M</td>
<td>–</td>
<td>X</td>
<td>X</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>X</td>
<td>M</td>
<td>X</td>
<td>–</td>
<td>X</td>
<td>M</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>M</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>–3</td>
</tr>
</tbody>
</table>

Therefore, the most effective EPP is export rewards annually received by exporters. Also, the “protection of transfer to export” and “training and announcement” are in the second position. Next, currency support, insurance support and international exhibitions are in the following ranks respectfully.

6. Conclusion

The paper presents a hybrid application of the stepwise DEA method and grey incidence analysis to determine the effectiveness of different export promotion programs in food product industry in Iran. The conducted analysis has determined the order of different programs and specified aggregated ranking. The results shown that while some scholars believed the ineffectiveness of export rewards this condition does not hold in the considered case. To achieve a better result, these findings can help policy makers with a better assignment of limited resources of different programs. Exporters strongly prefer receiving EPPs having a great effect on their performance. It seems that direct EPPs include a direct payment to exporters in a form of export rewards have more effects and then, indirect EPPs like training and transfer have such effects. Therefore, some revisions of the value and process of export rewards might be necessary. A similar approach can be also applied to evaluating the effectiveness of any set of programs in different industries.

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