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EVALUATING HOTEL ADVERTISEMENTS EFFICIENCY USING DATA ENVELOPMENT ANALYSIS

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Abstract. This paper introduces popular methods for ranking alternatives with multiple inputs and multiple outputs in the DEA context. The ranking methods are based on different criteria. Consequently, the ranking of the alternatives are not always the same, particularly as regards the best alternative. The decision maker, however, must make an absolute decision as to the most favored alternative. This study proposes a new ranking method, which is based on the average of the highly correlated ranking method. The new method is applied on a case study of ranking hotels in Israel.

Keywords: DEA, ranking models, advertising, hospitality.

1. Introduction

Countries throughout the world derive large parts of their respective gross national products (GNP) from the tourism and hospitality industries. Unfortunately, the increased threat of terrorism and general slowdown of the global economy has led to a decline in the consumption of tourism and hospitality goods and services. In their study of crisis management tactics and strategies, Israeli and Reaches suggested that reliance on intensive advertising may be an effective component of crisis management strategy and may lead to increased consumption [1].

While advertising is an important component of any marketing strategy, it is important to ensure that advertising is done effectively. Effective communication in advertising requires that specified messages (attributes) be conveyed to potential customers and that the result will be a corresponding demand from these customers at a profitable price. With respect to attributes perceived as important by consumers, a study conducted by Mehrez and Israeli on the Israeli hospitality industry found that hotel guests expect a variety of services, including swimming pool and spa, activities for children, adult activities, sports facilities, and more [2]. As part of the effort to attract different market segments, hotels often communicate the abovementioned attributes in advertisements. To consider an advertisement effective, a firm should be able to use what is being advertised (such as characteristics of the product or service) as justification for the price it requests and also to be able to secure a purchase from customers [3].

To examine the effectiveness of advertising to the hotel industry, this paper uses a real case in the Israeli hospitality industry and evaluates the effectiveness of an advertising supplement dedicated to promoting hotels that appeared in a national newspaper. Effectiveness was evaluated using different ranking models of Data Envelopment Analysis (DEA) procedures. In this context, the effectiveness of hotel advertisements using DEA assumes that when the hotel communicates attributes of quality in advertising and manages to ask for a premium for these attributes, its advertisement will be effective. This argument was presented and discussed in [4, 5, 6].

The next section introduces the presentation and formulation of DEA procedures employed in the analysis. The third section presents the various ranking methods used in the study. Section four illustrates how the effectiveness of hotel advertisements can be evaluated using all the models presented in part three. Finally, the findings are presented along with conclusions and recommendations for future applications and research.

2. Data envelopment analysis

DEA is a procedure designed to measure the relative efficiency in cases where there are multiple inputs and multiple outputs and no obvious objective as to how to aggregate both inputs and outputs into a meaningful index of productive efficiency [7]. DEA was developed by Charnes, Cooper and Rhodes (CCR), and the method provides a mechanism for measuring the efficiency of each Decision-Making Unit (DMU) [8]. The mechanism is extensively employed in diverse industries and environments (an extensive review of DEA applications is provided by Seiford) [9]. In the service sector, applications of DEA include education, recreation and health care management to name just a few [7, 10].

The efficiency in DEA is termed Technical and Scale Efficiency (TSE), and the relative efficiency of a DMU is defined as the ratio of its total weighted output to its total weighted input. The question is how to select the weights if no unit values can be assigned to the inputs and outputs. Here lies the core of the DEA procedure. DEA permits each DMU to select any weight for each input and output, provided that it satisfies certain reasonable conditions: first that no weights can be negative, and second that the weights must be universal, meaning that the resulting ratio should not exceed 1. The BCC model, named after Banker, Charnes and Cooper allows the production function to exhibit non – constant return to scale, while the CCR model imposes the additional assumption of constant returns to scale on the production function [11, 12].

The Technical and Scale Efficiency (TSE) with constant return to scale is computed according to the CCR model [8]. Consider n DMUs, when each DMU j (j=1,…,n) uses m inputs $X_j = (X_{1j}, X_{2j},\ldots, X_{mj})^T > 0$ for producing s outputs $Y_j = (Y_{1j}, Y_{2j},\ldots, Y_{sj})^T > 0$. The CCR model is as follows:

$$\text{MaxE}_k = \frac{\sum_{r=1}^{s} U_r^k Y_{rk}}{\sum_{i=1}^{m} V_i^k X_{ik}}$$

S.T

$$\frac{\sum_{r=1}^{s} U_r^k Y_{rj}}{\sum_{i=1}^{m} V_i^k X_{ij}} \le 1 \qquad j=1,2....n \tag{1}$$

$$U_r^k \ge 0 \qquad V_i^k \ge 0$$

$$r=1,2....s \qquad i=1,2....m$$

The weights are all positive and the ratios are bounded by 100 %. Each unit k is assigned the highest possible efficiency score by choosing the most optimal weights. If a unit reaches the maximum possible value of 100 % it is considered efficient, otherwise it is inefficient.

The formulation of (1) can be translated into a linear program, which can be solved relatively easily, and a complete DEA solves n linear programs, one for each unit.

$$\begin{aligned}
&\max imize \quad h_k = \sum_{r=1}^{s} U_r^k Y_{rk} \\
&subject\ to \quad \sum_{i=1}^{m} V_i^k X_{ik} = 1 \\
&\qquad \sum_{r=1}^{s} U_r^k Y_{rj} - \sum_{i=1}^{m} V_i^k X_{ij} \le 0 \quad j=1,2,..,n \\
&\qquad U_r^k \ge \varepsilon \quad r=1,2,..,s \\
&\qquad V_i^k \ge \varepsilon \quad i=1,2,...,m
\end{aligned} \tag{2}$$

Where ε is defined as an infinitesimal constant (a non – Archimedean quantity).

According to the model, h_k denotes the TSE efficiency for DMU_K. If $h_k = 1$, DMU_K is defined as efficient, and if $h_k < 1$, DMU_K is not efficient.

The dual to (2) is:

$$\text{minimize } \theta_k - \varepsilon\left(\sum_{r=1}^{s} S_{rk}^{+} + \sum_{i=1}^{m} S_{ik}^{-}\right)$$

subject to

$$\sum_{j=1}^{n} X_{ij}\lambda_j + S_{ik}^{-} = \theta X_k \quad i = 1,2,...,m$$

$$\sum_{j=1}^{n} Y_{rj}\lambda_j - S_{rk}^{+} = Y_{rk} \quad r = 1,2,...,s$$

$$\lambda_j \geq 0 \quad j = 1,2,...,n \tag{3}$$

$$S_{rk}^{+}, S_{ik}^{-} \geq 0 \quad r = 1,2,...,s, \quad i = 1,2,...,m$$

The BCC model computes Technical Efficiency (TE) with increasing returns to scale [11]. It can be defined by adding the constraint

$$\sum_{j=1}^{n} \lambda_j = 1.$$

3. Ranking methods

As previously mentioned, the DEA does not rank efficient DMUs, but rather ranks the inefficient DMUs. The DEA also separates the DMUs into two different groups: efficient (with efficiency ratio of 1), and inefficient (with a ratio less than 1). Next, we present six ranking methods in the DEA context (for further information see [13]).

Anderson and Peterson (A&P) Method

Anderson and Peterson [14] developed a new method for ranking only the efficient units because all of them received the score of 1, while the inefficient units are ranked according the DEA scores. The method enables an efficient unit k to achieve a score greater than one. The formulation is given in (4)

$$\text{maximize } h_k = \sum_{r=1}^{s} U_r^k Y_{rk}$$

$$\text{subject to } \sum_{i=1}^{m} V_i^k X_{ik} = 1 \tag{4}$$

$$\sum_{r=1}^{s} U_r^k Y_{rj} - \sum_{i=1}^{m} V_i^k X_{ij} \leq 0 \quad \forall j \neq k$$

$$U_r^k \geq \varepsilon \quad r = 1,2,..,s$$

$$V_i^k \geq \varepsilon \quad i = 1,2,...,m$$

The Cross Efficiency (CE) Method

The Cross Efficiency matrix was first developed by Sexton [15]. This method calculated the efficiency score of each unit n time using the optimal weights evaluated by each run. The results of all the DEA cross efficiency are summarized in a matrix as given in (5)

$$h_{kj} = \frac{\sum_{r=1}^{s} U_r^k Y_{rj}}{\sum_{i=1}^{m} V_i^k X_{ij}} \quad j = 1,2,..,n \quad k = 1,2,..,n \tag{5}$$

Thus h_{kj} represents the score given to unit j by the optimal weights of unit k. The elements in the diagonal h_{kk} represent the standard DEA scores h_k. The Cross Efficiency ranking method utilized the matrix h_{kj} for ranking the units one scale. If we define $\bar{h}_k = \frac{\sum_{j=1}^{n} h_{kj}}{n}$ as the average cross efficiency score for unit k, all the units can be ranked on a single scale according to $\bar{h}_k$. This score better represents the unit k evaluation than the DEA score as it utilizes the weights of all other units, and for each unit all the inputs and outputs are evaluated with the same set of weights.

Analytic Hierarchy Process/DEA Method (AHP/DEA)

AHP/DEA uses the Analytical Hierarchical Process (AHP) proposed by Saaty and uses pairwise comparisons to rank order the DMUs [16]. In the first step, the efficiency of each DMU is computed, as is the ratio between each pair. Then, in the second step, the correspondence between the own eigenvector and the maximum eigenvalue provides the ranking for each DMU [17].

The Global Efficiency (GE) Method

The Global Efficiency method finds a common weight for all the units that maximizes the sum of efficiency scores of all the units. Each efficiency score has the same structure as in the DEA, where the unit score is bound by 1. The formulation of GE is as follows:

$$\text{maximize } \sum_{k=1}^{n} E_k^*$$

$$\text{subject to } E_k^* = \frac{\sum_{r=1}^{s} U_r Y_{rk}}{\sum_{i=1}^{m} V_i X_{ik}} \leq 1 \quad k = 1,2,..,n \tag{6}$$

$$U_r \geq 0 \quad r = 1,2,..,s$$

$$V_i \geq 0 \quad i = 1,2,...,m$$

The ranking is based on the efficiency score with the common weights E_k^*. For further information, see [18].

The Discriminant Analysis of Ratio (DR) Method

This method is based on the classification of the units into two groups: efficient and inefficient from the DEA. Then, the common weights for the composite outputs W_j and composite inputs Z_j are found by maximizing the ratio of the variance between the two groups and the variance within the groups. According to the ratio $T_j = \frac{W_j}{Z_j}$ with the common weights, all the units can be ranked on a single scale. If any weight is negative, the non-negative constraints then need to be added to the optimization problem. For further information see [19].

The Canonical Correlation Analysis (CCA) Method

The Canonical Correlation Analysis is an extension of regression analysis. It finds the optimal common weights of the multiple outputs and multiple inputs, so as to maximize the coefficient of correlation between composite inputs $Z_j = \sum_{i=1}^{m} V_i X_{ij}$ and composite outputs $W_j = \sum_{r=1}^{s} U_r Y_{rj}$. Friedman and Sinuany-Stern utilize the CCA method for ranking the units using the ratio score $T_j = \frac{W_j}{Z_j}$ [20]. When using the CCA method, some of the common weights may receive negative values, and thus they cannot be used here for ranking unless a constraint that U_r and V_i has to be positive is added.

For further information see [20].

Average Method

Each of the six ranking methods has a different criterion for calculating the score that serves as the basis for ranking the units. The decision maker has to decide on the „best" ranking model. The probability that all the ranking methods will yield an agreement as to which alternative will be ranked first is very low. It is therefore proposed here that a method combining all the ranks of all the methods to one rank-score be used in the following manner:

Step 1 – Find the rank T_{ij} of each alternative *j* *(j=1,..,n)* by ranking method i $(i = 1,.., K)$.

Step 2 – Calculate the average rank of each alternative j – $\bar{T}_j$ as follows:

$$\bar{T}_j = \frac{\sum_{i=1}^{K} T_{ij}}{K} \quad j = 1,2,..,n.$$

Step 3 – Calculate the correlations of each of the ranking methods with the average rank score.

Step 4 – The methods that are not highly correlated significantly will be deleted by the following procedure:

Let us define the following notations - ρ_0 – Desirable correlation coefficient.

$r_{i,ave.}$ – Correlation coefficient in sample of size n between the rankings of method i and the rankings by the average.

Z_α – The critical point of the standard normal distribution with significant level α.

To test the hypothesis $\begin{matrix} H_0 : \rho \geq \rho_0 \\ H_1 : \rho < \rho_0 \end{matrix}$.

The critical point $Z = \frac{\sqrt{n-3}}{2} \ln\left[\frac{(1+r)(1-\rho_0)}{(1-r)(1+\rho_0)}\right]$.

(For more information see [21].

If

$$r_{i,ave.} < \frac{e^{\frac{2Z_\alpha}{\sqrt{n-3}}}(1+\rho_0)-(1-\rho_0)}{e^{\frac{2Z_\alpha}{\sqrt{n-3}}}(1+\rho_0)+(1-\rho_0)} \quad (7)$$

, then we reject H_0. Namely we will delete the ranking method i and return to step 2.

4. Data

The data set of this study included advertisements in an informative supplement of a popular national newspaper in Israel. The supplement was titled „Vacations and Hotels in Israel – December 1998, January 1999" [22]. This dataset was selected because it included advertisements of hotels in a uniform format. Therefore the effectiveness of the advertisements can be computed based on the information it provides, thus creating a common basis for comparison between advertisements with no variations attributed to flashy designs, graphics, ad location and ad size.

The advertisements were placed in the newspaper supplement. The top of each advertisement consisted of the hotel's name and its corporate affiliation (if any), in the middle a picture of the hotel appeared, and at the bottom was a statement giving the hotel's price per person in a double room and contact information (address, telephone). On the right–hand side of each advertisement were five small icons, which reported whether the hotel offered certain amenities or services. These included a swimming pool, activities for children, adult activities, sports facilities and handicapped accessibility (not required by law in all public buildings in Israel). If the service was offered, the icon appeared in the advertisement; otherwise it did not. The information on the hotels that elected to participate in the newspaper supplement was collected, generating a database consisting of 52 hotels.

An important issue in employing DEA is the selection of inputs and outputs. In this study, the selection was motivated by two factors. The first was the governing reasoning behind the use of advertisement. In advertising, a firm communicates attributes in an effort to be able to charge or justify a certain (preferably premium) price [23]. This analysis focuses on a supply-side perspective and posits that an advertisement will be considered effective if it supports the advertiser wish for posting a premium price. Consequently, prices are considered as outputs. The second factor that motivated the selection of inputs and outputs was the availability of information to the consumer. The inputs, or the hotel attributes, were included in the advertisement supplement that was analyzed. The outputs were the room prices as advertised in the hotel association guide. The data sources were reliable public and official publications and they were, therefore, considered suitable for the analysis.

As mentioned previously, the inputs collected from the advertisement supplement included a total of five attributes. These attributes were:

X_1 swimming pool
X_2 activities for children
X_3 adult activities
X_4 sports activities
X_5 number of rooms

The outputs in the dataset included room prices for:

Y_1 high season (*HS*)
Y_2 regular season (*RS*)
Y_3 low season (*LS*),

which were published in the Israel Hotel Guide [24].

The treatment to the binary variables X_1, X_2, X_3, X_4 was to assign 1 if the attribute was not offered and 2 if the attribute was available. This treatment is consistent with the procedure offered by Cooper et al. [25]. The data on 52 hotels with 5 inputs and 3 outputs are provided in Table 1.

5. Results

We run the DEA procedures on the 52 hotels with 5 inputs and 3 outputs. The DEA classifies hotels into two groups, efficient and inefficient. We then rank the hotels by the six ranking methods. For each model we generate a rank between 1 and 52, where 1 denotes the highest rank. All the ranks by the six ranking methods and the DEA scores are provided in Table 2. We calculate the average of six ranks received for the six ranking methods for each hotel, and again we rank the hotels according the average rank. The ranking according the average score is also provided in Table 2.

The correlations between the pairs of each ranking method and between each method and the average method are given in Table 3. A correlation of at least 0.9 indicates a high fit among each ranking method and the average method. The critical value of the sample coefficient of correlation to delete a method that is not significantly correlated with the average ranking method is less than a critical r. For example if $\alpha = 0.05$ and $\rho_0 = 0.9$, and sample size $n = 52$, the critical r *is* 0.845. Based on the critical value we deleted the GE from further consideration, and the average ranking method averaged only five ranking methods. These two average models are also included in Table 2.

The average ranking of six models and the new average ranking with five models were highly correlated (0.99). The information in Table 2 illustrates the difference between the rankings of each hotel. Even if these differences are not significant, the alternatives (hotels) ranked in the first places were not identical. Consequently, the decision maker cannot decide on the best alternative. For example, using the first average method, the Dan Pearl Hotel was ranked first and the King David Hotel ranked second. When using the new average method, the rankings were switched. Furthermore, the correlation between the new average ranking method and the other five ranking methods was improved after deleting the GE method. All the coefficients of the correlation were above 0.9 and are provided in Table 3.

6. Conclusions and future research

From a technical perspective, this case study demonstrated that the DEA techniques can be used to evaluate the effectiveness of hotel advertisements. This can be applied in the future to improve the effectiveness of marketing efforts. Another issue regards the inclusion of binary variables in the DEA following the principles offered by Cooper et al. [25]. In the case

Table 1. Inputs, outputs and star rating of 52 hotels in Israel

	DMU	Pool	Kids	Adult	Sport	Rooms	HS	RS	LS	Star Rating
		X_1	X_2	X_3	X_4	X_5	Y_1	Y_2	Y_3	
1	Ambassador	2	2	2	2	216	242	196	178	4
2	Americana	2	2	2	2	130	120	99	88	2
3	Ariel	1	1	1	1	128	135	115	115	4
4	Astoria	2	1	1	1	65	106	87	82	2
5	Caesar Eilat	2	2	2	2	241	182	167	133	4
6	Carlton Dead Sea	2	2	2	2	244	175	136	136	4
7	Carlton Tel Aviv	2	1	1	2	281	242	217	177	5
8	Carmel Beach	2	2	2	2	90	305	280	260	4
9	Carmel Mountain	1	2	2	1	99	70	70	70	3
10	Crown Plaza Dead Sea	2	2	2	2	302	250	240	218	5
11	Crown Plaza Eilat	2	2	2	2	266	328	218	218	5
12	Crown Plaza Tel Aviv	2	2	2	2	246	378	318	318	5
13	Dan Carmel	2	2	2	2	219	306	266	252	5
14	Dan Eilat	2	2	2	2	378	535	345	270	5
15	Dan Panorama	2	2	2	2	266	242	232	207	5
16	Dan Panorama Tel Aviv	2	2	2	2	500	261	222	222	5
17	Dan Pearl	2	2	2	2	104	423	311	311	5
18	Dvir	2	2	1	1	30	69	69	69	3
19	Edom Mountain	2	2	2	2	110	118	100	88	3
20	Edomit	2	1	2	1	85	120	96	93	3
21	Holiday Inn Patio	2	2	2	2	115	145	115	115	4
22	Holiday Inn Tiberias	2	2	2	2	246	238	180	173	4
23	King David	1	1	1	2	237	472	394	394	5
24	King Solomon	2	2	2	2	419	346	240	176	5
25	Laguna	2	2	2	1	256	234	213	175	4
26	Melody	1	1	1	1	34	125	117	113	4
27	Mercure Jerusalem	1	1	1	1	298	140	115	95	4
28	Mercure	2	2	2	2	159	130	110	100	4
29	Moon Valley	2	2	2	1	182	130	100	90	2
30	Nova	2	2	2	2	193	157	134	123	4
31	Palmira	2	2	2	2	195	235	196	167	4
32	Princess	2	2	2	2	420	588	307	281	5
33	Quiet Beach Tiberias	1	1	1	2	198	140	109	95	3
34	Raddisson Moria Dead Sea	2	2	2	2	196	230	200	200	5
35	Raddisson Moria Plaza	2	2	2	2	306	280	250	250	5
36	Raddisson Moria Plaza Dead Sea	2	2	2	2	220	290	250	250	5
37	Raddisson Moria Plaza Jerusalem	2	2	2	2	292	235	215	185	5
38	Raddisson Moria Plaza Tel Aviv	2	2	2	2	355	245	225	195	5
39	Raddisson Moria Plaza Tiberias	2	2	2	2	272	275	255	210	5
40	Ramada Continental	2	2	2	2	340	213	183	183	5
41	Reef	2	1	2	1	79	155	132	127	3
42	Royal Beach	2	2	2	2	363	666	457	309	5
43	Royal Plaza Jerusalem	1	1	1	2	300	200	144	144	4
44	Royal Plaza Tiberias	1	2	2	2	160	194	162	162	4
45	Sheraton Eilat	2	2	2	2	247	207	155	137	5
46	Sheraton Four Point	2	2	2	2	282	217	185	165	4
47	Sheraton Jerusalem	2	2	2	2	296	317	277	191	5
48	Sheraton Plaza Jerusalem	2	2	2	2	296	317	277	191	5
49	Sport	2	2	2	2	327	229	188	143	4
50	Tiberias Hotel	2	1	1	2	70	130	96	96	3
51	Topaz	2	2	2	1	81	120	110	97	3
52	Vista	2	2	2	1	84	144	115	104	3

Table 2. DEA efficiency score and the ranking of the hotels

		Ranking Methods							
Unit	DEA	A&P	CE	AHP	GE	DR	CCA	Average *	Average **
1	0.5153	33	21	21	23	21	26	23	25
2	0.3025	52	49	46	35	44	52	48.5	51
3	0.5838	22	37	28	27	20	18	28	26
4	0.5317	32	42	29	11	29	27	30	32
5	0.4217	42	33	49	39	39	37	39	42
6	0.357	48	43	51	46	49	47	52	49
7	0.5508	25	19	20	32	28	25	25.5	23
8	1	5	4	3	3	2	4	3	3
9	0.3787	45	52	48	42	45	49	50	50
10	0.5854	21	17	26	33	27	24	24	21
11	0.614	20	15	11	26	19	17	15	15
12	0.8071	9	5	4	10	6	5	6	5
13	0.6949	10	8	6	13	7	9	7.5	8
14	0.8396	8	6	8	16	8	7	7.5	6.5
15	0.5679	23	16	22	29	23	20	20.5	19
16	0.5635	24	29	37	51	51	40	38	36
17	1	2	2	2	1.5	1	2	1	2
18	0.692	11	45	25	4	31	34	27	29
19	0.3177	51	48	41	28	36	50	44	47
20	0.5452	28	44	30	15	33	31	31	35
21	0.3618	47	40	35	20	30	44	36	40
22	0.4715	37	28	34	34	32	32	34	33
23	1	1	1	1	5	4	1	2	1
24	0.5453	27	23	32	43	35	28	32	28
25	0.9991	6	22	31	30	26	10	19	17
26	1	4	14	10	1.5	3	6	5	6.5
27	0.5405	30	50	40	52	52	45	46	44
28	0.3185	50	47	50	38	47	51	51	52
29	0.4892	36	51	52	48	50	41	48.5	48
30	0.3656	46	41	47	37	41	46	45	45
31	0.3951	43	20	17	19	16	22	22	24
32	0.8965	7	7	9	25	12	8	10	9
33	0.3357	49	46	39	47	42	48	47	46
34	0.5429	29	18	16	18	15	21	16.5	18
35	0.6345	17	13	15	31	25	19	18	16
36	0.6521	15	9	7	14	9	12	9	10
37	0.5133	34	24	36	36	34	29	33	31
38	0.5387	31	25	38	44	38	33	35	34
39	0.6197	19	12	13	24	17	15	14	13
40	0.4645	38	31	43	49	48	39	43	41
41	0.6521	16	26	12	6	11	11	11	14
42	1	3	3	5	7	5	3	4	4
43	0.4237	41	38	24	50	46	43	41.5	38
44	0.5045	35	27	14	17	10	30	20.5	22
45	0.3951	44	34	45	41	40	38	41.5	43
46	0.4479	39	30	42	40	37	35	37	37
47	0.6541	13	10	18	21	13	13	12	11
48	0.6541	14	11	19	22	14	14	13	12
49	0.4285	40	32	44	45	43	36	40	39
50	0.5489	26	36	23	8	22	42	29	30
51	0.6336	18	39	33	12	24	23	25.5	27
52	0.6554	12	35	27	9	18	16	16.5	20

*- Average over six ranking methods. **- Average over five ranking methods (deleting GE).

Table 3. Spearman correlation between ranking methods and hotel star rating

	CE	AHP	GE	DR	CCA	Average *	Average **	Star Rating
A&P	0.751	0.806	0.670	0.777	0.903	0.891	0.906	-0.387
CE		0.841	0.491	0.807	0.880	0.883	0.914	-0.747
AHP			0.758	0.922	0.873	0.9481	0.947	-0.439
GE				0.865	0.697	0.798	/	0.029
DR					0.899	0.959	0.933	-0.341
CCA						0.963	0.970	-0.472
Average *							0.990	-0.451
Average **								-0.516

*- Average over six ranking methods.
**- Average over five ranking methods (deleting GE).

study presented here, part of the information was presented in a binary format to denote input that may or may not exist, for example, the variable for activities for children exists only at some hotels. The King David Hotel has low inputs (most of the binary variables receive the low score of 1), while the outputs were very high, making this hotel efficient. At the Mercure Hotel all its binary variable are high (score of 2), but the outputs are very low relatively, meaning that this hotel's advertisements are ineffective and it ranked in last place. Another purpose of the case study was to examine the correlation between the rankings of the star ratings for each hotel (from 2-5) (Table 1). The GE has the least coefficient of correlation with the star rating (0.03), while the highest was the CE (0.74). All the others spanned between 0.35 – 0.47.

Another aspect that was investigated in Table 3 was the correlation between the effectiveness of hotel advertising and their quality rating or star rating. Under the star rating system, hotels can be awarded up to 5 stars based on the level of service offered. This was monitored by a special code published by the Israeli Ministry of Tourism. Despite the popularity of the star rating system in Israel and around the world, and despite the reliance of hotels on this system as a justification for pricing, pressures were mounting on the system by investors to "bend the rules" and assign high star ratings to hotels that did not meet the standards [5, 6]. Additionally, short-term manipulations of the hotel facilities, carried out only when the star-rating reviewers inspected the hotel, became popular among many businesses. Given that the aforementioned activities effectively decreased the validity and reliability of the star rating system and as inspection and enforcement of the code became too expensive, the Ministry of Tourism decided not to use the system in Israel. Regardless of the decision of the Ministry not to enforce the star rating system, hotels continue to advertise and communicate the star rating that they had before the ranking system was terminated. Moreover, Israeli and Uriely [4] and Israeli [6] clearly demonstrate that hotels use their star rating as a signal of quality, to justify a request for a premium price.

One surprising finding was that the correlation between the star rating and each of the ranking methods was very low (see Table 3). Moreover, this finding may be rooted in the context that was examined. The need to engage in advertising was triggered by a certain problem in performance in the overall context of a growing crisis in the industry. In other words, if hotels did not face problems with demand they would probably not turn to advertising. When a problem arises, and advertising is used, it may signal that the advertiser is facing a problem. From this weak position, the hotel may offer its infrastructure at a lower price to increase consumption. This fact may lead to a low correspondence between the effectiveness of the advertisement and the overall quality rating of the hotel (as signaled by the star rating).

Another aspect examined was the correlation between the ranking of the hotel advertisement using the different DEA methods and star rating of these hotels (provided in Table 1). The high correlations between the different ranking methods indicate that even when each ranking method has a different objective function, all of them are highly correlated. Nevertheless, even when the different methods are correlated, the ranking of hotels, particularly in the first few places are different. To help the decision maker decide exactly what the best alternative is, it is suggested that the decision maker choose one ranking method based on the average ranking methods that are significantly correlated.

Pricing strategic assets is a problematic issue that has been addressed in past research [4, 5, 6, 26]. This paper demonstrates how hotels can craft an effective advertisement if they know how to assign the right price to the attributes (or assets) they own and communicate effectively in the advertisement. This paper does not examine the effectiveness of an advertisement as a function of the demand it generates. Given that this is an important output of advertisement, it is suggested that future research address the marginal change in demand in the calculation of advertisement effectiveness.

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References

1. Israeli, A.; Reichel, A. Hospitality Crisis Management Practices: The Israeli Case, *International Journal of Hospitality Management,* Forthcoming, 2004.
2. Mehrez, A.; Israeli, A. Factors of Satisfaction among Guest in Israeli Hotels. *Central Bureau of Statistics Quarterly*, Issue number 122, 2001.
3. Batra, R. J., Myers, G. and Aaker, D. A. *Advertising Management*, Prentice Hall, Inc., Upper Saddle River, NJ, 1996.
4. Israeli, A. and Uriely, N. The Impact of Star Ratings and Corporate Affiliation on Hotel Room Prices, *International Journal of Hospitality and Tourism Research*, 2000, Vol. 2, No. 1, p. 27–36.
5. Israeli, A.; Adler, N.; Mehrez, A. and Sundali, J. Investigating the Use of Advertising for Communicating Hotels' Strategic Assets. *Journal of Hospitality and Leisure Marketing*, 2001, Vol. 7, No. 3, p. 22–38.
6. Israeli, A. Star Rating and Corporate Affiliation: Their Influence on Pricing Hotel Rooms in Israel. *International Journal of Hospitality Management*, 2002, 21 (4), p. 405–424.
7. Sexton, T. R.; Sleeper, S. and Taggart, R. E. Jr. Improving Pupil Transportation in North Carolina, *Interfaces*, 1994, Jan/Feb Vol. 24, No. 1, p. 87–104.
8. Charnes, A.; Cooper, W. W. and Rhodes, E. Measuring the Efficiency of Decision Making Units, *European Journal of Operational Research*, 1978, Vol. 2, p. 429–444.
9. Seiford, L. M. The Evolution of the State–of–art (1978–1995), *Journal of Productivity Analysis*, 1996, Vol. 7, p. 99–137.
10. Sherman, H. D. Improving the Productivity of Service Businesses. *Sloan Management Review*, 1984, Vol. 23, No. 3, p. 11–23.
11. Banker, R. D.;Charnes, A. and Cooper, W. W. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science*, 1984, 30, p. 1078–1092.
12. Banker, R. D. and Chang, H. A Simulation Study of Hypothesis Tests for Differences in Efficiencies. *International Journal Production Economist,*1995, 39, p. 37–54.
13. Adler, N.; Friedman, L. and Sinuany–Stern, Z. Review of Ranking Methods in the DEA Context. *European Journal of Operational Research* , 2002, 140, pp. 249–265.
14. Andersen, P. and Petersen, N. C. A Procedure for Ranking Efficient Units in Data Envelopment Analysis. *Management Science*, Vol. 39, No. 10, pp. 1261-1264 (1993).
15. Sexton, T. R.; Silkman, R. H. and Hogan, A. DEA: Critique and Extensions. In R.H. Silkman (ed.), *Measuring Efficiency: An Assessment of DEA.* San Francisco: American Evaluation Association, Jossey Bass, Inc. 1986, p. 73–105.
16. Saaty T.L. *The Analytic Hierarchy Process, Planning Priority Setting Resource Allocation*, McGraw-Hill Book Company, New York, 1980.
17. Sinuany–Stern, Z.; Mehrez, A. and Hadad, Y. An AHP/DEA Methodology for Ranking Decision Making Units, *International Transactions In operational Research*, 2000, Vol. 7, p. 109–124.
18. Friedman, L. and Hadad Yossi. Common Weights for Ranking in the DEA Context. Communication in Dependability and Quality Management, 2002, Vol. 5(1), p. 43–55.
19. Sinuany–Stern, Z. and Friedman, L. DEA and the Discriminant Analysis of Ratios for Ranking Units, *European Journal of Operational Research*, 1998, Vol. 111, p. 470–478.
20. Friedman L. and Z. Sinuany-Stern. Scaling Units via the Canonical Correlation Analysis in the DEA Context, *European Journal of Operational Research*, 1997, Vol. 100, No. 3, p. 629–637.
21. Walpole R.E. and Myers, R. H. *Probability and Statistics for Engineers and* Scientists. Macmillan Publishing Company, (Fourth Edition), 1990.
22. Rechtman, N. (editor) 27. 11. 99. Vacations and Hotels in Israel – December 1998, *Ma'ariv*, Israel (in Hebrew), 1999.
23. Nagle, T. T. *The Strategy and Tactics of Pricing*, Prentice Hall, Englewood Cliffs, NJ, 1987.
24. Israeli Hotel Association. The Israeli Hospitality Industry – National Conference. Tel Aviv (in Hebrew), 1999.
25. Cooper, W. W.;Seiford, M. L. and Kaoru, T. *Data Envelopment Analysis*, Kluwer Academic Publishers, Second printing, 2000.
26. Lewis, R. C. and Chambers, R. E. *Marketing Leadership in Hospitality – Foundations and Practices*, Van Nostrand Reinhold, New York, NY, 1989.