Data Envelopment Analysis: An Application To Measure Technical Efficiency Of Hotel Units In Elbasan, Albania

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***Abstract*—Performance evaluation has become an important improvement tool for hotels to be sustainable in today's highly competitive environment. Although the evaluation of hotel efficiency has been approached from various perspectives, difficulties were encountered when multiple inputs and outputs relative to a hotel's performance needed to be considered. The purpose of this paper is to examine efficiency of hotels units operating in Elbasan city, Albania, by adopting an approach using a framework of non-parametric programming – Data Envelopment Analysis (DEA). The objectives of this paper are: to evaluate the technical efficiency, to investigate the inefficiency causes and to make suggestions for improving the efficiency of hotel units. Interviews with managers of each hotel were conducted to collect the data for the analysis. The results indicated that 50% of hotels were efficient and the average efficiency score of the sample was 83.3 percent. For each inefficient bank was calculated the level of each input suggested by DEA to achieve efficiency. The findings of this paper can help hotel managers to improve efficiency of their hotel. Also, managers get important insights for their strategic and operational decisions to improve performance.**

Keywords—efficiency score, mathematical programming, MaxDea Basic, hotel unit, Albania

I. INTRODUCTION

Data Envelopment Analysis (DEA) is one of the most common techniques used in the analysis of efficiency of organizations. The main alternative to DEA is the use of stochastic production or stochastic cost frontiers. Because it is a non-parametric technique, DEA has the advantage, over the stochastic frontier approach, of avoiding the need to make assumptions regarding the functional form of the best practice frontier (Cobb-Douglas or logarithmic transformation), as well as avoiding the need to make distributional assumption regarding the residuals in the regression analysis. DEA can also incorporate multiple outputs and be used to calculate the efficiency using only the information on output and input quantities.

DEA is a non-parametric technique that was first introduced by [1] to describe the mathematical programming approach to construct the efficient (production) frontiers and to measure the efficiency of organizations. The authors proposed a model (CCR, named after the authors) that had an input orientation and assumed constant returns-to-scale (CRS). However, the later study considered an alternative set of assumptions. The assumption of variable returns-to-scale (VTS) was first introduced by [2] and the model is known as the BCC model. Apart from the CCR and BCC models, there are five other basic DEA models, less common in the literature. DEA is applied to unit assessment of homogeneous units such as banks, hospitals and hotels. The unit of assessment is normally referred to as a DMU which converts inputs into outputs. The identification of DMUs, inputs and outputs in an assessment is as difficult as it is crucial [3]. DEA models are broadly divided into two categories on the basis of orientation: input-oriented and output oriented. Input oriented models have the objective of minimizing inputs while maintaining the same level of outputs, whereas output-oriented models focus on increasing outputs with the same level of inputs.

Tourism has a basic role within economy but also within a country and within the human social assembly. In the course of time, tourism services have become the key component of tourism activity, therefore a detailed attention has been provided to the units supplying tourism services, but especially to hotels and factors that can influence competitiveness of these units. One of the most important components of tourism is the hospitality industry whose development is overwhelming both internationally and nationally. Furthermore, specialists in the field provide a significant attention to the hospitality industry, and within it, especially to the hotel units [4], [5], [6].

Tourism sector is wide spread in Albania. The growth in tourism in recent years confirms that Albania is on the path towards making tourism an active generator of its economic development. Hotel Industry in Albania is bridging investment opportunities. The existing structure of hotels in Albania (mainly those along the coastline area) corresponds in average to 20- Room capacity hotels. Hotels of this size are not able jet to work with bigger tourist groups organized in package tours, by western operators. Currently, such hotel capacities only match the demand of individual clients or small organized groups of tourists. New accommodation capacities recommended for development have been calculated to meet foreign market demands (not including ethnic Albanians' demands), according to projected overnight forecasts and desired number of beds per accommodation structure, as well as international standards required by these markets. Also, it is set that areas suggested for the development of such capacities should fulfill the requirements of tourist segments part of international market. There are numerous mountain resorts with quality hotels that cater needs of visitors. The favorable climate, together with country's natural & cultural heritage and geographic variety make Albania an attractive country for various kinds of tourism (Albania Tourism Today, www.globalbispartners.com).

This study will use a linear programming-based approach, data envelopment analysis (DEA), to evaluate the efficiency of hotel companies operating in Elbasan, Albania. DEA is a method of evaluating the relative efficiency of decision-making units (DMUs). In this study the decision-making units are the hotel companies. The study further explores if there exists a relationship between the efficiency and size of the hotel companies.

There is a lack of studies that have measured the efficiency of the hotel companies in Elbasan City. The DEA models used in this study assigns efficiency scores to each of the hotel unit taken in the sample of 10 hotel units for the year 2014. As this study evaluates the efficiency of the hotel and restaurant sector, it separates the most efficient hotel units from the non-efficient ones. The study identifies the top performers in this sector. The inefficiency causes are identified and, moreover, suggestions are made to hotel owners and managers, at the level of strategic and operational management, so as to increase hotel efficiency.

II. LITERATURE REVIEW

Since DEA was first introduced, the simple powerful method has been vastly developed and used to assess the efficiencies of multiple-input and multiple-output DMUs. The popularity of DEA is due to its ability to measure efficiencies of multiple input and multiple-output DMUs without prior weights on the inputs and outputs. DEA is widely researched and is being applied as internal/external benchmarking tool in many areas and domains, and in hotel management too.

In his study, [7] evaluated the efficiency of 68 hotel and restaurant companies operating in India using the DEA methodology for the year 2004-2005. The study found that the average score for all the companies as a group stands at 0.73 and thus, the hospitality industry is perceived as doing well.

The analysis of the efficiency of 43 Portuguese state-owned hotels by DEA was done by [8]. The input variables include the number of full-time equivalent employees, the book value of the premises, and the number of rooms, while the output variables include sales, the number of guests, and the aggregated number of nights spent. The results show that there are only four hotels achieving technical efficiency and allocative efficiency, and the hotels close to main tourist routes or with more rooms receive higher efficiency scores. Organizational management environments with accountability, transparency and efficiency incentives may also improve the hotel performance.

In their study [9] used revenue per room as the output variable, and they use total cost and investment expenditure as the input variables to analyze the technical efficiency of 12 Luanda hotels by DEA. Their found that the efficiency of these hotels may increase during the observation period, but at a decreasing rate. In addition, market share and joint members of a group may also positively affect the efficiency of these hotels.

In their study, [10] used a world-wide sample of hotel companies and two cases to illustrate how DEA can be used to develop strategic guidelines to improve organizational performance. The study shows hotel managers should concentrate on productivity improvements (that is how to transform inputs into outputs) and not on scale issues (such as increases or decreases in the size of operations); and the majority of the hotel companies in the sample are operating under decreasing returns-to-scale, which implies that a decrease in the size of the companies would have a positive effect on the average efficiency level of the industry.

In their study of the relative efficiency between 25 hotels operating under a brand and 25 hotels operating independently, on the island of Crete, Greece through the data envelopment analysis methodology, [11] found that nationally branded hotels are relatively the most efficient; internationally branded are the least efficient, while those operating under a local brand and the independent ones lie in between; and the hotels' inefficiency cause is mainly due to the input/output configuration and not due to their management teams' performance to organize the inputs in the production process. The input variables used in the present study are the number of employees , the number of beds and the total operational cost of a hotel, whereas output variables used , are total revenues and total number of nights spent in an establishment.

III. METHODOLOGY

A. Basic DEA models

Consider there are n DMUs, each DMUj, (j = 1, 2, …, n) uses m inputs in respective amounts x_{ij} (i = 1, …, m) and generates s outputs in respective amounts y_{rj}

(r = 1, …, s). The input-oriented CCR model can be presented by the following linear programming problem, for DMU_p (p = 1, 2, …, n):

$$\min \quad \theta_p$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \le \theta x_{ip} \qquad i = 1,2,...,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \ge y_{rp} \qquad r = 1,2,...,s$$

(1)

and $\lambda_j \ge 0, \quad j = 1,2,...,n$; θ_p unrestricted in sign

where θ_p indicates the efficiency score of DMU $_p$, and λ_j are the dual variables.

The DMUp is considered CCR-efficient if and only if $\theta_p(\min) = 1$, if $\theta_p(\min) < 1$, the unit is inefficient showing the need for a proportional reduction of inputs for unit p to become efficient. Efficient DMUs lie on efficient frontier, whereas inefficient units envelope below from the efficient frontier.

The output-oriented CCR model can be formulated as:

$$\max \quad \phi_p$$

subject to

$$\begin{cases} \sum_{j=1}^{n} \lambda_j x_{ij} \le x_{ip} & i = 1,2,...,m \\ \sum_{j=1}^{n} \lambda_j y_{rj} \ge \varphi_p y_{rp} & r = 1,2,...,s \end{cases}$$

(2)

and $\lambda_j \ge 0, j = 1,2,...,n$; ϕ_p unrestricted in sign

The DMUp is considered CCR efficient if $\phi_p(\max) = 1$ and if $\phi_p(\max) < 1$, the unit is inefficient, indicating the need for increased output to achieve efficiency. Efficient DMUs lie on efficient frontier, whereas inefficient units envelope above from the efficient frontier.

The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming CRS and it delivers the overall technical efficiency (OTE). The CRS assumption is only justifiable when all DMUs are operating at an optimal scale.

However, banks in practice may face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of OTE will be contaminated with scale efficiency (SE). The BCC model is used to assess the efficiency of DMUs characterized by VRS. The VRS assumption provides the measurement of pure technical efficiency (PTE), which is the measurement of OTE devoid of the SE effects. If there appears to be a difference between the OTE and PTE scores of a particular DMU, then it indicates the existence of scale inefficiency, that is, TE = PTE × SE. The former relates to the capability of managers to utilize banks' given resources, whereas the latter refers to exploiting scale economies by operating at a point where the production frontier exhibits CRS. Three efficiency measures, OTE, PSE and SE are bounded between zero and one. The CCR model gives the same overall technical efficiency score for input orientation and output orientation.

With the addition of the (convexity) constraint $\sum_{j=1}^{n} \lambda_j = 1$, models (1) and (2) above become BCC models (with VRS assumption). The convexity constraint implies that an inefficient DMU is benchmarked against banks of a similar size and therefore the projected point of that DMU on the DEA frontier will be a convex combination of efficient DMUs. If the OTE scores for a particular DMU p with or without the convexity constraint imposed are the same, then the DMU is operating under CRS, otherwise is operating under VRS.

Three efficiency measures are bounded between one and zero. The measure of scale efficiency (SE) does not indicate whether the DMU in question is operating in the area of increasing or decreasing returns-to-scale. The nature of returns-to-scale can be determined from the magnitude of optimal $\sum_{j=1}^{n} \lambda_j^*$ in the CCR model [12]. According to [13], and [14], if $\sum_{j=1}^{n} \lambda_j^* = 1$ then CRS prevail on DMU p; if $\sum_{j=1}^{n} \lambda_j^* < 1$ then increasing returns-to scale (IRS) prevail on DMUp and if $\sum_{j=1}^{n} \lambda_j^* > 1$ then decreasing returns-to scale (DRS) prevail on DMU p. IRS means that an increase in inputs results in a higher increase in outputs, while DRS means that an increase in inputs results in lower increase in outputs.

For each inefficient unit, DEA identify a reference set of efficient units. Reference units are those units that have positive values of dual variables λ in the optimal solution of the model ((1) or (2) respectively) for the inefficient unit. Identification of reference units is very useful. In practice, reference units can be used to point out the aspects of poor performance of the respective inefficient unit. The levels of input/output of a reference unit often indicate useful target level for inefficient unit.

DEA not only determine the efficiency score of sample units, but find the target values for input and output levels for a inefficient unit p. The target values of input i or output r for unit p are find by: $x_{ip}^* = \sum_{j=1}^{n} x_{ij} \lambda_j^*$ for each input i, i = 1, 2, ..., m and $y_{rp}^* = \sum_{j=1}^{n} y_{rj} \lambda_j^*$ for

each output *r*, *r* = 1, 2, ..., *s*, where λ^* are the optimal values of dual variable in the problem of unit p.
It has only been accepted that the sample size of DMU must be greater than the double of the sum of inputs and outputs to obtain reliable results, although [15] established as a general rule that the number of firms be equal to or above the triple of the variables included in the model.

B. The data and the specification of input/output variables

This study includes 10 hotel units operating in Elbasan. A questionnaire was prepared to fill by hotel managers. The choice of input and output variables constitute a difficulty, which must be addressed carefully. Such choice is influenced by a number of factors, such as, the availability of reliable information.

Three inputs and two outputs were used for the analysis. Input variables were: full-time workers (X_1), number of rooms (X_2), total cost (X_3), and output variables were: average number of occupied rooms (Y_1), total revenue (in Albanian lek) (Y_2).
The variables selected are based on the reviewed literature and the availability of the data.

The results of CCR and BCC DEA models were obtained by using the MaxDEA Basic software.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

Table 1. Results of input-oriented CCR and BCC DEA models

Hotel unit	***TE score (CRS)***	***PTE score (VRS)***	***SE score***	***RTS***
Boci	1.000	1.000	1.000	Constant
Grand	0.893	1.000	0.893	Decreasing
Guri	0.690	0.798	0.864	Increasing
Imperial	0.830	0.883	0.940	Decreasing
Monarch	1.000	1.000	1.000	Constant
Mondial	1.000	1.000	1.000	Constant
Real Skampis	1.000	1.000	1.000	Constant
Kriva	1.000	1.000	1.000	Constant
Skampa	0.335	0.943	0.356	Increasing
Univers	0.579	0.774	0.748	Decreasing

IV. RESULTS AND DISCUSSION

The managers of 10 hotel units responded the questionnaire. Eight hotels had 3 or 4 stars, four hotel had 5 to 10 rooms and four other had 21 to 30 rooms. Eight hotels had 20 or less full-time workers and the maximum capacity in a night was less than 50 persons for majority of the hotels (6 of them). The average number of rooms was 18.4, the average number of full-time works was 10.8. The average total cost was 5,248,800 lek, whereas average total revenue was 10,326,000 lek in year 2014.

The results of input-oriented CCR and BCC DEA models are shown in table 1. The results of CCR model, with CRS assumption, indicated that the technical efficiency score varied from 0.335 to 1. Five hotel units, Boci, Monarch, Mondial, Real Skampis ans Kriva, were efficient during year 2014. Other units were inefficient, and they can improve their efficiency by reducing their level of inputs. The technical efficiency scores among inefficient banks ranged from 0.335 for Skampa Hotel to 0.893 for Grand Hotel. Skampa Hotel can potentially reduce the input levels by 66.5% while maintaining the same level of outputs; in other worlds, the same levels of output for year 2014 can be produced with only 33.5% of the inputs.

Under VRS assumption, one of inefficient hotelss under CRS assumption became efficient (Grand). For this hotel, technical inefficiency was not caused by poor inputs utilization (managerial inefficiency) but by the operations of the hotel with inappropriate scale size (scale inefficiency). Guri Hotel and Imperial had PTE score less than SE score, indicating that their inefficiency is primarily attributed to the managerial inefficiency rather than to the scale inefficiency. Grand, Skampa and Univers Hotel had SE score less than PTE score, indicating that their inefficiency is primarily attributed to the scale inefficiency rather than to the managerial inefficiency.

Furthermore, Guri Hotel and Skampa Hotel were operating below their optimal scale size and thus experiencing IRS. These banks can enhance TE by increasing their size of their activities. Other inefficient hotels, Grand, Imperial, and Univers hotel were operating with DRS.
As the source of inefficiency for the banks was largely the scale inefficiency, according to the data reported in table 1, 3 hotels were operating at DRS, 2 hotels were operating at IRS, and 5 hotels were operating at the optimum scale, that is, constant return to scale.

During the study year, the hotels exhibited an average TE score of 0.833 with standard deviation 0.23. This value of average TE score suggests that the hotels could have saved 16.3% of their inputs to produce the same level of outputs that they have produced. In other worlds, the banks could have produced the same amount of outputs by using only 83.3% of the amount of inputs used.

Table 2. Results of output-oriented CCR and BCC DEA models

Hotel unit	***TE score (CRT)***	***PTE score (VRS)***	***SE score***	***RTS***
Boci	1.000	1.000	1.000	Constant
Grand	0.893	1.000	0.893	Decreasing
Guri	0.690	0.702	0.983	Decreasing
Imperial	0.830	0.891	0.930	Decreasing
Monarch	1.000	1.000	1.000	Constant
Mondial	1.000	1.000	1.000	Constant
Real Skampis	1.000	1.000	1.000	Constant
Kriva	1.000	1.000	1.000	Constant
Skampa	0.335	0.337	0.995	Decreasing
Univers	0.579	0.807	0.717	Decreasing

The decomposition of the overall technical efficiency into its pure technical and scale efficiency components suggests that the scale inefficiency dominates the pure technical inefficiency of the hotels, this means that the source of inefficiency is that their operations were at the wrong scale. The average PTE score for 20 hotels was 0.94 with standard deviation of 0.09, whereas the average SE score was 0.88 with standard deviation 0.22. The lower mean and higher standard deviation of the SE score compared to PTE score indicated a greater portion of technical inefficiency was due to scale inefficiency.

The results of output-oriented CCR and BCC DEA models in table 2, indicated that Boci, Monarch,

Mondial, Real Skapis and Kriva Hotel were efficient during year 2014; Grand, Guri, Imperial, Skapma and Univers Hotel had DRS. Inefficient hotels can improve their efficiency by increasing their level of outputs for the same level of inputs. For inefficient Hotels, Guri, Imperial and Skampa predominated managerial inefficiency whereas for the other inefficient hotels,Grand and Univers, predominated scale inefficiency.

According to the data reported in table 2, 5 inefficient hotels were operationg at DRS, other 5 hotels were operating at the optimum scale.
Knowing the optimal values of dual variables of the efficient DMUs, for each of 10 models, can be found the reference set and the level of each input /output suggested by DEA.

The optimal level of an input is equal to the sum of products of the values of the actual input of the DMUs with the optimal values of dual variables.

Table 3. Potential improvement in the levels of inputs for inefficient hotels suggested by input oriented CCR model

Inefficient unit	***Reference set***	***Reduction of X_1(%)***	***Reduction of X_2 (%)***	***Reduction of X_3 (%)***
Grand	Boci, Mondial, Real Skampis	10.65	31.25	10.66
Guri	Boci, Mondial, Real Skamis	30.98	58.17	30.98
Imperial	Boci, Monarch, Real Skampis, Kriva	17.00	17.00	17.00
Skampa	Monarch, Mondial, Real Skampis	89.26	66.44	66.44
Univers	Monarch, Mondial	54.52	42.06	42.06

The results of table 4 indicated that all inefficient hotels had input surplus during year 2014 for the same level of output. For the Univers Hotel to achieve the efficiency is required an increase of the first output level (Y_1) with 234%.

Table 4. Potential improvement in the levels of for inefficient hotels suggested by input oriented BCC model

Inefficient unit	***Reference set***	***Reduction of X_1(%)***	***Reduction of X_2 (%)***	***Reduction of X_3 (%)***
Guri	Boci, Mondial, Real Skamis	20.17	38.47	20.17
Imperial	Boci, Monarch, Real Skampis, Kriva	55.46	11.67	11.67
Skampa	Monarch, Mondial, Real Skampis	73.33	5.72	5.72
Univers	Monarch, Mondial	78.92	38.83	22.57

To become efficient, Guri hotel must increase the level of Y_2 by 218%, Skampa hotel should increase the level of Y_1 by 101% and the level of Y_2 by 392%, whereas Univers must should the level of Y_1 by 281%.

Table 5. Potential improvement in the levels of outputs for inefficient hotels suggested by output oriented CCR model

Inefficient unit	***Reference set***	***Increase of Y_1(%)***	***Increase of Y_2 (%)***
Grand	Boci, Mondial, Real Skampis	11.90	11.92
Guri	Boci, Mondial, Real Skamis	44.9	44.9
Imperial	Boci, Monarch, Real Skampis, Kriva	20.5	20.5
Skampa	Monarch, Mondial, Real Skampis	198	198
Univers	Monarch, Mondial	477	72.6

For Grand Hotel is required and reduction of the level of X_2 of 23%, for Guri Hotel 39.4%,
whereas for Skampa and Univers an reduction of 68% and 21.5% respectively for the input X_1, in order to achieve efficient frontier.

Table 6. Potential improvement in the levels of outputs for inefficient hotels suggested by output oriented BCC model

Inefficient unit	***Reference set***	***Increase of Y_1(%)***	***Increase of Y_2 (%)***
Guri	Boci, Mondial, Real Skamis	42.4	42.4
Imperial	Boci, Monarch, Real Skampis, Kriva	12.1	12.1
Skampa	Monarch, Mondial, Real Skampis	197	197
Univers	Monarch, Mondial	366	23.83

For Guri Hotel is required to reduce the level of X_2 by 40.4%, for Imperial to reduce the level of X_1 by 45.88%, for Skampa to reduce the level of X_1 by 68.8% and for Universe to reduce the level of X_1 by 76.2% and level of X_2 by 27.55% in order to became efficient.

V. CONCLUSIONS

The aim of this study was to measure the efficiency of hotel units operating in Elbasan, and to identify the inefficiency causes, using CCR and BCC DEA models, with both orientations (input and output). The results of analysis, indicated that 50% (5 out of 10) hotel units were technical efficient, and other were inefficient. The average technical efficiency score of the sample units was 83.3 percent. For each inefficient hotels was calculated the level of inputs and outputs suggested by DEA to make them efficient. It is found that half of the hotels had input surplus and 40% had output slack during year 2014. But, the inefficient banks may not become efficient by simply reducing the level of inputs. A detailed analysis is required to determine other underlying causes of inefficiencies.

Some characteristics that make DEA a powerful method are: DEA can handle multiple input and multiple output models; it do not require an assumption of functional form relating inputs to outputs; DMUs are directly compared against another unit or combination of other units; inputs and outputs can be measured in different units (number or value). Some limitation of that should keep in mind when choosing to use or not to use DEA are: measurement error can cause significant problems; DEA is a good method to compare a unit with other homogenous units in the sample, not compared to a "theorical maximum"; the number of DMUs must be greater than the double of the sum of inputs and outputs variables.

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