DATA ENVELOPMENT ANALYSIS
A TECHNIQUE FOR MEASURING EFFICIENCY

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ABSTRACT

Universities play an important role in the social and economical development of a country. Therefore, governments usually provide the financial resources universities need. On the other hand, universities should be efficient in satisfying the government's conditions of functional resources.

Finding a transparent and systematic way to distributing the funds to each university is a major challenge for government. With participation in higher education amongst young people rising, governments around the world have been faced with increasing pressure on their finances, giving rise to the need to operate universities with a higher degree of efficiency.

Data Envelopment Analysis (DEA) is a powerful method widely used in the evaluation of performance of Decision Making Units (DMUs). These can be business units, government agencies, police departments, hospitals, educational institutions, and even people DEA have been used in the assessment of athletic, sales and student performance). This paper provides an introduction to DEA and some important methodological extensions that have improved its effectiveness as a productivity analysis tool. Data Envelopment Analysis (DEA) techniques are used to estimate technical and scale efficiency of individual Saudi Arabia universities 2010. The purpose of this paper is to present basic principles of DEA and evaluate its application possibilities to assess the performance of nineteen Saudi Arabia universities. DEA is a choice between constant returns to scale CRS and variable returns to scale VRS. The CRS efficiency score represents technical efficiency, which measures inefficiencies due to input/output configuration and as well as size of operations. On the other hand, the VRS efficiency score represent pure technical efficiency, that is, a measure of efficiency without scale efficiency. The results found that the number of universities with maximum relative efficiency was ten out of nineteen universities when CRS was used. The number of universities with maximum relative efficiency was fifteen out of nineteen universities when VRS was used. The percentage of inefficiency was determined for each inefficient university, together with the extent of inputs that could be reduced and the extent of outputs that could be increased in these universities in order for them to be fully efficient.

Keywords: Data Envelopment Analysis, Decision Making Units, efficiency, Saudi Arabia universities.

INTRODUCTION

Data Envelopment Analysis has become a popular tool for evaluating the efficiency of decision making units. Data Envelopment Analysis (DEA) is a nonparametric mathematical programming approach to the measurement of efficiency that was introduced in the operations research literature by Charnes, Cooper, and Rhodes (1978) and Banker, Charnes, and Cooper (1984). The nonparametric approach has been widely applied to educational production. Using linear programming, an observed decision making unit (DMU) is evaluated relative to the production frontier, which consists of combinations of observed production possibilities using minimal assumptions. The primary advantage of the approach is the ability to handle multiple inputs and multiple outputs, particularly in the case when input prices are unavailable. One important application of (DEA) is to the analysis of educational production. Many states have undergone legal challenges because school districts are not providing educational services efficiently and outcomes are not adequate. Reform has moved away from traditional issues like equity to adequacy and efficiency. The important policy implication is that school districts need to spend their money more wisely and increase their outcomes to acceptable levels. One popular technique that has been used for measuring efficiency in education is DEA. DEA is used to measure the performance of educational production in nineteen Saudi Arabia universities. The results found that the number of universities with maximum relative efficiency was fifteen out of nineteen universities when VRS model was used. DEA is most useful when a comparison is sought against "best – practice" Decision Making Units (DMUs).

DATA ENVELOPMENT ANALYSIS AND UNIVERSITIES

With participation in higher education amongst young people rising, governments around the world have been faced with increasing pressure on their finances, giving rise to the need to operate universities with a higher degree of efficiency. The higher education sectors of many countries obtain at least some of their income from public funds making it essential, in the interests of accountability, to measure the efficiency of the institutions which comprise these sectors. The series of application of DEA in education started with the article by Charnes et al in 1981. Thereafter several studies have applied DEA in measuring the efficiency of schools. The series of application of DEA in education started with the article by Bessent and Bessent (1980) used DEA in measuring the relative efficiency of education programs in an urban school district and to identify those that are less efficient than others with respect to the Pareto optimality criterion. The study demonstrated how DEA can be used in improving programs, terminating programs, initiating new programs, or discontinuing inefficient programs. Vargas and Bricker (2000) combined the Charnes, Cooper and Rhodes CCR output oriented model of DEA and Factor Analysis to evaluate the performance of academic units of a university's graduate programs relative to their counterparts nationally. Factor analysis and constructed outputs can be deduced from the observable outputs, and can be expressed as a linear combination of observed and random components. Ng and Li (2000) presented study attempted to examine the effectiveness of education reform implemented in china. The study focused on the research performance of the institutions, individual institution efficiency is computed by the method of DEA. The study found that research performance of institutions across regions has improved, although the institutions as a whole have remained inefficient. Moreno and Tadepalli (2002) proposed DEA for evaluating the efficiency of academic departments at a public university. The study provided the DEA as a single measure of efficiency for academic unit, and identified the causes behind the inefficiencies exhibited by poor performing. Afonso and Aubyn (2005) addressed the efficiency in education and health sectors for a sample of organization for economic co-operation and development (OECD) countries by applying two alternative non – parametric methodologies Free Disposable Hull and DEA. Those are two areas where public expenditure is of great importance so that findings have strong implications in what concerns public sector efficiency. Johns (2006) applied DEA to Economics graduates from United Kingdom universities in order to assess teaching efficiency. The results suggested that the efficiencies derived from DEA performed at an aggregate level include both institution and individual components, and are therefore misleading. Thus the unit of analysis in a Data Envelopment Analysis is highly important. Ruggiero (2006) applied DEA to aggregated data and show that aggregation can lead to unbiased efficiency estimates. These results represent an important contribution to the Data Envelopment Analysis literature, and performance evaluation using aggregate data can produce reliable results, even when measurement error is substantial. Johnes (2006) examined the possibility of measuring efficiency in the context of higher education. The paper begins by exploring the advantage and drawbacks of the various methods for measuring efficiency in the higher education context. The ease with which DEA can handle multiple inputs and multiple outputs makes it an attractive choice of technique for measuring the efficiency of higher education institutions (HEIs), yet its drawbacks cannot be ignored. Johnes and Li YU (2008) this study used DEA to examine the relative efficiency in the productivity research of 109 Chinese regular universities in 2003 and 2004. Output variables measure the impact productivity of research; input variables reflect staff, students, capital and resources. Mean efficiency is just over 90% when all inputs and outputs variables are included in the model, and this falls to just over 80% when student – related input variables are excluded from the model. The rankings of universities across models and time periods are highly significantly correlated. Emrouznejad and et.al. (2008) presented an extensive; if not nearly complete, listing of DEA research covering theoretical developments as well as "real – world" applications from inception to the year 2007. Kao and Hung (2008) applied data envelopment analysis (DEA) to assess the relative efficiency of the academic departments at National Cheng Kung University in Taiwan. The outputs considered are total credit- hours, publications, and external grants; and the inputs utilized by the departments are personal, operating expenses, and floor space. Toth (2009) aimed to determine the relationship between the efficiency of European higher education's systems and the degree of state support as well as the family's socio-economic background. The study found that the GDP per capita has the most considerable influence on what results the countries achieve in higher education relative to their inputs, and the degree of the state contribution is negatively correlated to the efficiency measure. For solving this problem, two major trends were formed:

stochastic (based on probability) analysis and the so-called Data Envelopment Analysis (DEA) requiring mathematical programming. Rayeni and Saljooghi (2010) computed disaggregate performance measures of universities. The traditional models for data envelopment analysis (DEA) type performance measurement are based on thinking about production as a "black box". Network DEA models consider processed which represent the main component of the system being studied. Chen and Chen (2011) presented Inno-Qual performance system (IQPS) which is adopted by using data envelopment analysis (DEA) to evaluate the Inno-Qual efficiency of 99 Taiwanese universities. The found that over half (73%) of the universities are highly inefficient in improving the Inno-Qual performance. Lopez and et.al (2011) measured the technical efficiency of the state universities of Mexico using DEA. Some of the conclusions that can be obtained from the analysis of the results are not necessarily the institutions with greater public financing obtained the highest scores of efficiency, in the case of the Private Universities (UP), will depend on the conditions under which is to receive pupils to first year, in terms of teaching staff and resources. Agha and et.al (2011) evaluated the relative technical efficiencies of academic departments at Islamic University in Gaza during the years 2004- 2005. The study applied DEA to assess the relative technical efficiency of the academic departments. The study found that the average efficiency score is 68.5% and that there are 10 efficient departments out of the 30 studied. Monaco (2012) provided an assessment of levels of technical efficiency in university education among Italian universities and, subsequently, analyzes the environmental factors which may justify different levels of technical efficiency. In particular, the study examined the relationship between levels of technical efficiency and choices of university dropout. Therefore, the study estimated technical efficiency of Italian universities applying DEA on data collected by the National Evaluation Committee (CNVSU), relative to the academic year 2009/10. Sav (2012) estimated and compared operating efficiencies of publicly owned associate degree granting colleges in the United States using data envelopment analysis (DEA) and stochastic frontier analysis (SFA). Comparisons are based on panel data for 698 colleges over four academic years, 2005-09. Included are both constant and variable returns to scale DEA estimates along with half and truncated normal inefficiency SFA estimates. This paper provided DEA and SFA estimates of operating efficiencies for 698 publicly owned and operated two-year colleges accredited to offer associate degrees in the U.S. Antonio and et.al (2012) proposed an approach to measure the institutional efficiency in Mexican University combining analytic hierarchy process (AHP) with data envelopment analysis (DEA). Both methods are frequently used independently. The use of the two methodologies as an evaluation tool is novel and very useful in institutional efficiency studies. Rahimi and Behmanesh (2012) purposed, combination of data envelopment analysis (DEA) and requisite data mining techniques same as Artificial Neural Network (ANN) and Decision Tree (DT) are employed in order to enhance the power of predicting the DMUs evaluation performance because of their well- known efficiency and thereby to present precise decision rules for improving their efficiency.

Pareto- Koopmans Efficiency

Formalization of the efficiency concept began with Pareto in 1927. Pareto efficiency (optimality) is attained by any DMU if and only if none of its inputs or outputs can be improved without worsening some of its other inputs or outputs [Charnes et al., 1994].

Koopmans, 1951 adapted Pareto efficiency to the production process by defining optimality as the productive efficiency analog to the efficiency measure developed by Pareto. So, he introduced the first definition of technical efficiency. Koopmans efficiency occurs when no output can be increased without decreasing another output given the resource constraints. In other words, an input-output vector is technically efficient if and only if increasing any output or decreasing any input is possible only by decreasing some other output or increasing some other input.

Farrell Efficiency

The first measure of technical efficiency was proposed by Debreu, 1951. Despite the theoretical relevance of this study, efficiency was not quantified in it. This task was undertaken by Farrell, 1957, who considered the pioneer in the measurement of technical efficiency as he measured the efficiency of agricultural production in the United States.

Farrell proposed that the efficiency consists of two components: technical efficiency, which reflects the ability to obtain maximal output from a given set of inputs (or the ability to produce a given physical output with a minimum quantity of inputs), and allocative (price) efficiency, which reflects the ability to use inputs in optimal proportions given their respective prices. A combination of technical and allocative efficiency yields a measure of total economic (overall) efficiency.

Farrell's Technical-Efficiency measurement method was able to consider more than one output or more than one input simultaneously. His approach allowed an analyst to measure the productivity in terms of a single input that produces two separate outputs or two inputs used to produce a single output. It was able to plot the efficiency rating of organizations in relation to one another, and created an efficiency frontier, or set of best performers. These best performers could be plotted on the efficient frontier, since they use their inputs most efficiently to create outputs. This approach however has a limitation of working only for two inputs/outputs simultaneously [Sav 2012].

The relative technical efficiency of any DMU is calculated by forming the ratio of a weighted sum of outputs to a weighted sum of inputs, where the weights (multipliers) for both outputs and inputs are to be selected in a manner that calculates the Pareto efficiency measure of each DMU subject to the constraint that no DMU can have a relative efficiency score greater than unity [Lopez and et.al 2011].

The efficiency score in the presence of multiple input and output factors is defined as:

$$DEA\ efficiency = \frac{weighted\ sum\ of\ outputs}{weighted\ sum\ of\ inputs} \quad (2.1)$$

$$Efficiency\ of\ unit\ (j) = \frac{u_1 y_{1j} + u_2 y_{2j} + \ldots}{v_1 x_{1j} + v_2 x_{2j} + \ldots} \quad (2.2)$$

where

u_i: weight of output i; $i=1, 2, \ldots$

y_{ij}: quantity of output i derived from unit j.

v_k: weight of input k; $k=1, 2, \ldots$

x_{kj}: quantity of input k used by unit j.

In the process, DEA assigns an efficiency score, ranging between zero and one, to each unit by comparing the efficiency score of each unit with that of its peers. It identifies a frontier comprising best performers. Those units that lie on the frontier, achieving an unity efficiency score since they have the most appropriate combinations of input and output variables, are recognized as efficient, and those that do not, with efficiency scores of less than one are referred to as inefficient ones, which means that a linear combination of other units from the sample could produce the same vector of outputs using a smaller vector of inputs.

Data Envelopment Analysis Models

Since 1978, when DEA was originally introduced by Prof. A Charnes, Cooper and Rhodes, many different models have been developed by various researchers. Two basic models are CCR [Charnes et al., 1978] and BCC [Banker et al., 1984]. However, there are numerous models and selection of an appropriate model depends on the nature of production-technology. The objective of DEA models is to evaluate overall efficiencies of decision making units (DMUs) that are responsible to convert a set of inputs into a set of outputs. In general, these models differ in their orientation (input orientation, output orientation ...), disposability (strong, week), diversification and returns to scale (constant returns to scale (CRS), variable returns to scale (VRS).

The input oriented DEA models measure how efficiently inputs generate the existent output by looking at units with the same amount of outputs and compare their input quantities. To improve performance, inputs should be reduced. Inefficiencies quantify a slack, the needed reduction of inputs to maintain the existing levels of outputs. When the inefficiently used inputs are reduced, the unit in question becomes efficient. So, the objective of input oriented models is to minimize inputs while producing at least the given output levels. **The output oriented** DEA models measure the potential increase in outputs given the existent levels of inputs. So, they try to maximize outputs while using no more than the observed amount of any input. Here, inefficiencies quantify a slack as well: the needed increase in outputs to effectively use the existing levels of inputs to generate outputs. With inputs constant, the output increases to an efficient level, because currently they do not generate efficient performance relative to the levels of inputs used [Cooper, and et.al 2000], [Sav 2012][Lopez and et.al 2011].

Returns to scale (RTS) refers to a technical property of production that examines changes in output subsequent to a proportional change in all inputs (where all inputs increase by a constant). If output increases by that same proportional change assuming that one unit of input results in one unit of output, then there are constant returns to scale (CRS). The variable returns to scale (VRS) assume that one unit of input can result in one unit of output, less than one unit of output or more than one unit of output.

The basic four models of DEA are: the CCR model, the BCC model, the additive model and the multiplicative model. The models CCR model, the BCC model will be discussed as follows.

The Charnes, Cooper and Rhodes (CCR) Model

The CCR model was developed by Charnes, Cooper and Rhodes in 1978 to measure production efficiency under constant returns to scale (CRS) conditions.

Assume that there are *n* decision making units, and that the decision making units under consideration convert *m* inputs to *s* outputs. In particular, let the *k*th decision making unit (DMU) produces outputs y_{rk} using x_{ik} inputs. To measure the efficiency of this conversion process by a DMU, a fractional mathematical programming model, denoted as (2.3), is proposed.

Primal form of CCR linear programming model is given as follows:

$$Max\ h_k = \frac{\sum_{r=1}^{s} u_{rk}\ y_{rk}}{\sum_{i=1}^{m} v_{ik}\ x_{ik}}$$

$$Subject\ to \qquad (2.3)$$

$$\frac{\sum_{r=1}^{s} u_{rk}\ y_{rj}}{\sum_{i=1}^{m} v_{ik}\ x_{ij}} \leq 1, \quad j=1,\dots,n$$

$$u_{rk}, v_{ik} \geq 0, \quad r = 1, \dots, s, \quad i = 1, \dots, m$$

where

k: the decision making unit being evaluated in the set of $j = 1, 2, \ldots, n$ decision making units.

h_k: the measure of productivity or efficiency of decision making unit "k" in the set of $j = 1, 2, \ldots, n$ decision-making units (DMUs) rated relative to the others.

y_{rk}: the amount of output "r" produced by DMU "k" during the period of observation.

x_{ik}: the amount of resource input "i" used by DMU "k" during the period of observation.

y_{rj}: the amount of service output "r" produced by DMU "j" during the period of observation.

x_{ij}: the amount of resource input "i" used by DMU "j" during the period of observation.

u_{rk}: the coefficient or weight assigned to service output r computed in the solution to the data envelopment analysis model.

v_{ik}: the coefficient or weight assigned to resource input "i" computed in the solution to the data envelopment analysis model.

m: the number of resources or inputs used by the DMUs.

s: the number of services or outputs produced by the DMUs [Raveh and Adler, 2008].

The objective function of the model maximizes the ratio of weighted outputs to weighted inputs for the DMU under consideration subject to the condition that the similar ratios for all DMUs be less than or equal to one. The kth DMU is the base DMU in the above model. The optimal value of the objective function of the model is the data envelopment analysis efficiency score assigned to the kth DMU.

It is difficult to solve the above model because of its fractional objective function. However, if either the denominator or numerator of the ratio is forced to be equal to one, then the objective function will become linear, and a linear programming problem can be obtained.

Linear form of CCR model is given as follows:

$$Max \ h_k = \sum_{r=1}^{s} u_{rk} \ y_{rk}$$

Subject to:

$$\sum_{i=1}^{m} v_{ik} \ x_{ik} = 1 \qquad (2.4)$$

$$\sum_{r=1}^{s} u_{rk} \ y_{rj} - \sum_{i=1}^{m} v_{ik} \ x_{ij} \leq 0, \quad j=1,...,n$$

$$u_{rk}, v_{ik} \geq 0, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m$$

where

k: the decision making unit being evaluated in the set of $j = 1, 2, \ldots, n$ decision making units.

h_k: the measure of productivity or efficiency of decision making unit "k" in the set of $j = 1, 2, \ldots, n$ decision-making units (DMUs) rated relative to the others.

y_{rk}: the amount of output "r" produced by DMU "k" during the period of observation.

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x_{ij}: the amount of resource input "i" used by DMU "j" during the period of observation.

u_{rk}: the coefficient or weight assigned to service output r computed in the solution to the data envelopment analysis model.

v_{ik}: the coefficient or weight assigned to resource input "i" computed in the solution to the data envelopment analysis model.

m: the number of resources or inputs used by the DMUs.

s: the number of services or outputs produced by the DMUs [Cooper, and et.al 2000].

A special case called weakly efficient causes the DEA model to be modified in practice. A particular DMU may be weakly efficient if, in the solution to the DEA linear programming model, its DEA efficiency score is 1 and one or more of its weights are equal to zero, but, it is actually dominated by points on the convex hull. To address this problem the Charnes, Cooper and Rhodes DEA formulation requires each weight to be greater than ε, an infinitesimal value, to assure that weakly efficient DMUs are not classified as efficient [Raveh and Adler, 2008]. The modified linear formulation therefore becomes:

$$Max\ h_k = \sum_{r=1}^{s} u_{rk}\, y_{rk}$$

Subject to:

$$\sum_{i=1}^{m} v_{ik}\, x_{ik} = 1 \qquad (2.5)$$

$$\sum_{r=1}^{s} u_{rk}\, y_{rj} - \sum_{i=1}^{m} v_{ik}\, x_{ij} \le 0, \quad j=1,...,n$$

$$u_{rk},\ v_{ik} \ge \varepsilon, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m$$

ε: an infinitesimal positive number which constrains the input and output coefficients to be positive, eliminating the possibility that they will be given a zero relative value in the data envelopment analysis results.

The dual of the CCR model is represented by (2.6) which considered as **the input oriented CCR model:**

$$
\begin{aligned}
& Min \quad \theta \\
& Subject\ to: \\
& \sum_{j=1}^{n} \lambda_j \ x_{ij} \ \leq \ \theta \ x_{ik} \qquad ; i = 1, 2, ..., m \qquad (2.6) \\
& \sum_{j=1}^{n} \lambda_j \ y_{rj} \ \geq \ y_{rk} \qquad ; r = 1, 2, ..., s \\
& \lambda_j \ \geq \ 0 \qquad ; j = 1, 2, ..., n
\end{aligned}
$$

where

k: the decision making unit being evaluated in the set of j = 1, 2, …, n decision making units.

y_{rk}: the amount of output "r" produced by DMU "k" during the period of observation.

x_{ik}: the amount of resource input "i" used by DMU "k" during the period of observation.

y_{rj}: the amount of service output "r" produced by DMU "j" during the period of observation.

x_{ij}: the amount of resource input "i" used by DMU "j" during the period of observation.

θ: the efficiency score.

λ_j: the weights allocated to the various DMUs in a composite unit with outputs $\sum_{j=1}^{n} \lambda_j \ y_{rj}$ and inputs $\sum_{j=1}^{n} \lambda_j \ x_{ij}$.

m: the number of resources or inputs used by the DMUs.

s: the number of services or outputs produced by the DMUs [Raveh and Adler, 2008].

AN APPLICATION OF DATA ENVELOPMENT ANALYSIS IN Saudi Arabia UNIVERSITIES

Data and Methodology:

Data collected on inputs and outputs for universities in Kingdom of Saudi Arabia for the academic year 2010 form the basis of the analysis. DEA was chosen as the analysis technique for a number of reasons, not least that there is no restriction on the types of variables which can be included in the analysis. In DEA studies variables can be measured in different units and there is no need to convert them in to a common scale.

The proposed model was planned to include seven variables. Four input variables and three output variables in this study. The first step in applying DEA is to identify the set of input and output measures to be included in the analysis. The objective is to select a set of inputs and outputs that are relevant to performance appraisal and for which a moderate statistical relationship exists. The study suggests the following four inputs and three outputs. The first input variable is the money appropriations or the budget for each university. The second is the total number of academic teaching staff. The third is the number of non academic teaching staff. Non academic teaching staff administers students, teaching and research staff generally which facilitate the teaching and research process. The fourth is the number of collage. The first output is the total number of enrolled students. The second is the total number of new student. The third is the total number of the graduates last year. DEA- Solver professional version is used to run a DEA performed on the assumption that all the defined inputs affect the process of production using an input- oriented approach. The CRS efficiency score represents technical efficiency, which measures inefficiencies due to input/output configuration and as well as size of operations. On the other hand, the VRS efficiency score represent pure technical efficiency, that is, a measure of efficiency without scale efficiency. The study used CRS, and VRS models to measure the efficiency of Kingdom of Saudi Arabia universities. DEA is a non- parametric linear programming technique that computes a comparative ratio of outputs to inputs for each unit, which is reported as the relative efficiency score. The efficiency score is usually expressed as either a number between 0-1 or 0-100%. A decision- making unit with a score less than 100% is deemed inefficient relative to other units. Table 1 represents output and inputs of Saudi Arabia universities which are selected to measure their relative technical efficiency.

Table1. The inputs and outputs of the nineteen universities

university	budget	Teaching staff.	n.collage	adm.& tech.staff	graduates last year	student	New student
King Saud University (Riyadh)	3982	7058	46	3905	10161	76232	19889
King Fahad University for Petroleum & Minerals	767	958	9	1379	1241	9541	3333
King Abdul Aziz University,	2702	5107	25	2243	12540	86107	30609
King Faisal University	833	2358	33	1726	9766	58388	17208
Imam Mohammad Bin Saud Islamic	1702	2092	13	1952	4917	37521	15226
Umm Al-Qura University	1335	2711	24	1347	9337	53201	15941
Islamic University	432	717	5	616	1575	8422	3758
King Khaled University	1214	1984	37	915	8287	54451	12711
Taibah University	841	1528	21	753	7746	44402	14177
Qaseem University	939	1761	26	1067	5738	40797	11471
Taif University	723	1477	18	594	5236	29111	11514
Jazan University	522	1473	14	447	5695	26647	6248
ALJouf University	467	648	15	273	3017	15619	5807
Hail University	398	1287	10	364	2826	17477	4536
Tabuk University	348	690	11	317	3471	14165	5031
AL-Baha University	328	537	11	295	2576	14251	4725
Najran University	279	457	10	217	1495	8795	2785
AL-Hudoud alshamalya university	300	356	12	155	1520	7479	3223
Princess Nora university for girls	679	923	33	1203	9151	44708	19843

Data source: King of Saudi Arabia statistical yearbook for 2010.

Descriptive statistics for the data set input and outputs appear in Table 2. One thing is very clear from these: the standard deviations for all variables are high in relation to the mean. As an initial step, correlations were calculated to analyze the candidate set of inputs and outputs and identify variables that are highly interrelated.

Table2. Descriptive statistics for 19 universities (133observations)

	Mean	Standard deviation	minimum	maximum
Inputs				
Budget	989	937.89	279	3982
Teaching staf.	1795.89	1684.69	356	7058
n.collage	19.63	11.22	5	46
adm.&tech.staff	1040.42	931.13	155	3905
Outputs				
Graduates last year	5594.47	3512.61	1241	12540
Student	34069.16	23834.11	7479	86107
New student	10949.21	7606.76	2785	30609

Table 3 shows correlations among all study input and output variables. Correlations among all variables are approximately strong and positive correlation. This shows the careful selection, existence of relationships between input and output variables.

Table3. Correlation coefficients among inputs and outputs

	budget	teaching staf	n.collage	adm.& tech.staff	grdutes last year	student	new student
Budget	1						
Teaching staf.	.972	1					
n.collage	.672	.702	1				
adm.&tech.staff	.939	.912	.693	1			
grdutes last ye	.679	.745	.834	.669	1		
student	.811	.856	.842	.785	.968	1	
new student	.737	.755	.726	.730	.938	.946	1

Results:

In this study the DEA when input orientation is performed with CRS and VRS. The study choosing between CRS and VRS is to run the performance models under each assumption and compare the efficiency scores. The nineteen Saudi Arabian universities were tested under constant returns to scale CRS and variable returns to scale VRS. Comparing the two runs reveals different efficiency scores, thus confirming the presence of variable returns to scale among Saudi Arabian universities.

In Table 4 the study present, for the 19 universities, efficiency scores in the hypothesis of constant returns to scale CRS shows that only a 52%of universities in the sample have a very high level of efficiency, while 48% of them have low level of efficiency. Variable returns to scale VRS shows that only a 78%of universities in the sample have a very high level of efficiency, while 22% of them have low level of efficiency.

Table4. CRS, VRS efficiency scores for nineteen universities

University (DMU Name)	Input- oriented CRS efficiency	Input- oriented VRS efficiency
King Saud University (Riyadh)	0.56558	0.58289
King Fahad University for Petroleum & Minerals	0.43707	0.70268
King Abdul Aziz University, Jeddah	1.0000	1.0000
King Faisal University	1.0000	1.0000
Imam Mohammad Bin Saud Islamic University	1.0000	1.0000
Umm Al-Qura University	0.94626	0.99848
Islamic University	0.74394	1.0000

King Khaled University	1.0000	1.0000
Taibah University	1.0000	1.0000
Qaseem University	0.78870	0.80255
Taif University	1.0000	1.0000
Jazan University	1.0000	1.0000
ALJouf University	1.0000	1.0000
Hail University	0.82884	1.0000
Tabuk University	1.0000	1.0000
AL-Baha University	0.88561	1.0000
Najran University	0.668710	1.0000
AL-Hudoud alshamalya university	0.98817	1.0000
Princess Nora university for girls	1.0000	1.0000

In this study King Fahad University for Petroleum & Minerals is the least efficient unit (efficiency=0.43707). DEA identify a facet or cone in order to create a smaller, more relevant comparison set. The efficient units identified by DEA analysis are King Abdul Aziz University, Imam Mohammad Bin Saud Islamic University and Taibah University. Therefore, for King Fahad University for Petroleum & Minerals to become efficient, it would have to emulate King Abdul Aziz, Imam Mohammad Bin Saud Islamic and Taibah universities. DEA calculates slacks which specify the amount by which an input or output must be improved in order for the university to become efficient. In the King Fahad University for Petroleum & Minerals there are two input slacks, (budget=65.26322 and adm & teach. Staff=331) and one output slacks (graduates last year= 266) in order for the university to become efficient. Table5. Computed slacks (an input or output) for all insufficient universities when CRS model was used.

Computed slacks (an input or output) for all insufficient universities when VRS model was used in table 6.

Table5. Slacks (an input or output) for all inefficient universities when CRS model was used.

university	budget	Teaching staff.	n.collage	adm.& tech.staff	graduates last year	student	New student
King Saud University (Riyadh)	124.533	0	0	416	1553	0	6440
King Fahad University for Petroleum & Minerals	65.2632	0	0	331	266	0	0
King Abdul Aziz University,	0	0	0	0	0	0	0
King Faisal University	0	0	0	0	0	0	0
Imam Mohammad Bin Saud Islamic	0	0	0	0	0	0	0
Umm Al-Qura University	28.3086	0	0	215	0	0	467
Islamic University	29.979	0	0	190	0	1704	0
King Khaled University	0	0	0	0	0	0	0
Taibah University	0	0	0	0	0	0	0
Qaseem University	0	0	0	63	1438	0	1821
Taif University	0	0	0	0	0	0	0
Jazan University	0	0	0	0	0	0	0
ALJouf	0	0	0	0	0	0	0

University							
Hail University	0	463	0	2	221	0	1038
Tabuk University	0	0	0	0	0	0	0
AL-Baha University	23.66	0	2	0	0	0	52
Najran University	24.94	5	2	0	50	0	0
AL-Hudoud alshamalya university	42.84	0	3	0	147	1137	0
Princess Nora university for girls	0	0	0	0	0	0	0

Table6. Slacks (an input or output) for all insufficient universities when VRS model was used .

university	budget	Teaching staff.	n.collage	adm.& tech.staff	graduates last year	student	New student
King Saud University (Riyadh)	100.205	0	0	285	1559	0	8108
King Fahad University for Petroleum & Minerals	132.385	0	0	429	520	0	572
King Abdul Aziz University,	0	0	0	0	0	0	0
King Faisal University	0	0	0	0	0	0	0
Imam Mohammad Bin Saud Islamic	0	0	0	0	0	0	0
Umm Al-Qura University	0	99	0	47	0	4473	3078
Islamic University	0	0	0	0	0	0	0
King Khaled University	0	0	0	0	0	0	0

Taibah University	0	0	0	0	0	0	0
Qaseem University	0	0	0	80	1416	0	1698
Taif University	0	0	0	0	0	0	0
Jazan University	0	0	0	0	0	0	0
ALJouf University	0	0	0	0	0	0	0
Hail University	0	0	0	0	0	0	0
Tabuk University	0	0	0	0	0	0	0
AL-Baha University	0	0	0	0	0	0	0
Najran University	0	0	0	0	0	0	0
AL-Hudoud alshamalya university	0	0	0	0	0	0	0
Princess Nora university for girls	0	0	0	0	0	0	0

Conclusion:

Universities play an important role in the social and economical development of a country. Therefore, governments usually provide the financial resources universities need. DEA is a powerful method widely used in the evaluation of performance of Decision Making Units (DMUs). These can be business units, government agencies, police departments, hospitals, educational institutions, and even people DEA have been used in the assessment of athletic, sales and student performance).

Data Envelopment Analysis (DEA) techniques are used to estimate technical and scale efficiency of individual Saudi Arabia universities 2010. The purpose of this paper is to present basic principles of DEA and evaluate its application possibilities to assess the performance of nineteen Saudi Arabia universities 2010. For this purpose a ranking analysis was carried out according to the relative efficiency score. This efficiency may be a convenient method to rank policy alternatives in the case of an absence of information on stated preferences on outcomes, as well as negative environmental impacts. The results found that the number of universities with maximum relative efficiency was ten out of nineteen universities (52%) when CRS was used. The number of universities with maximum relative efficiency was fifteen out of nineteen universities (78%) when VRS was used. The percentage of inefficiency was determined for each inefficient university, together with the extent of inputs that could be reduced and the extent of outputs that could be increased in these universities in order for them to be fully efficient. The paper proposes a methodology based on DEA, a non parametric benchmarking technique, specifically developed to assess the relative efficiency of alternative water pricing policies. For this purpose a ranking analysis was carried out according to the relative efficiency score. This efficiency may be a convenient method to rank policy alternatives in the case of an absence of information on stated preferences on outcomes, as well as negative environmental impacts.

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