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An Evaluation of the Performance of Higher Educational Institutions using Data Envelopment Analysis: An Empirical Study on Algerian Higher Educational Institutions

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Received: 14 December 2016 Accepted: 4 January 2017 Published: 15 January 2017

Abstract

The aim of this research paper is to clarify to evaluate the performance of the Algerian institutions of higher education using data envelopment analysis method based on the concept of benchmarking. Five indicators of inputs as well as outputs that reflect three dimensions of teaching, learning, and scientific research were used were used; total number of students enrolled in graduation, total number of students enrolled in post-graduation, permanent professors, graduated students, and scientific publications. The findings of data envelopment analysis pointed out that there is a significant variation in the performance of the Algerian institutions of higher education in favor of the academic years. It was highlighted that inefficient internal processes or poor conditions surrounding these processes were the main causes of the weak performance.

Index terms— data envelopment analysis method, efficiency, performance indicators, performance evaluation.

1 Introduction

ne of the most common conceptualizations of performance was the evaluation of this concept based on the financial outcomes using the income statement or so-called profit and loss account. However, complexity of business structures and transactions along with the multiplicity of financial reporting standards make the identification and evaluation of performance harder (ICAS, 2016), which in turn led to question the efficiency and effectiveness of using the rest of the institution's resources, i.e., nonfinancial resources in the process of performance evaluation. Hence, new approaches and methods used to evaluate the performance of profit-oriented or nonprofit institutions using different institutional resources have been considered. In fact, the simplest and oldest method utilized to evaluate performance depends on calculating the technical efficiency index that goes along with Farrell's (1957) definition of efficiency, which deemed efficiency as a ratio of outputs to inputs, provided that all inputs as well as outputs are assessed correctly. Farrell's (1957) definition evinces that a highly efficient institution is the one that has succeeded in producing as many outputs as possible using a specified amount of inputs. Thereupon, one can considers that the definition of Farrell remains acceptable and valid if an institution have a multiple homogeneous outputs and multiple homogeneous inputs withknown relative weights. Consequently, performance can be evaluated by calculating the efficiency index, which equals the ratio of total homogeneous output to total homogeneous inputs (Kaftroodya & Aminnaserib, 2014) as shown in the following equation:

2 Performance

(efficiency) index = (U 1 Y 1 +U 2 Y 2 +?+UrYr) / (V 1 X 1 +V 2 X 2 +?+VmXm), where Y: outputs X: inputs U1, U2, ? Ur: relative weights of outputs V1, V2, ? Vm: relative weights of inputs Even though clarity and accuracy of the above equation, the process of measuring the performance of higher education institutions is not easy, especially as they fall within the complex organizations that use multiple and different inputs to produce multiple and different outputs. In this sense, the current study aims at clarifying the extent to which the performance of higher education institutions can be measured and evaluated using a relatively modern method known as data envelopment analysis, which is based on benchmarking and is widely used in assessing the performance of many non-profit institutions.

For the purpose of the current study, the detailed overview of data envelopment analysis and how this analysis can be used to evaluate the performance of institutions in general, was included in the theoretical framework. The empirical part of the study demonstrated how data envelopment analysis was used in the current study to evaluate the performance of Algerian higher education institutions during 16 consecutive academic years.

3 II. Theoretical Framework: A Detailed Overview of Data Envelopment Analysis

The method of data envelopment analysis is a result of a doctoral dissertation prepared by Edwardo Rhodes under the supervision of William Cooper at Carnegie Mellon University's School of Urbanand Public Affairs. The dissertation was designed to evaluate educational programs provided to disadvantaged and underprivileged students, through conducting largescale studies on a sample of similar public schools in the United States, with the support of the federal government. Rhodes was able to access the largest quantitative database with multiple input variables and outputs related to the target group. No information on the prices was available. Consequently, the researcher found it difficult to measure efficiency in an effective manner. Even after several attempts and the use of a set of standard statistical approaches, the researcher did not obtain satisfactory results to evaluate the efficiency of this program in each school (Cooper et al., 2011). Hence, the researcher began to think about a more effective method by re-focusing on Farrell's work published in 1957 in order to develop new models to assess productivity, in addition to reviewing a previous work conducted by the supervisor of the thesis and Charnes, which the researchers presented an applicable mathematical model known as Tjalling Koopmans. A model that falls under the concepts of activity analysis used by Farrell (1957). With the combined efforts of the three researchers, it was concluded that input prices and output quantities could be determined by their ability to meet final demand (identifying inputs through outputs). More importantly, the performance of other decision-making units (public schools) can be used to assess the behavior of each decision unit on all outputs and inputs of other decision-making units used in the study. This enables them experimentally to determine their relative efficiency (Cooper et al., 2011). In 1978, Charnes, Cooper, and Rhodes published a scholarly article in the European Journal of Operations Research, in which the term Data Envelopment Analysis (DEA) was first coined (Cooper et al., 2011). From that time on, the use of this technique spread and many attempts were made to modernize its models. The DEA method is one of the most widely methods used to analyze the efficiency of government organizations (Abbott & Doucouliagos, 2003). A review of the literature revealed that DEA was utilized to evaluate the performance of hospital departments, banks, military institutions, courts, industrial and commercial companies as well as educational institutions, in addition to evaluation of economies of countries.

4 III. The Concept Data Envelopment Analysis

The method of data envelopment analysis is a modern mathematical method used in the field of quantitative management models (Kaftroodya & Aminnaserib, 2014). It is a linear programming technique viewed as a data-oriented approach employed to assess the performance of a group of entities (Cooper et al., 2011). This method is one of the best-known and used approaches to evaluate and compare the relative efficiency of a group of similar decision-making units. It also helps to determine the best practice of resource use among a similar set of organizations or decision-making units. As a technical analysis, the DEA method depends on analyzing a group of decision-making units (DMUs), identifying a group of these units that are fully efficient. This group is regarded as a reference unit for the other inefficient units. Mathematically, DEA is a linear programming procedure for the input and output frontier analysis. The DEA assigns a balance of 1 or 100% for the fully efficient input / output unit compared to the other units and assigns a different balance from one (1) for inefficient units (Rosenmayer, 2014). The group of highly efficient units form a belt that encapsulates all inefficient units. This is actually, why this analysis is named data envelopment analysis (Fahmi, 2009). a) Basic models of data envelopment analysis i. Charnes, Cooper and Rhodes (CCR) Model

The CCR model is the first applied model used the DEA method, which was presented in the research paper that was conducted by Charnes, Cooper and Rhodes in 1978. The short name of this model is the first letters of the names of the three researchers. The model was used to evaluate a program called "Follow through Program" and provided a new definition of the efficiency used in assessing the contribution of non-profit organizations' activities in public programs. A model in which several inputs and outputs of decision-making units participated in this program is monitored in order to extract a numerical scale of the efficiency of each unit, which provides a new way to estimate and identify shortcomings (Charnes at al., 1978).This model calculates the total efficiency and combines it into a single value. It is valid for units that operate at their optimal size. Thereupon, the efficiency index on this model represents CRS as an abbreviation for Constant Returns to Scale. This assumption indicates that the decision-making units (DMU) operate under constant return to scale. That is, any increase in the inputs will result in a proportional increase in the outputs (Marti et al., 2009).

ii. Banker, ??harnes, and Cooper Model Due to the widespread use of data envelopment analysis and its related research, the researchers Banker, Charnes and Cooper developed a model in 1984. This model was abbreviated as BCC based on the first letters of the three researchers' names. It is a model that includes the concept of variable returns to scale rather than constant returns to scale. The reason for this is that it is illogical for all institutions to operate at optimal volumes, especially in the face of competition and restrictions on organizations, whether governmental, financial or otherwise restrictions. Under this mode, a new variablehas been added, (?), which can be used to identify variable returns to scale of the decision-making unit under study ??Mahmoud and Madhar, 2010). This model distinguishes between two types of efficiency, namely, technical efficiency and efficiency scale. The latter is expressed by the following possibilities: First, the change in the results of outputs or inputs is regarded as incremental for the other one, and this known as increasing return to scale (IRS). Second, the increased inputs result in increased outputs, in a percent greater than the increase in the outputs, and this is known as decreasing variable return to scale (DRS). These models can be applied according to the quality of the decision-making units whose performance will be measured, either by input-oriented or outputoriented directing (Fahmi, 2009). Input-oriented directing means measuring efficiency by minimizing inputs, i.e., using a possibleminimum amount of inputs to produce a certain amount of services or outputs. In order to conduct benchmarking using this type of directing, one of the two models can be used. A model known as CCR-I that assumes constant returns to scale by minimizing inputs, or the model known as BCC-I that presumes variable returns to scale by minimizing outputs. On the other hand, output-oriented directing refers to the measurement of efficiency based on maximizing outputs, i.e., the measurement of the efficiency of decision-making units that aim at producing a larger amount of services or outputs using the available amount of inputs. In this case, one of two models can be adapted. A model known as CCR-O that assumes constant returns to scale by maximizing outputs, or the model known as the BCC-O model that postulates variable returns to scale by maximizing outputs.

5 b) The difference between the models of returns to scale

The first difference that can be derived from the concept of each model is that CCR model theorize that all enterprises operate at their optimum size, either by input-oriented or output-oriented directing. In contrast, BCC model considers the change in the return to scale, which may be decreasing, constant or increasing. On the other hand, the efficiency indicators according to the CCR model are determined by input-oriented directing and output-oriented directing are same. Therefore, the application of one direction is adequate. However, one can find that evaluations often differ according to the type of direction, input-oriented or output-oriented in case of BCC application. In fact, the main reason behind this is that the different assumptions of each model (Marti et al., 2009). In most assessments, an efficient decision unit in one model, i.e., CCR, is also found to efficient in the other model, i.e., BCC model. Hence, this unit of decision meets the requirements of the efficient constant returns to scale, or in other words operates at its optimum size (Fahmi, 2009). Finally, the efficiency measurement results from BCC model represents the net efficiency of the internal processes. While the efficiency measurement results from CCR model refers to the overall efficiency. In this case, both models are compared in order to identify the sources of inefficiency of inefficient units; is it due to inefficient internal processes of these units, due to environmental conditions surrounding the work of these units, or due to both reasons size (Fahmi, 2009). c) Advantages of using data envelopment analysis On the basis of the above-mentioned literature related to DEA, one can said that this method represents the best method based on the idea of benchmarking. According to Marti et al. (2009), examples ofDEA advantages include: a frontier-based methodology, analyze every decision making unit alone based on the minimum or maximum scale of performance of each unit. The author regarded DEA as a main alternative that can be used to avoid the use of the limits of random cost, due to the fact that DEA is a non-boundary method. DEA is characterized by a random frontier approach that does not require the development of any mathematical formula related to the functional form of the best mathematical formula of the function that links input and output variables. Cooper et al. (2011) provided additional advantages of DEA such as: the definition of decision making unit is characterized by comprehensiveness and flexibility, DEA requires very few assumptions in order to illustrate the relationship between multiple inputs and outputs correlated to decision making units, the relative effectiveness is defined in accordance of DEA avoids the need for other prices or other assumptions of variables' weights, which must be identified in advance and which are presumed to reflect the relative importance of different inputs and outputs. Finally, DEA enables to avoid the need for clarifying the supposed relationships between inputs and outputs. Fahmi (2009) identified the following advantages of DEA: this method combine both internal efficiency, either quantitative or qualitative, and external efficiency. Therefore, the method deals with descriptive variables that are difficult to measure, such as quality, customer satisfaction with services provided, in case of the availability of sufficient as well accurate qualitative data. On the other hand, DEA deals with factors that are beyond the control of the unit to be measured, determines sources and amounts of constant capacity of inputs used by the less efficient units, determines sources and amounts of excess capacity or the possibility of increasing outputs in less efficient units without increasing inputs. Finally,DEA determines the nature of the return on the volume of production at the limits of efficiency (fixed or variable return). d) Limitations of using DEA Despite the above-mentioned features of DEA, this method has its own shortcomings, such as the identification of identify input and output variables, especially in the higher education sector, which includes multiple and overlapped variables. Montoneri (2014) indicated that the basic models of

DEA, i.e., CCR and BCC model, assess the relative efficiency of decisionmaking units based on benchmarking. However, these models do not permit any ranking or classification of the efficiency of these units. Abbott and Doucouliagos (2003) highlighted that the common practice of the DEA method is to utilize inputs that can only be controlled by senior level officials, usually focused on quantitative inputs, thus eliminating the use of input data and intangible outputs, such as experiences, competencies, quality ... etc., in the process of efficiency analysis and evaluation, despite the possible use of such outputs in case of sufficient data availability. For Rosenmayer (2014), the DEA method reveals the efficiency of inputs used to achieve the required outputs, but does not tell how costs can be reduced or how the value of outputs can be increased using different combinations of inputs and used outputs. e) Basic conditions and rules for measuring and comparing performance using the DEA method It was conclude that meeting the conditions of evaluation and comparing efficiency using DEA requires an available set of symmetric and homogenous decision making units in terms of inputs, outputs with a same objective or same output function. Furthermore, in order to get efficiency in the form of numbers, either coefficients or ratios, the inputs as well as the outputs under DEA method should be positive and quantifiable values. Finally, the relationship between inputs and outputs should be linear, so that an increase in input units results increased units of output and vice versa. Rosenmayer (2014) added that the measurement and comparison of the relative efficiency can be done in one of these cases: a time period for the same entity, multiple entities in the same year, time period and multiple cases.

Concerning the basic rules required to ensure the successful implementation of DEA models, Manzoni (2007) identified three rules. First, the number of decision making units involved in the study should be greater than or equal to the return of inputs and outputs. That is S s ? I*O, where "I" refers to inputs and "O" represents outputs. Second, the number of decision making units involved in the study should be greater than or equal to the sum of inputs and outputs. That is S s ? 2(I+O). the third rule indicates thatthe number of decision making units with full efficiency based onconstant returns to scaleshould be less than or equal to one third of the decision-making units involved in the study. That is, Eff DMUs ? 1/3*S s ,where "I" refers to inputs,"O" represents outputs, Ss represents the sample size, and EffDMUs stands for decision making units with full efficiency. Among various programs designed specifically to measure the performance of a set of similar decision making units using the DEA method, DEAP Version 2.1 will be used to achieve this goal.

IV.

6 Assessment of Algerian Higher Educational Institutions Performance

In order to connect the theoretical framework presented above in the first part of this paper, and to give the study an applied character that proves or rejects the extent to which the DEA models can be used to evaluate performance, this method was appliedto evaluate the performance of the Algerian higher education institutions in each academic year . To achievement of this goal, a series of stages were followed.

7 a) Identification of input and output indicators

The precise identification of the basic input and output group required for the application of data envelopment analysis provides a precise results of performance measurement which facilitate their analysis and subsequent interpretations. For the current study, three inputs and four outputs were selected: Inputs: three inputs were selected, which represents fundamental bases for any educational institution and reflect teaching and learning process. These inputs are:

(1) students enrolled in graduation stage, which comprise the total number of students enrolled in the bachelor's degree. (2) students enrolled in postgraduate stage, which consist all students enrolled in Masters and doctorate programs. (3)Permanent instructors (or academic staff), which include the total number of fulltime members from all academic levels. Outputs: two outputs were selected, which represents academic processes and scientific research. These outputs are: (1) degrees' holders of graduates, which include the total number of students in the graduation stage. (2) scientific publications, which refer to the total number of scientific papers published every year in addition to theses, articles presented in conferences and available on the websites. b) Identification of decision making units Decision making units that reflect the sample of the study to which the data analysis method will be applied, a group of similar entities may be set within one year or may be set within several years related to one entity, or may be set as several entities that reflect a period of time. The present study used decision-making units of 16 academic years, including indicators of inputs and output of all institutions of higher education in Algeria.

8 c) Summarizing data

Table **??** shows a summary of the aggregated data of all higher education institutions in Algeria during 16 academic years.

Table **??**: Indicators of aggregated data of higher education institutions in Algeria for 16 years d) Evaluation of the correct use of DEA method in assessment of higher education institutions in Algeria

Since the input and output indicators shown in Table (1) represent positive quantitative values concern the indicators of the total Algerian higher education institutions over 16 successive academic years, from 2000 to 2015, this allows to initially employ the DEA method to evaluate and compare the performance of these institutions in each year. Before inserting the data in Table **??** into the DEAP program and conducting the DEA method, one should ensure that correct selection of the method and the availability of the conditions of the estimation power of the method. Consequently, following steps were followed: i. Assessment of the positive relationship between inputs and outputs

In order to ensure a positive correlation between the variables of the study, we should ensure that inputs and outputs of the total number of the higher educational institutions in Algeria, which is already organized in Table (1), are correlated. Since we have quantitative variables, Pearson correlation Coefficients (r) were calculated. Table 2 displays the matrix correlation between inputs and outputs of Algerian higher educational institutions. The findings shown in Table 2 reveal that all correlation coefficients are statistically significant at 0.01. The table shows that there is a strong positive correlation of more than 0.9 (90%) among all input and output variables. This indicates a strong positive correlation between the output variables and the three input variables, i.e., the increase in one or all inputs will inevitably lead to an increase in the quantity of outputs. In addition, there is a strong positive correlation coefficient greater than 0.9 (90%), among the three input variables and among the output variables.

ii.

Before analyzing the data presented in Table **??**, the extent to which the initial rules of DEA method should be investigated. The first rule was met due to the result that the return of inputs and outputs is less than the number of decision making units included in the study:[Ss?I*O] [16 >3*2] [16 > 6]

Where O: number of outputs, I: number of inputs, Ss: number of decision making units.

Additionally, the second rule was met by reason of the result that the number of decision making units is greater than the twice of the total of inputs and outputs.[Ss? 2(I+O)] [16 >2(3+2)] [16 > 10]

On the strength of the previous steps it was concluded that the basic requirements for applying DEA model as well as estimation power rules of DEA are all available, which means thatwe have input and output indicators covering 16 academic years (a time period) for one entity, which means the ability to measure the performance and to compare the achieved performance between years. On the other hand, the values of inputs and outputs are positive. The correlation coefficient between the selected indicators of inputs and outputs are positive, which indicates their homogeneity and the existence of a positive relationship between these indicators. The sample size (number of decision-making units) is greater than the return value of inputs and outputs. Moreover, the sample size (number of decisionmaking units) is three times greater than the values of inputs and outputs. Finally, the sum of outputs and inputs are less than one-third of the number of decisionmaking units.

V.

9 Results of the Measurement of the Performance of Algerian Higher Education Institutions Using DEA

After the data entry of the quantitative values of the input and output variables into the analysis software, DEA method was applied by selecting BCC model using output-oriented directing, in order to measure the performance of Algerian higher education institutions during 16 academic years, constant return to scale technical efficiency (Crste), variable return to scale technical efficiency (Vrste), efficiency scale (ES), return to scale (RS), decision making units (DMU). The results are shown in Table 3. Before the discussion of performance results based on BCC-I and BCC-O models, which we explained in detail in Table 3, we should assess the extent to which the third rule of the DEA method is achieved.

EffDMUs ? 1/3*Ss 3 ? 1/3*16 3 < 5.33

The third rule was met, which means that the sample size is acceptable because of the number of decision-making units or the number of academic years with full efficiency according to the Vrsteindicator is less than one-third of the academic years in the study. Since all the requirements and rules of the estimation power were met, this makes the performance measurement results obtained using the DEA method accurate and valid. These results will be analyzed, interpreted and compared as follows:VI.

Discussion of the Results of the Performance of Algerian Higher Education Institutions b ased on

10 BCC-I And BCC-O

We first applied the BCC-I model, which takes into account the change in returns to scale in terms of using the least amount of inputs to achieve a certain amount of outputs. Then, we applied the BCC-O model, which assumes a change in returns to scale , in terms of maximizing outputs using the inputs already available. The BCC model gives both directions one value (1.00 or 100%) for a full efficiency academic year, and a value different from one for the academic year that is not efficient. Through the various indicators of relative efficiency and efficiency scale shown in Table **??**3), we noted the following: (1) there is a variance in efficiency ratios (performance) of Algerian higher education institutions between academic years either by inputoriented or output-oriented directing. (2) Algerian higher education institutions achieved full efficiency in seven academic years according to the Vrste indicator in both models: **??**000, 2001, 2009, 2011, 2013, 2014 and 2015. (3) Higher education institutions have not achieved full efficiency in nine academic years, neither in terms of Crste or Vrste in both input-oriented and output-oriented directing: ??002, 2003, 2004, 2005, 2006, 2007, 2008, 2010 and 2012. (4) Higher education institutions in 2000, 2001, 2009 and 2015 achieved full efficiency in terms of Vrste and did not achieve the efficiency of the Crste, which confirms that Algerian higher education institutions are subject to change in returns to scale from one academic year to another. (5) The Vrste indicators for inefficient academic years were varied in both models and relatively close to the full efficiency rate (i. e., close to 1.00). (??) Algerian higher education institutions from 2000 to 2010, in addition to 2012 (i. e., 12 academic years), were operating at increased returns to scale, which means that the increase in their annual inputs led to an increase in their annual output by a ratio greater than the rate at which inputs increased. Thus, in these years, the Algerian higher education institution could expand its production. This expansion is in varying proportions between an inefficient academic year and another, as shown in the seventh column and the thirteenth column of Table ??3). (??) Higher education institutions in 2011, 2013 and 2014 achieved full efficiency according to Crste, Vrste, and even efficiency scale of institutions of higher education in these years is 1.00, which is the best three academic years in terms of internal processes efficiency, and the overall efficiency of Algerian higher education institutions, and that the institutions of higher education in these years used all inputs to achieve their actual outputs, and it was not in their interest to expand in 2012 and 2015 and had to maintain their optimum performance. (8) Algeria's higher education institutions are working at a decreasing return to scale in 2015, which means that the increase in output of this year required institutions to use more of its inputs.(??) According to the BCC-I model, the year 2000 was a reference academic year for twice; while 2001 and 2013 were repeated as a reference year for eight inefficient academic years, while 2009 was repeated five times as a reference academic year, while 2011 was repeated only three times. (10) According to the BCC-O model, 2000 was repeated for one time as a reference academic year. While 2001 was repeated eight times. On the other hand, 2009 and 2011 was repeated four times as a reference unit for inefficient academic years. The year 2013 was repeated eight times as a reference year for inefficient academic years. (11) 2014, and 2015 have not been repeated as academic reference year for the rest of the academic years is not efficient according to the both models. The above observations, which we obtained by reading the results of Table 3 can be explained by Table 4, in which we explained the quantities of excess inputs and constant outputs according to inputs minimization or output maximization. For quantities of excess inputs and constant outputs in the academic years 2002 to 2008, as well as 2010 and 2012, Algerian higher education institutions did not achieve full efficiency, in accordance with the goal of minimizing inputs and the goal of maximizing output as shown in Table 4.That is, the possibility of achieving outputs in larger quantities than the actual outputs actually shown in Table 3 by using less inputs than actually used, because higher education institutions operate at increased returns to scale. The excess number of first and second entries represented in the total number of students enrolled in the gradate stage, and the total number of students registered in the post-graduate stage, show that the general policy of higher education in Algeria aims to increase the annual quantities of these two inputs, while ignoring the need to maximize outputs, particularly those of total scientific publications.

In our review of the results of the measurement of the quantitative performance of higher education institutions as a unit according to Vrste model in terms of input-oriented or output-oriented directing, we can say that the performance of the higher education institutions in Algeria varies between years. The Algerian higher education institutions were able to use their actual inputs to achieve their actual outputs , i.e., more efficient in 2011, 2013 and 2014 and were operating at their optimal size levels. In the years 2000, 2001 and 2009, although they achieved their actual outputs using their actual inputs, institutions were able to expand their output to achieve the possible outcomes through the use of more than the actual amount of inputs. For the rest of the academic years in which higher education institutions did not achieve full efficiency and were able to use fewer inputs to achieve the same outputs or even maximize these outputs, it was clear through the results of excess inputs, constant outputs, that in the period from 2002 to 2010 there was a large surplus in the number of students enrolled in the graduate stage, and in the years 2002, 2004, 2007, students enrolled in the graduate stage, and in the years ??002, ??004, ??007, ??008, ??010, ??012 there were surplus in the number of students enrolled in the postgraduate phase. the third input represented by permanent academic staff, there were surpluses registered in 2003 only. In the rest of the years, all quantities were used to achieve the actual output possible to use the same quantities to maximize the amount of output as well.

11 VII.

12 Conclusion

This paper aims to explain the effectiveness of using the method of data envelopment analysis in the evaluation of the performance of Algerian higher education institutions, and despite the use of five indicators of inputs and outputs of quantitative values and limited to reflect only the dimensions of teaching and scientific research only, and does not reflect the service of the community and the quality of scientific research. However, the results of the study are useful to various stakeholders and policy makers in the Algerian higher education sector and in other institutions of higher education in the Arab world, because the results this study revealed will facilitate the process of distribution and allocation of resources in future. It also provides institutions with an ideal way

341 to measure and compare the performance of universities, institutes, colleges, and departments and stand on the reasons for the inefficiency of each of them and try to improve its performance in future. [1]

2

Variables	1	2	3	4	5
Total number of students in graduate stage	1				
Total number of students in postgraduate stage	**9800.	1			
Total number of permanent instructors	**9460.	**9880.	1		
Total number of degrees holders	**9330.	**9720.	**9840.	1.	
Total number of scientific publications	**9490.	**9870.	**9960.	**9820. 1	

Significant at p-value ? 0.01
Source: results of SPSS statistics, V. 22

Figure 1: Table 2 :

3

BCC-O

Figure 2: Table 3 :

4

DMU	Excess inputs		Constant outputs	Excess inputs	Constant outputs
Input 1	Input2	3 Input	Output Output		

Figure 3: Table 4 :

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[Source et al. ()] , : Ddp/ Source , Annuaire Sdpp , Republique Statistique ; Mesrs , Algerienne , Et Populaire . 17/10/2017. http://www.scimagojr.com/countrysearch.php?country=dz 2009-2015. (References Références Referencias)

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