Education and Science

Vol 40 (2015) No 177 31-41

Efficiency Analysis of Foundation Universities in Turkey

Gamze Özel Kadılar [1]

Abstract

Inadequacy of ratio analysis and parametric methods when comparing educational institutions and failure to achieve success in determining the most effective institutions, decision makers have led to the use of the Data Envelopment Analysis (DEA) technique, in comparative efficiency measures between in educational institutions. Furthermore, the number of research activities focused on the efficiency analysis of foundation universities in Turkey is not sufficient. The aims of this study are a) to determine the efficiencies of the foundation universities by using DEA which is a performance measurement method for increasing the efficiency of educational institutions and to rank foundation universities with regard to efficiency values (b) to examine which universities use their inputs unproductively and produce their output inefficiently. In this study, the numbers of professor, associate professor, assistant professor, research assistants and total budget expenses are used as input variables, the numbers of undergraduate, graduate and graduated students, the number of projects, the number of international publications are used output variables for 33 foundation universities in Turkey for year of 2009-2010. According to results, it is seen that Sabancı and Bilkent Universities are super-efficient for the academic year 2009-2010. Istanbul Arel University is the most inefficient university in Turkey. The findings indicate that foundation universities in Ankara are first, foundation universities in Izmir are second and foundation universities in Istanbul are the last order with regard to efficiency values. Besides, the foundation universities established before 2000 are more efficient than the foundation universities established after 2000 in Turkey.

Keywords

Foundation University
Efficiency
Productivity
Performance
Data Envelopment Analysis

Article Info

Received: 01.22.2012
Accepted: 01.07.2015
Online Published: 02.15.2015

DOI: 10.15390/EB.2015.1813

Introduction

Today a new global economic structure with the transition to information society has emerged knowledge economy. This situation led to increase the competitions between universities and expectations from universities in the production and sharing of information. The most commonly used keywords related to higher studies in the last three years are priority to research, globalization, competition, creativity, productivity, relationship with industry, and accountability etc. These words are also significantly a favorite of the new concept of a university. In recent years, the passage has

[1] Hacettepe University, Faculty of Science, Department of Statistics, Turkey, gamzeozl@hacettepe.edu.tr

been began from second generation to the third generation universities (3GU) in which academic and industrial researches become important and based on international cooperation and funding diversity. In the world, universities such as Stanford, Harvard, Cambridge, Leuven and Munich etc. have turn into technology stations. 3GU universities, also referred to as thematic universities, are seen as the future of education in Turkey.

A global academic competition has been occurred by means of increases in income countries with globalization, international education facilities, and academic competition between universities. Therefore, control of the education agency that fails to reach the goals of their activities and to assess uses resources efficiently to make planning for the future is important. Therefore, the efficiency analysis is a necessary management tool for educational institutions. The training of qualified required individuals, when viewed in terms of knowledge production and service to society, higher education is important for the country. Purpose of higher education is to train individuals who are able to think independently, questioning capable, researchers, with useful knowledge and skills to self and society. This situation is possible producing science and technology, providing continuous support to the research and production, with efficient universities with regard to academic, financial and administrative.

The purpose of performance analysis is to identify effective use of resources efficiently in line with the objectives of the organization or organizations (Özden, 2008). Efficiency analysis has been one of the recently used method to evaluate the performance of educational institutions. Determination of place among other educational institutions of an educational institution made possible by periodically and performance analysis based on measurable data. Education units determine the advantages and disadvantages of performance analysis and sample acquisition (Benchmarking) is able to work as efficiently between similar units (Özel, 2014). Hence, performance dimensions such as efficiency and productivity have become important for educational institutions. Improvement of many performance analysis development is due to importance of the effectiveness and efficiency (Yeşilyurt, 2009). Ratio analysis, parametric and non-parametric methods are methods used to measure the effectiveness of educational institutions. "The ratio of the input variables of an output variable" defined as the ratio analysis. In ratio analysis, a large number of variables, or if the input and output variables cannot be converted to a common currency lead to interpretation difficulties. Parametric methods provide analytical production function of educational institutions and estimation of the parameters of this function. Regression analysis is the most commonly used parametric method and seeks to explain the relationship between cause and effect relationship between dependent and independent variables. In nonparametric methods such as linear programming, many input and output variables without any assumption of in the production function can be examined together. DEA is used in the event of inability to convert a large number of inputs and outputs to a single input and output of in order to compare the relative effectiveness of educational institutions defined as decision making units (DMUs). Thus, the reasons for inefficient DMUs to be active with the DEA and be an example for this unit DMUs are determined.

Charnes et al. (1978) compared the efficiency of schools by using DEA for the first time for the educational institutions. The relative effectiveness of state and foundation universities was determined with DEA by Ahn and Seiford (1993). The relative effectiveness of 38 state universities in Australia was determined by Abbott and Doucouliagos (2003) and the efficiency of the 15 state universities in Germany was determined by Fandel (2007) by the help of DEA. In addition, DEA was used to analyze the effectiveness of American universities by Dundar and Darrell (1995) and the Canadian state universities by McMillan (1997). Similarly, DEA was used for the universities in England by Athanassopoulos and Shale (1997) and United Kingdom universities by Johnes and Johnes (1993). The efficiency of institutions and organizations operating in many areas such as tourism, banking, education and health in Turkey were investigated by the DEA.

DEA was used by Kaygin (2006) to examine the effectiveness of the secondary schools in the East Anatolia. Educational performance of schools in Sivas was examined with DEA by Göktolg and Artut (2011) by taking advantage of the OSS results in 2009. Bektas (2007) was investigated the efficiency of 44 foundation schools which operates in Ankara in 2006 benefiting from the DEA. As seen from previous studies, classroom, teacher and student numbers, etc. were defined as input variables. The DEA studies performed for the overall state universities in the country include the examination in the university department and faculty level. DEA was used by Kutlar & Kartal (2004) to examine the effectiveness for the faculties of Cumhuriyet University. The effectiveness of Faculty of Dentistry of Cumhuriyet University was identified by Gülcü (2004) with the DEA between 1999-2001. Babacan and Eagles (2007) were compared the efficiency of Cumhuriyet University by other public universities in terms of DEA. Yeşilyurt (2009) were investigated the efficiency of Department of Economics of the state universities in Turkey by examining 2007 KPSS scores. The effectiveness of the state universities in our country were obtained by Baysal et al. (2005), Kutlar & Babacan (2008), Özel (2014). The effectiveness of 25 foundation universities in the Higher Education Council catalog in 2007 was found by Özden (2008). The efficiency for 23 foundation universities of the top 100 universities in academic performance ranking of URAP (University Rank by Academic Performance, 2010) was examined by Bal (2013) based on data in 2010. However, there has not been any study on a rank of foundation universities in Turkey using super-efficiency model. The aim of this study is to investigate the effectiveness and ranking efficiency of the 33 foundation universities serving in Turkey. For this purpose, the efficiency of 33 foundation universities was calculated based on the statistics of 2010 of the Higher Education Council of with DEA. In addition ranking of universities was determined with super efficiency model by obtaining the degree of efficiency.

Method

In this section, the selection of research units to be used in DEA, determining the input and output variables considered to be relevant and the choice of appropriate DEA model are given.

Selection of Research Units

The most important assumption of DEA is to produce the same kind of output of DMUs with similar strategic objectives by using the same kind of input (Golany & Yu, 1997). In our country, anniversary of the universities, the financial structure and teaching methods are different from each other. State and foundation universities in finance are different from each other. There are public financing system for public universities and special financing system for foundation universities (YÖK, 2010). Therefore, in this study, the efficiency of the foundation universities has been investigated using statistics from the 2009-2010 academic year due to statistics of Higher Education Council post 2010 has not been published yet. Gazikent, KTO Karatay & Zirve Universities founded after 2010 could not be included in the study because of lack of data, remaining 33 foundation universities have been investigated.

Determination of Input and Output Variables

For each DMU it is necessary to identify the same inputs and same outputs in DEA. For this purpose, examine the input and output variables used in the efficiency analysis of state and foundation universities has been investigated in the literature and variables in the some studies are summarized in Table 1:

Table 1. Input and Output Variables used for VZA in previous studies (Özel, 2014)

Author	Input Variables	Output Variables
Tomkins and Green (1988)	Number of Employees Operating Expenses Other Expenses Personnel Expenses	Numbers of Graduate and Undergraduate Students Number of Publications Total Income
Beasley (1995)	Operating Expenses Research Income Personnel Expenses	Number of Graduate and Undergraduate Students Number of Indexed Publications
Abbott and Doucouliagos (2003)	Operating Expenses Number of Academic Staff Number of Administrative Staff Fixed Assets	Research Quantity Number of Graduate and Undergraduate Degree Number of Students
Flegg et al. (2004)	Number of Graduate Students Number of Graduate Students Number of Faculty Members Total Expenses	Project Revenues Number of Undergraduate Degree Number of Graduate Alumni
Kutlar and Kartal (2004)	Runners, Staff, Service Procurement and Consumption Expenditures Number of Administrative Staff Area Number of Academic Staff	Number of Graduate Students Student Fees Number of Projects Number of Students
Baysal et al. (2005)	Number of Faculty Members Investment Expenses Personnel Expenses Other Current Expenses	Number of Publications Number of Doctoral Students Number of Graduate Students Number of Graduate Students
Babacan and Kartal (2007)	Number of Professor Number of Associate Professor Number of Assistant Professor Number of Assistant Lecturer General Budget Expenditures Number of Administrative Staff Budget Expenditures	University Income Number of Indexed Publications Number of Graduate Alumni Number of Graduate Students Number of Undergraduate Degree Number of Graduate Students
Kutlar and Babacan (2008)	General Budget Expenditures Budget Expenditures Number of Professor Number of Associate Professor Number of Assistant Professor Number of Assistant Lecturer Number of Administrative Staff	Number of Indexed Publications University Income Number of Graduate Students Number of Undergraduate Degree Number of Graduate Students Number of Graduate Alumni
Özden (2008)	Number of Faculty Members Other Academic Staff Total Expenses	Number of Publications Number of Graduate Students Number of undergraduate and graduate students Other Income Education Revenues
Bal (2013)	Number of Faculty Members Other Number of Academic Staff	Number of Students / Faculty Number rate The sum of SCI, SSCI, AHCI indexed articles and citations

In DEA model, a large number of input and output variables and distress of data to reach, decrease the ability to distinguish between efficient and non-efficient DMUs. In this study, input-output principle proposed by Vassiloglou and Giokas (1990) which is the number of DMU (n) is at least three times the output number (s) and the input (m), in other words, the principle of $n \geq 3(m+s)$ is utilized. It was decided to use the number of professors, the number of associate professors, the number of assistant professors, the number of research assistants and budget expenditures as input variables. Official information of the academic staff in higher education from 2009-2010 Academic Year Higher Education Statistics, total personnel expenses, the data of the purchase of goods and services were obtained from the Ministry of Finance, Budget Management Information System. The number of projects, master's, doctoral student numbers, the number of undergraduate and graduate students, international publication numbers were identified as output variables. Number of scientific publications can be considered as an important output variable since they produce in order to advance the science of the university. For this purpose, the number of publications in the international index (SCI, SSCI, AHCI) based on the statistics of 2010 is determined by in the form of output variables. Another output variable was determined as the total number of scientific projects started in 2010, continuing and ending the EU (European Union), State Planning Organization (SPO), TUBITAK (Scientific and Technological Research Council of Turkey) and SRP (Scientific Research Project), and other form.

Determination of DEA Model

Purpose of a DEA model is to choose DMUs with the best performance using input and output variables and build an efficient production frontier with these DMUs. The efficiency values of DMU`s which are not on the boundary are determined using this efficient frontier. The reference set is a set created with efficient DMUs (Baysal vd., 2005). Efficient DMUs located in reference sets are used to bring to effectively inactive DMUs in the determination of the required corrections. Many DEA models using the input and output variables are available in the determination of university efficiencies. In the DEA, a change in the input variable is concerned in parallel with the direction of the change in output is or fixed return. The model under constant returns to scale CCR is defined by Charnes, Cooper and Rhodes (1978) and the model under variable returns to scale BCC is defined by Banker and Cooper (1992). When the input is up to three times, the process is producing up to three times, the constant returns to scale is used. However, if inputs are more than three times, the output process produces three times less or more output, the data is modeled with variable returns to scale. Since universities in Turkey have an autonomous structure in this study variable returns to scale (BCC) is thought to be more appropriate. DEA models, depending on the distance from the boundary of the efficient production of in effective units, can be grouped as input and output oriented models. In the input-oriented model, the required input combinations are determined producing most effective output combinations. In output-oriented model, it is decided to maximum output composition produced by a particular combination of inputs. When the university as education institutions are concerned, an efficient university should increase inputs or decrease output. When the input variables considered in this study examined, four input variables should be related to human resources, and it has been shown to be impossible to reduce these entries. However, it is observed that budget increase of foundation universities is certain in Turkey. Therefore, in the study, the evaluation of the inefficient DMUs is presented with output-oriented BCC model. Let y_{rj} $(r = 1, 2, ..., s)$ be s-dimensional output vector of j^{th} DMU and x_{mj} $(i = 1, 2, ..., m)$, be m-dimensional output vector of jth DMU where n is the number of DMU. Hence, the goal function in DEA, with condition the ratio of output to input is less than 1, is the maximum ratio of output to the inputs. In DEA, separately, the solution of the equation is found for each DMU. Therefore, discrete programming problem is given by

$$\max z_k = \varphi$$
$$\varphi_k y_{rk} - \sum_{j=1}^{n} y_{rj}\lambda_j + s_r^+ = 0$$
$$\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{ik}$$
$$\sum_{j=1}^{n} \lambda_j = 1$$
$$s_i^-,\ s_r^+,\ \lambda_j \geq 0 \qquad (1)$$

In Equation (1), λ_j is the weight of DMUs, X_j, is m-dimensional input vector, Y_j, s-dimensional output vector and a_k^* is the optimum value of goal function for kth DMU. Dual model is given by

$$\min q_k = \sum_{i=1}^{m} v_i x_{ik} - v_k$$
$$\sum_{r=1}^{s} \mu_r y_{rk} = 1$$
$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - v_k \leq 0,\ j = 1, 2, ..., n$$
$$v_i, \mu > 0, \quad i = 1, 2, ..., m \qquad (2)$$

When dual model is analyzed, it is seen that the weighted sum of inputs should be at least minimum and the weighted sum of outputs for DMUs should be equal to 1. However, in other circumstances, the weighted sum of output for each DMU is smaller than the sum of the weighted inputs. Then, the efficiency score of an efficient DMUs is 1 and efficiency score of an inefficient DMU is greater than 1. Although the DEA is able to identify with efficient DMUs, it is not possible to determine efficiency rankings of DMUs. Therefore, it is utilized from super efficiency model, in other words, Anderson and Peterson method is used. Super efficiency model is given in Equation (3):

$$a_k^* = \text{Min } a_k$$
$$\sum_{\substack{j=1 \\ j\neq p}} \lambda_j X_j \leq a_k X_k$$
$$\sum_{\substack{j=1 \\ j\neq p}} \lambda_j Y_j \geq Y_k$$
$$\lambda_j \geq 0 \qquad (3)$$

The efficient DMUs are compared with the other DMUs based on super-efficiency model in Equation (3). An inefficient DMU is also identified as inefficient DMU in super efficiency model. However, an efficient DMU can have small efficiency scores than 1 in super-efficiency model.

Results

In this study, output-oriented and variable return to scale BCC model is used to rank the effectiveness of 33 foundation universities in Turkey by means of EMS 1.3 software package. The super-efficiency model is also used to determine efficiencies of foundation universities. The obtained results are presented in Table 2:

Table 2. Efficiency scores of foundation universities with output-oriented and variable return to scale BCC model

University	Efficiency Value (%)	Reference Set	Super Efficiency Value (%)	Super Efficiency Rank
Acıbadem University	61,8	27 (0,67) 28 (0,33)	366,67	27
Atılım University	**100,0**	**5**	**81,68**	**14**
Bahçeşehir University	**100,0**	**2**	**92,61**	**16**
Başkent University	**100,0**	**0**	**60,62**	**10**
Beykent University	**100,0**	**8**	**52,95**	**6**
Bilkent University	**100,0**	**1**	**big**	**1**
Çağ University	381,35	2 (0,09) 5 (0,00) 21 (0,16) 26 (0,30) 28 (0,31) 30 (0,14)	436,65	29
Çankaya University	85,52	5 (0,11) 17 (0,40) 26 (0,15) 30 (0,35)	105,37	20
Doğuş University	758,1	2 (0,08) 5 (0,02) 6 (0,06) 26 (0,42) 30 (0,43)	171,40	24
Fatih University	174,23	3 (0,43) 6 (0,26) 23 (0,31)	100,78	19
Gediz University	**100,0**	**2**	**75,60**	**13**
Haliç University	539,63	2 (0,01) 3 (0,05) 5 (0,22) 24 (0,29) 28 (0,38) 30 (0,04)	183,37	26
Işık University	116,47	5 (0,09) 6 (0,02) 26 (0,04) 28 (0,66) 30 (0,18)	112,09	22
İst. Arel University	293,27	2 (0,10) 26 (0,04) 29 (0,81) 30 (0,05)	773,60	29
İst. Aydin Üniversitesi	17,31	5 (0,11) 26 (0,01) 27 (0,10) 28 (0,79)	106,69	21
İst. Bilgi University	**100,0**	**2**	**67,04**	**11**
İst. Bilim University	**100,0**	**2**	**57,59**	**8**
İst. Kültür University	1040,6	5 (0,17) 6 (0,16) 16 (0,12) 22 (0,41) 24 (0,02) 28 (0,12)	179,08	25
İst.Ticaret University	365,34	16 (0,21) 17 (0,05) 23 (0,01) 28 (0,48) 30 (0,25)	149,80	23
İzmir Ekonomi Univ.	**100,0**	**0**	**81,76**	**15**
İzmir University	**100,0**	**5**	**0,00**	**2**
Kadir Has University	**100,0**	**9**	**0,00**	**2**
Koç University	**100,0**	**0**	**0,00**	**2**
Maltepe University	**100,0**	**2**	**97,08**	**17**
Melikşah University	**100,0**	**8**	**70,05**	**12**
Okan University	**100,0**	**7**	**55,32**	**7**
Özyeğin University	**100,0**	**2**	**11,17**	**3**
Piri Reis University	**100,0**	**1**	**39,95**	**4**
Sabancı University	**100,0**	**0**	**big**	**1**
TOBB University	**100,0**	**0**	**51,19**	**5**
Ufuk University	**100,0**	**0**	**97,70**	**18**
Yaşar University	855,9	2 (0,17) 5 (0,23) 6 (0,05) 26 (0,07) 28 (0,41) 30 (0,07)	388,99	28
Yeditepe University	**100,0**	**0**	**60,49**	**9**

When Table 2 is examined, it was seen that 12 universities in Istanbul, 6 universities in Ankara, 4 universities in Izmir, one university in Mersin and one university was established in Kayseri. In 2009-2010, 12 of 21 universities in Istanbul; 5 of 6 universities in Ankara; 3 of the 4 universities and one foundation university in Izmir, one foundation university in Kayseri have been shown to have a high efficiency value. In the study, 13 of the 20 foundation universities which were established before the year 2000 and 8 of the 13 foundation universities established after 2000 found as efficient. It was determined that 100 percent efficiency in DEA results which were efficient or productive university. Based on Table 2, 21 of the 33 foundation universities can be said to be effective 2009-2010. Therefore, approximately 63% of foundation universities in Turkey proved to be effective and 37 % of foundation universities was not efficient. In addition, the efficiency values of the Istanbul Arel University was found to be the lowest. A reference set of this university was consist of Atılım University (Rank: 2), Okan University (Rank: 26), Sabancı University (Rank: 29) and TOBB University (Rank: 30). According to the super-efficiency values in 2009-2010 Sabanci University and Bilkent University, were found to be the most efficient universities. This result is similar to the world university rankings. According to the results of the QC and THE institutions, Sabancı and Bilkent Universities were among the world's top 500 universities in 2010. According to the study results, after Sabancı and Bilkent Universities, in the 2009-2010 academic year, Izmir University, Kadir Has University, Koç University, Özyeğin University, Piri Reis University, TOBB University, Beykent University, Okan University, Istanbul Bilim University, Yeditepe University, Başkent University, Istanbul Bilgi University, Melikşah University, Gediz University, Atılım University, Izmir Ekonomi University, Bahçeşehir University, Maltepe University and Ufuk University were found to be efficient.

Discussion, Conclusions and Recommendations

The aim of university is to educate individuals with the necessary information can be used in business. However, the number of personnel and financial resources are not unlimited in universities. Therefore, the university is required to use the most effective limited resources. Today, DEA is used frequently from for the distribution of resources as effectively and to determine the effectiveness of the university. In this study, the efficiency of the foundation universities in Turkey was determined using DEA for the 2009-2010 academic year. Therefore, professors, associate professors, assistant professors and research staff numbers, the total budget expenditures of universities were used as input variables, and associate, undergraduate, postgraduate student numbers, the number of projects, the number of international publications were used as output variables. As a result, it was determined 21 of the 33 foundation universities were efficient in 2009-2010. It was also observed that Sabancı University and Bilkent University were more effective than other universities. The lowest value in the 2009-2010 year belongs to Istanbul Arel University. Foundation universities, in general, was determined to be effective. According to the obtained results, 12 of the 21 universities in Istanbul; 5 of the 6 universities in Ankara; 3 of the 4 universities in Izmir and one foundation university in Kayseri, said that high efficiency values in 2009-2010. Thus, it was found that the top of the first effective foundation university was in Ankara, the second was in Izmir and the last was in Istanbul. Foundation universities established after 2000 in Turkey was also determined to be more effective than the university founded before 2000. These results are considered to be the guiding new foundation university to be established in Turkey. While the average efficiency was found by Ozden (2008) as 0.92 with data from the 2007, the average efficiency in this study was determined to be 0.63 with data for 2010. This situation indicates that there is a general inefficiency in foundation universities compared to 2007. While Çankaya and Işık Universities were efficient in the study of Özden (2008), these universities were not effective in this study. While Atılım, Bahçeşehir, Başkent, Bilkent, Istanbul Bilgi, Istanbul Bilim, Maltepe, Özyeğin, Sabancı, Ufuk and Yeditepe Universities were found to be ineffective in 2007, in this study these universities were effective in 2010. However, no improvement has been shown in the efficiency of Doğuş, Fatih and Yaşar universities in 2010 compared with 2007.

In summary, spread of outstanding 3GUs will be inevitable very soon in the concept of to make a difference, entrepreneurial programs, business partners and technopark facilities, financial strength of infrastructure, techno-leadership and entrepreneurship researches (Bircan, 2010). It would be appropriate taking into account these new developments in the higher education system in Turkey to restructure itself. It can be said that DEA would be useful for foundation universities to focus on this process as a performance analysis method.

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