Measurement of the Relative Efficiency of the Primary Schools in Kütahya, by Data Envelopment Analysis

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Abstract

In this study, efficiency of some primary schools in Kütahya, a province in Turkey, was tried to be measured by data envelopment analysis (DEA). Accordingly, in order to achieve more rational results, 10 primary schools in Kütahya, which are similar to each other in terms of their inputs and outputs were selected. Inputs and outputs which are thought to ideally reflect the efficiency measurements of the primary education institutions were determined. In this study, input-oriented CCR and BCC models were selected and used in the analyses. As a result of these analyses, efficient schools were identified and for those which were determined to be inefficient, proposals were suggested for a possible improvement.

Keywords: Data Envelopment Analysis, CCR Model, BCC Model, Efficiency, Education.

1. Introduction

Literature includes a great number of analyses of the effectiveness, efficiency, performance and quality of the education systems by different models and different inputs and outputs (Baysal and Toklu, 2001: 203). The reason of this is that the studies regarding the educational institutions, especially the primary education institutions are more important as they constitute the first step of basic education (Atan et. al., 2002: 1). Education is one of the most important factors that will enable the society to achieve a certain level (Erciş, 2009: 322). As the primary education is a process in which the behaviour of an individual is shaped, comprehension of information, regular and continuous improvement of the habits and attitudes, ability to detect problems and contribution to the solution process have also been addressed as a different perspective in the studies on basic education (Balkan and Arıkan, 2010: 133).

Efficiency is an important concept in educational institutions which are regarded as fundamental for the countries, individuals and societies (Okursoyand Tezsürücü, 2014: 2). Efficiency is the ability to attain maximum outputs from a given set of inputs. The concept of efficiency which is related with the objectives means taking appropriate actions for the determined objectives by appraising the sources and strengths (Kecek, 2010: 31). DEA efficiency measurements enable the determination of the position of educational institutions among the similar institutions, their level of efficiency, and solution proposals for the improvement of the deficiencies, if any (Gökolta and Artut, 2011: 64). Comparative analysis of schools carried out in 1978 by Charnes et al. represents the first DEA in the field of education (Gökolta and Artut, 2011: 64). In the following years, these analyses continued to be carried out and also diversified. In various studies addressing the efficiency measurement of primary education institutions, different performance criteria have been utilised.

However, as there are many aspects affecting the efficiency of education, analysis with a single input and output has not been sufficient; and relatedly, data envelopment analysis includes aspects that cannot be fully expressed as alternatives(Balkan and Arıkan, 2010: 134). This study was carried out by utilising Data Envelopment Analysis to obtain some information about the education in the primary schools in Kütahya, to improve the efficiency of education in the province, and to determine the factors to be improved, together with the related administrators.

2. Data Envelopment Analysis

Data envelopment analysis which is a technical analysis based on a linear programme used in the measurement of efficiency (Kecek, 2010: 55) is a non-parametric efficiency measurement analysis developed to measure the relative efficiency of the similar decision units with multiple inputs and outputs in terms of goods and services (Erciş, 2009: 321; Bircan, 2011: 331; Diabat et al., 2015: 326). DEA, a data based mathematical approach manages multiple variables, constraints and data (Mehdi et. al., 2014: 623).

Data envelopment analysis was firstly set forth in 1957 by "Farrell" in his study titled "Frontier Production Function"; then in 1978, "Charnes, Cooper, Rhodes (CCR)" contributed to the study; and in 1984, "Banker, Charnes, Cooper" studied on VRS and called it as BCC model. Later on, based on two basic assumptions, different models were developed (Yılmazand Karadayılar, 2010: 506; Özata and Sevinç, 2010: 79; Baysalet. al., 2005: 68). The model which was developed by Charnes, Cooper and Rhodes in 1978 is called CCR model in the literature (Charnes and Cooper, 1978).

Input oriented CCR Model, can be written in DP form as below;

$$(DP_0)\ \max_{v,u} uy_0$$

Subject to

$$vx_0 = 1$$

$$-vX + uY \le 0$$

$$v \ge 0, u \ge 0$$

u : Output multiplier vector, v : Input multiplier vector.

Dual of CCR model above can be expressed as below;

$$(DDP_0)\ \min_{\theta,\lambda} \theta$$

Subject to

$$\theta x_0 - X\lambda \ge 0$$

$$Y\lambda \ge y_0$$

$$\lambda \ge 0$$

$$(\lambda = \lambda_1, ..., \lambda_n)^T$$

In the model θ real and λ are non-negative variables.

BCC model is a technique developed by Banker, Charnes and Cooper in 1984.Primal form of input oriented BCC model can be shown as below;

$$\min_{\theta_B,\lambda} \theta_B$$

Subject to

$$\theta_B x_0 - X\lambda \ge 0$$

$$Y\lambda \ge y_0$$

$$e\lambda = 1$$

$$\lambda \ge 0$$

Dual form of input oriented BCC model can be expressed as below;

$$\max_{v,u,u_0} z = uy_0 - u_0$$

Subject to

$$vx_0 = 1$$

$$-vX + uY - u_0 e \le 0$$

$$v \ge 0, u \ge 0$$

u_0 unrestricted

For a DMU to be efficient in CCR model, it should be both scale and technically efficient, however being technically efficient is enough to be efficient in BCC model (Bowlin, 1998:3).

Since the time it was firstly set forth, DEA attracted great interest; and many books and studies on it have been released. DEA, which was initially applied in non-profit organizations, was utilised in various fields later on. Now, it is commonly used by non-profit organizations, service businesses, air forces, companies, universities, local administrations, banks, post offices, pharmacists, municipalities, public institutions and in market researches, and agriculture (Yılmaz and Karadayılar, 2010: 507; Karahan and Akdağ, 2014: 182; Yeşilyurt and Alan, 2003: 94). The reason of this is that DEA is important in determining the relation between the outputs of the units and the inputs used to obtain these outputs.

Data envelopment analysis models may be set in three different ways as input-oriented, output-oriented and non-oriented. In input-oriented models, desired output is tried to be achieved through minimum input; and in output-oriented models, maximum output is tried to be achieved with the given inputs (Uzgören and Şahin, 2013: 99).
In an analysis made with DEA method, there are two important points to be mainly considered:

I: Selection of the decision-making units
II: Determination of the input and outputs

Selection of the decision-making units: This is the primary step of data envelopment analysis to make an efficiency analysis. Decision units to be evaluated in terms of efficiency should be comparable, and have characteristics with similar objectives (Kecek, 2010: 78; Demir and Bakırcı, 2014:112). To be able to use Data Envelopment Analysis, decision making units with similar organizations, applying the same decisions, fulfilling the same duties in line with the same objectives and contained in the same market segment should be selected. In input-oriented and output-oriented models, most appropriate inputs and outputs to be used for an efficient production of a certain composition of inputs should be determined (Ömürbek et al., 2013: 23; Uzgören and Şahin, 2013: 97).

Determination of the input and outputs: This is the second step of data envelopment analysis to make an efficiency analysis. Another important point to be considered in terms of the application of data envelopment analysis is the determination of inputs and outputs, as an increase or decrease in the input and output ratios will affect efficiency (Uzgören and Şahin, 2013: 98). Input-oriented models try to measure technical inefficiency by proportionally decreasing the use of inputs while output-oriented models try to measure technical inefficiency by proportionally decreasing the use of outputs (Kabakuş, 2014: 314).Input and output clusters used in data envelopment analysis application in education field are shown in Table 1.

3. Application

3.1. Objective and Scope of the Study

As the education and training in the primary education period is the first step of the future educational periods, it is advantageous to lay a sound basis in that period. Objective of this study is to measure the efficiency of 10 primary schools in Kütahya, by the Data Envelopment Analysis; and to make proposals to the administrators for improvement. In order to achieve more rational results, 10 schools in the central district of Kütahya, which are similar in terms of inputs and outputs were included in the research. The data addressed in the research were obtained from the Provincial Directorate of National Education.

3.2. Data Used in the Study

In this study, input-oriented CCR and BCC models were selected. The schools with similar number of students, physical conditions, number of teachers, number of classrooms and resources were included in this research to measure and compare their efficiencies.

Inputs	Outputs
X1:Student/Teacher X2:Student/Classroom X3:Student/section	Y1:Total Teogscore in 2014 Y2:Number of graduates

Inputs and outputs are above. Variables in this study were determined according to the inputs and outputs, which are thought to reflect the main functions of the primary schools. Inputs and outputs addressed in the research are presented in Table 2.

3.3. Findings of the Analysis

3.3.1. Efficiency Scores of Data Envelopment Analysis

In the evaluation process involving ten primary school, 3 inputs and 2 output are taken into consideration and analyzed using the CCR and BCC models of DEAP software and results are discussed. Correlation Coefficient Values with Three Inputs and Two Outputs are presented in Table 3.

Examining the correlation values in the table, a correlation between X2 and X3 variables can be found, thus analyses are evaluated separately with two inputs and two outputs. As a result of analyses conducted using CCR and BCC models with two inputs (X1 and X2) and two outputs, Atatürk Primary School, Linyit Primary School, Seyitömer Primary School and Çamlıca Primary School are found to be efficient. Efficiency values of analyses with two different models are close to each other (Table 4).

As a result of analyses conducted using CCR and BCC models with two inputs (X1 and X3) and two outputs, Atatürk Primary School, Linyit Primary School, Seyitömer Primary School and Çamlıca Primary School are found to be efficient. Along with the closer values in analyses with different models, analyses with different inputs also show closer results (Table 5).Summary of the data related to efficiency analysis conducted with input oriented CCR and BCC models, are presented in Table 6.

3.3.2. Potential Improvement Values for Inefficient Decision Making Units

In the study, suggestions to school managements will be made by calculating target values for inefficient units to become efficient as a result of analyses with CCR and BCC models with two inputs (X1-X3) and (X1-X2), and two outputs. Inputs and outputs can be decreased or increased in order to make primary schools more efficient.
As a result of analyses conducted using CCR and BCC models with two inputs (X1 and X3) and two outputs, Atatürk Primary School, Linyit Primary School, Seyitömer Primary School and Çamlıca Primary School are found to have efficiency value of "1", so there is no difference between actual values and target values. However, improvements have to be made in other schools. Targets and Potential Improvement Obtained with BCC and CCR Models with Two Inputs (X1-X3) and Two Outputs are presented in Table 7.

Considering the actual values and target values with BCC model, number of students per teacher and number of students per section should be lowered in Atakent, Cumhuriyet, Sırören, Dumlupınar, İnköy, and Evliya Çelebi Primary Schools. Moreover, TEOG scores can be increased if the suggested improvements are made. Considering the actual values and target values with CCR model, number of students per teacher and number of students per section should be lowered in Atakent, Cumhuriyet, Sırören, Dumlupınar, İnköy, and Evliya Çelebi Primary Schools.

As a result of analyses conducted using CCR and BCC models with two inputs (X1 and X2) and two outputs, Atatürk Primary School, Linyit Primary School, Seyitömer Primary School and Çamlıca Primary School are found to have efficiency value of "1", so there is no difference between actual values and target values. However, improvements have to be made in other schools. Targets and Potential Improvement Obtained with BCC and CCR Models with Two Inputs (X1-X2) and Two Outputs are presented in Table 8.

According to BCC model, number of students per teacher and number of students per classroom should be lowered in Atakent, Cumhuriyet, Sırören, Dumlupınar, İnköy, and Evliya Çelebi Primary Schools. Moreover, TEOG scores can be increased if the suggested improvements are made.

According to CCR model, number of students per teacher and number of students per classroom should be lowered in Atakent, Cumhuriyet, Sırören, Dumlupınar, İnköy, and Evliya Çelebi Primary Schools.

3.3.3. Reference schools and reference weights

Reference schools for inefficient schools as a results of the analysis with CCR model with inputs X1 and X2 are shown in Table 9. In that case, Atatürk Primary School has been given as reference 6 times, Linyit Primary School has been given as reference 2 times, Seyitömer Primary School has been given as reference 2 times and Çamlıca Primary School has been given as reference 2 times (Table 9).

Reference schools for inefficient schools as a results of the analysis with input oriented CCR model with inputs X1 and X3 are shown in Table 10. In that case, Atatürk Primary School has been given as reference 6 times, Linyit Primary School has been given as reference 2 times, Seyitömer Primary School has been given as reference 3 times and Çamlıca Primary School has been given as reference 2 times.

Reference schools for inefficient schools as a results of the analysis with input oriented BCC model with inputs X1 and X2 are shown in Table 11. In that case, Atatürk Primary School has been given as reference 6 times, Linyit Primary School has been given as reference 2 times, Seyitömer Primary School has been given as reference 3 times and Çamlıca Primary School has been given as reference 2 times.

Reference schools for inefficient schools as a results of the analysis with input oriented BCC model with inputs X1 and X3 are shown in Table 12. In that case, Atatürk Primary School has been given as reference 6 times, Linyit Primary School has been given as reference 2 times, Seyitömer Primary School has been given as reference 3 times and Çamlıca Primary School has been given as reference 3 times.

4. Results and Discussion

In developing and underdeveloped countries, primary schools, as the first step of education system, have crucial roles in developing individuals in socio-cultural and educational aspects so that the country can reach the desired level of welfare. On this significant matter, constant researches are made in order to provide suggestions to authorities so as to increase efficiency using sets of inputs and outputs from schools.

In this study, a comparative efficiency analysis has been carried out with input oriented CCR and BCC models using DEAP software for ten primary schools located in the central district of Kütahya. Examining Table 6, four primary schools are found to efficient but other schools need improvements to be efficient. Primary schools in developing countries, such as Turkey, should provide an efficient education in order to raise as much qualified, cultured, productive and critical thinking individuals as possible so as to reach the desired level of welfare. Conducted analyses will be quite helpful to detect inefficient schools and make them efficient

In this study, analyses are conducted only with mentioned schools. For further studies with primary schools, different evaluations can be made by adding different inputs and outputs affecting efficiency and expanding the scope of the study by including other schools in Kütahya city.

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Table 1:Input and Output Clusters Used in DEA application in Education Field

Research.	Input	Output
Bessent et. al.,(1982)	School budgets, Number of teachers	ITBS test scores
Ganley and Cubbin (1992)	Cost of secondary education for each student, Ratio of students without a family, Ethnic origin differences	Percentage of examinees who score 5 or above in CSE exam,Percentage of examinees who score 3 or above in CSE exam
Noulas et. al., (1998)	Student-teacher ratio, Student-Administrator ratio, Student-Non Teaching StaffRatio	Number of students who pass the class, Test scores at Higher Education exams
Atan et. al., (2002)	Total number of students, Total number of teachers, Number of sections, Number of classrooms, Number of computers, Number of laboratories	Number of graduated students, Number of students placed in higher education with ÖYS (Student Placement Exam), Success rate of class passing, Success rate at ÖYS
Oulette and Vierstrate (2005)	Costs, numbers and salaries of teachers, Costs, numbers and salaries of other staff, Cost and amount of education materials, Cost and amount of power used by school, Other costs, Capital sum	Number of students studying at primary level, Number of students studying at secondary level
Baysal, and Toklu (2001)	Number of teachers, Personnel costs	Number of students placed in higher education with ÖSS, Number of students placed in higher education with ÖYS
Kutlar et. al., (2004)	Academic staff, Administrative staff, Personnel costs, Total area	Number of students, Tuition fees
Gülcü et. al., (2004)	Academic staff, Auxiliary staff	Number of patients treated, Net profit to revolving fund from patients
Tomkins and Green (1988)	Number of full-time staff, Personnel costs, Business operating costs, Other costs	Number of university students, Number of PhD students, Total income, Number of publications

Kirjavainen and Loikkanen (1998)	Number of hours for educational and non-educational activities per week, Education of teachers, Expertise level, Education level of parents, Number of hours for non-educational activities (Secondary level students)	Number of students who pass the class, Number of graduated students, Exam results
Beasley (1995)	Research income, Business operating costs, Personnel costs	Number of undergraduate and graduate level students, Number of publications in indexed journals
Abbot and Doucouliagos (2003)	Number of academic staff, Number of non-academic staff, Business operating costs, Fixed assets	Number of students, Numbers of students with Associate's Degree, Bachelor's Degree, Master's Degree or PhD Degree, Number of researches
Yeşilyurt and Alan (2003)	Minimum entrance score for Science High Schools, Fixed input	ÖSS-Applied Sciences, ÖSS-Social Sciences, ÖSS-Equal Weight
Flegg, et. al. (2004)	Number of Academic Members, Number of undergraduate level students, Number of graduate level students, Total costs	Research and consultant expenses, Number of students with Associate's or Bachelor's degree, Number of students with Master's or PhD degree
Warning (2004)	Personnel costs, Other costs	Publications in indexed journals, Number of students
Kutlar and Kartal (2004)	Number of academic staff, Number of Administrative staff, Staff travel, recruitment and consumption expenses, Total area	Number of students, Tuition fees, Projects, Number of graduate level students
Baysal, et. al. (2005)	Personnel costs, Other current expenditures, Investment Costs, Transfers, Number of Lecturers (State Universities)	Number of Bachelor's Degree students, Number of Master's Degree students, Number of PhD students
Özcan and Anıl (2005)	Number of classrooms, Number of computers in use, Total number of second grade students in academic year 2003-2004, Total number of courses, Number of full-time staff, Number of Lecturers assigned according to the Articles 31 and 40/a of Higher Education Law No. 2547.	Number of graduated students in the academic year 2003-2004, GPAs of the students graduated in the academic year 2003-2004, Academic activity scores of full-time Lecturers in the Vocational School
Babacan et. al. (2007)	Overall budget expenses, Off-budget expenses, Number of Professors, Number of Associate Professors, Number of Assistant Professors, Number of Lecturers, Number of Administrative staff	Tuition fees, Projects, Number of graduate level students
Kutlar and Babacan (2008)	Overall budget, Off-budget expenses, Number of Professors, Number of Associate Professors, Number of Assistant Professors, Number of Lecturers, Number of Administrative staff	Publications in indexed journals, University income, Number of undergraduate level students, Number of students graduated from undergraduate levels, Number of graduate level students, Number of students graduated from graduate levels
Özden (2008)	Total costs, Number of Academic Members, Number of other Academic Staff	Number of students at Associate's or Bachelor's Degree level, Number of graduate level students, Number of publications, Educational incomes, Other incomes
Yeşilyurt (2009)	Study Duration	Raw scores at General Skills and General Knowledge sections of KPSS (Public Personnel Selection Exam)
Oruç et. al. (2009)	Number of Academic Members, Number of Lecturers, Number of Research Assistants, Total personnel costs	Number of students at Associate or Bachelor's Degree level, Number of graduate level students, Number of projects, Project budgets
Kecek (2010)	Number of students/Number of teachers, Number of students/Number of classrooms, Number of students/Number of sections	OYP (Academic Member Training Program) score, Number of graduates
Balkan and	Student-Teacher ratio, Student-Classroom	Average score in ÖSS-Applied Sciences, Average

Arıkan (2010)	ratio	score in ÖSS-Social Sciences, Average score in ÖSS-Equal Weight, Rate of higher education placement with ÖSS
Uzgören and Şahin (2013)	Number of students/Number of Lecturers, Number of students/Number of Administrative staff, Number of students/Floor area, Budget expenses	Sum of tuition fees, Total number of graduates
Bal (2013)	Numbers of Professors, Associate Professors, Assistant Professors and Lecturers with PhD degree, Number of Research Assistants and Number of Lecturers	Number of international publications, Student-Academic Member ratio
Demir and Durakoğlu (2013)	Number of teachers, Number of students, Number of sections	YGS-LYS Success ratio, Average score in YGS, Average score in LYS-Applied Sciences, Average score in LYS-Equal Weight, Average score in LYS-Social Sciences
Gülel (2014)	Number of Academic Members (Professor, Associate Professor, Assistant Professor), Number of students (Bachelor's Degree, Master's Degree, PhD), Number of academic units connected to the university	Number of international publications, Number of graduates (Bachelor's Degree, Master's Degere, PhD)
Şıklar and Doğan (2015)	Student-Teacher ratio, Student-Classroom ratio, SBS Minimum Score	[AVERAGE (Average Score in LYS-Applied Sciences-Average Score in LYS-Equal Weight)], Average Score in LYS-Social Sciences
Kadılar (2015)	Numbers of Professors, Associate Professors, Assistant Professors and Research Assistants, Total Budget Expenses	Numbers of Undergraduate, Graduate and Graduated Students, Number of Projects, Number of International Publications

Source: Created by researches using the studies of Uzgören and Şahin, 2013; Balkan and Arıkan, 2010; and Özden, 2008.

Table 2: Data regarding the Primary Schools included in the Study

Schools	Number of Classrooms	Number of Classes	Number of Students	Number of Teachers	Number of Male Graduates	Number of Female Graduates	Inputs			Outputs	
							X1:Student/Teacher	X2:Student/Classroom	X3: Student/section	Y1:Teog scores in 2014	Y2: Number of graduates
Atakent	15	25	728	40	43	54	18.2	48.53	29.11	335	97
Atatürk	30	47	899	75	62	47	11.98	29.96	19.12	362	109
Linyit	26	50	1593	76	121	90	20.96	61.26	31.86	370	211
Cumhuriyet	12	21	626	38	58	33	16.47	52.16	29.8	350	91
Seyitömer	4	8	162	14	12	9	11.57	40.5	20.25	357	21
Sırören	5	8	195	12	24	23	16.25	39	24.37	325	47
Çamlıca	5	9	109	9	10	10	12.11	21.8	12.11	341	20
Dumlupınar	24	49	1313	74	69	75	17.74	54.7	27	352	144
İnköy	6	11	262	12	33	18	21.83	43.66	23.81	311	51
Evliya Çelebi	16	32	795	50	69	56	15.9	49.68	24.84	342	125

Table 3: Correlation Coefficient Values with Three Inputs and Two Outputs

	Input (X1)	Input (X2)	Input (X3)	Output (Y1)	Output (Y2)
Input (X1)	1	0,709845	0,729768	-0,33311	0,497763
Input (X2)	0,709845	1	0,938672	0,215396	0,731914
Input (X3)	0,729768	**0,938672**	1	0,120685	0,686762
Output (Y1)	-0,33311	0,215396	0,120685	1	0,546841
Output (Y2)	0,497763	0,731914	0,686762	0,546841	1

Table 4: Input Oriented BCC and CCR Efficiency Values with Two Inputs (X1, X2) and Two Outputs

School	CCR Efficiency	BCC Efficiency
Atakent	0,609	0,655
Atatürk	**1,000**	**1,000**
Linyit	**1,000**	**1,000**
Cumhuriyet	0,701	0,722
Seyitömer	**1,000**	**1,000**
Sırören	0,668	0,735
Çamlıca	**1,000**	**1,000**
Dumlupınar	0,844	0,849
İnköy	0,514	0,564
Evliya Çelebi	0,833	0,842
	Mean 0.817	**Mean 0.837**

Table 5:Input Oriented BCC and CCR Efficiency Values with Two Inputs (X1, X3) and Two Outputs

School	CCR Efficiency	BCC Efficiency
Atakent	0,609	0,656
Atatürk	**1,000**	**1,000**
Linyit	**1,000**	**1,000**
Cumhuriyet	0,701	0,722
Seyitömer	**1,000**	**1,000**
Sırören	0,668	0,728
Çamlıca	**1,000**	**1,000**
Dumlupınar	0,863	0,870
İnköy	0,562	0,611
Evliya Çelebi	0,837	0,850
	Mean 0.824	**Mean 0.844**

Table 6: Statistics of Analysis Results

	CCR Model		BCC Model	
	(X1-X3) Input Oriented	(X1-X2) Input Oriented	(X1-X3) Input Oriented	(X1-X2) Input Oriented
Total Number of Schools	10	10	10	10
Number of Fully Efficient Schools	4	4	4	4
Number of Inefficienct Schools	6	6	6	6
Min. Lowest Value of Efficiency	0,562	0,514	0,611	0,564
Max. Efficiency Value	1	1	1	1
Mean Efficiency Value	0,824	0,817	0,844	0,837
Standard Deviation	0,1	0,1	0,1	0,1

Table 7. Targets and Potential Improvement Obtained with BCC and CCR Models with Two Inputs (X1-X3) and Two Outputs

Schools	Actual Values				BCC Model Target Values				CCR Model Target Values			
	X1: Student/Teacher	X3: Student/Section	TEOG Score	Number of graduates	X1: Student/Teacher	X3: Student/Section	TEOG Score	Number of graduates	X1: Student/Teacher	X3: Student/Section	TEOG Score	Number of graduates
Atakent	18,2	29,11	335	97	11,93	19,09	360,9	97	11,08	17,72	335	97
Atatürk	11,98	19,12	362	109	11,98	19,12	362	109	11,98	19,12	362	109
Linyit	20,96	31,86	370	211	20,96	31,86	370	211	20,96	31,86	370	211
Cumhuriyet	16,47	29,8	350	91	11,89	19,351	360,9	91	11,542	17,71	350	91
Seyitömer	11,57	20,25	357	21	11,57	20,25	357	21	11,57	20,25	357	21
Sırören	16,25	24,37	325	47	10,83	17,75	354	47	10,86	16,28	325	47
Çamlıca	12,11	12,11	341	20	12,11	12,11	341	20	12,11	12,11	341	20
Dumlupınar	17,74	27	352	144	15,06	23,49	364,7	144	14,97	23,29	352	144
İnköy	21,83	23,81	311	51	12	14,55	348,3	51	10,71	13,38	311	51
Evliya Çelebi	15,9	24,84	342	125	13,38	21,11	363,2	125	13,25	20,78	342	125

Table 8:Targets and Potential Improvement Obtained with BCC and CCR Models with Two Inputs (X1-X2) and Two Outputs

Schools	Actual Values				BCC Model Target Values				CCR Model Target Values			
	X1: Student/Teacher	X2: Student/Classroom	TEOG Score	Number of graduates	X1: Student/Teacher	X2: Student/Classroom	TEOG Score	Number of graduates	X1: Student/Teacher	X2: Student/Classroom	TEOG Score	Number of graduates
Atakent	18,2	48,53	335	97	11,92	31,39	361,31	97	11,076	28,21	335	97
Atatürk	11,98	29,96	362	109	11,98	29,96	362	109	11,98	29,96	362	109
Linyit	20,96	61,26	370	211	20,96	61,26	370	211	20,96	61,26	370	211
Cumhuriyet	16,47	52,16	350	91	11,86	32,11	360,97	91	11,54	30,78	350	91
Seyitömer	11,57	40,5	357	21	11,57	40,5	357	21	11,57	40,5	357	21
Sırören	16,25	39	325	47	11,94	28,66	351,08	47	10,86	26,06	325	47
Çamlıca	12,11	21,8	341	20	12,11	21,8	341	20	12,11	21,8	341	20
Dumlupınar	17,74	54,7	352	144	15,06	40,7	364,74	144	14,97	40,82	352	144
İnköy	21,83	43,66	311	51	12,06	24,64	348,31	51	10,71	22,42	311	51
Evliya Çelebi	15,9	49,68	342	125	13,38	34,87	363,25	125	13,24	35,08	342	125

Table 9. Reference Schools and Reference Weights According to CCR Model with Two Inputs (X1 and X2) and Two Outputs

School	Reference		Reference weights	
Atakent	Seyitömer	Atatürk	0,045	0,881
Cumhuriyet	Seyitömer	Atatürk	0,166	0,803
Sırören	Atatürk	Çamlıca	0,776	0,129
Dumlupınar	Atatürk	Linyit	0,582	0,382
İnköy	Atatürk	Çamlıca	0,373	0,516
Evliya Çelebi	Atatürk	Linyit	0,719	0,221

Table 10. Reference Schools and Reference Weights According to CCR Model with Two Inputs (X1 and X3) and Two Outputs

School	Reference			Reference weights		
Atakent	Çamlıca	Seyitömer	Atatürk	0,005	0,04	0,881
Cumhuriyet	Atatürk	Seyitömer		0,803	0,166	
Sırören	Atatürk	Çamlıca	Seyitömer	0,318	0,235	0,364
Dumlupınar	Linyit	Atatürk		0,382	0,582	
İnköy	Atatürk	Çamlıca		0,373	0,516	
Evliya Çelebi	Linyit	Atatürk		0,221	0,719	

Table 11. Reference Schools and Reference Weights According to BCC Model with Two Inputs (X1 and X2) and Two Outputs

School	Reference			Reference weights		
Atakent	Atatürk	Seyitömer		0,864	0.136	
Cumhuriyet	Atatürk	Seyitömer		0.795	0.205	
Sırören	Atatürk	Seyitömer	Çamlıca	0.301	0.236	0.463
Dumlupınar	Linyit	Atatürk		0.343	0.657	
İnköy	Atatürk	Çamlıca		0.348	0.652	
Evliya Çelebi	Linyit	Atatürk		0.157	0.843	

Table 12. Reference Schools and Reference Weights According to BCC Model with Two Inputs (X1 and X3) and Two Outputs

School	Reference			Reference weights		
Atakent	Seyitömer	Atatürk	Çamlıca	0.114	0.864	0.022
Cumhuriyet	Seyitömer	Atatürk		0.205	0.795	
Sırören	Çamlıca	Seyitömer	Atatürk	0.266	0.436	0.298
Dumlupınar	Linyit	Atatürk		0.343	0.657	
İnköy	Atatürk	Çamlıca		0.348	0.652	
Evliya Çelebi	Linyit	Atatürk		0.157	0.843	