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Efficiency Analysis of Higher Education Institutes: A Study on Colleges under Vidyasagar University in West Bengal, India

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Abstract: Higher education sector in India in recent years is under a mounting pressure to increase efficiency and improve their quality. Evaluation of the performance of educational institutions is difficult because profit maximization is not their main objective. There is limited number of studies on the assessment of performance of higher educational institutions in India, particularly in West Bengal. The present paper using Data Envelopment Analysis (DEA) methodology attempts to find the efficiency scores of 41 colleges affiliated to Vidyasagar University in West Bengal, India to evaluate their comparative performance. We have used three inputs and five outputs in our Input Oriented VRS DEA model. The results suggest that though eleven colleges have achieved 100% efficiency, many other colleges are working inefficiently.
Keywords: Efficiency, Data Envelopment Analysis (DEA), higher education, College

INTRODUCTION

The measurement of performance of educational institutions has been the subject of increasing attention in recent years [1]. Evaluation of the performance of the units in social sector like education is difficult because profit maximization is not their main objective. The educational institutions use variety of inputs like the different quality of students, the different quality of teachers and the different costs per student. The outputs also vary in terms of the pass percentage of colleges, average grade etc. It is very difficult the capture the performance of an institution by indicator ratios representing efficiency in production (like percentage of successful candidates) or efficiency in costs (like unit cost of education) only. It is important to study the performance of the educational institutions recognizing the divergence of the inputs and outputs. The technique of Data Envelopment Analysis is useful tool where we can replace simple ratios of one output to one input by composite ratio derived from linear programming technique. The major objective of the paper is to assess the efficiency of the colleges under Vidyasagar University in West Bengal, India.

There is wide literature on the measurement of efficiency of educational institutions using DEA. From the time of the original Data Envelopment Analysis (DEA) study by Charnes *et al*. [2] for measuring the efficiency of decision-making units, Emrouznejad [3] presents an extensive listing of DEA research covering theoretical developments as well as "real-world" applications from inception to the year 2007.Athanassopoulos and Shale [4] examine the comparative performance of higher education institutions in the UK. Johnes [5] applied DEA to a data set of more than 100 HEIs in England using data for the year 2000/01. Through bootstrapping procedures she finds that differences between the most and least efficient English HEIs are significant. Afonso and Aubyn [6] address the efficiency of expenditure in education provision by comparing the output (PISA results) from the educational system of 25 countries (mostly OECD) with resources employed (teachers per student, time spent at school. Glass *et al*. [7] investigates whether best-practice efficiency measurement based on data envelopment analysis (DEA) provides empirical support for the higher education policy goals in UK that encourage the publicly funded universities to become more-specialised and larger in size without compromising output quality. Bougnol and Dulá [8] compare two classification and ranking schemes involving universities; one from a published report, 'Top American Research Universities' by the University of Florida's *The Center* and the other using DEA. They compare the two methods and discover important equivalences. Colbert *et al*. [9] uses Data envelopment analysis (DEA) to determine the relative efficiency of 24 top ranked US MBA programs using three output sets of the MBA programs: student satisfaction, recruiter satisfaction. The paper by Nazarko [10] describes a comparative efficiency study of 19 Polish universities of technology. Detailed analysis of potential input, output and environmental variables describing the HEI efficiency model was carried out. The study used the CCR-CRS output-oriented DEA

model. DEA results of Ahn and Seiford [11] strongly support the hypothesis that public schools are more efficient than private schools when visible and closely monitored output variables are used for evaluation.

Though there is wide literature on the measurement of efficiency higher education institutes, the number of studies for higher education institutes in India is very limited. As a case study, we have taken the colleges under Vidyasagar University to evaluate their comparative performance.

MATERIAL AND METHODS

We have used DEA for judging the efficiency of the colleges under Vidyasagar University, West Bengal, India. Data envelopment analysis (DEA) is a non-parametric approach that involves the use of linear programming methods to construct a non-parametric frontier and to evaluate the relative Input-Output efficiency of a Decision Making Unit (DMU). Unlike the econometric approach DEA makes no assumptions regarding the distribution of inefficiencies. The methodology was developed by Charnes, Cooper and Rhodes [12] based on M.J. Farrel's contribution to productive efficiency. In his classic paper, M.J. Farrell [13] argues that the measurement of productive efficiency is of theoretical and practical importance; a satisfactory efficiency measure allows both empirical testing of theoretical arguments and economic planning to improve the productivity of particular industries.

DEA models differ in the emphasis of their orientation (like input or output oriented model) and on the assumption of scale conditions (like CRS and VRS). Technical Efficiency (TE) of a firm can be measured either by (i) output-oriented measure or by (ii) input-oriented measure. In case of output oriented measure the TE of a firm can be computed by comparing its actual output with the maximum producible outpur from its observed inputs i.e. by how much can output quantities be proportionally expanded without altering the inputs quantities used? In input oriented measure, the TE of a firm can be measured by comparing its actual input in use with the minimum input that would produce the targeted output level i.e. by how much can input quantities be proportionally reduced without changing the actual output bundle . On the other hand, under variable VRS the envelopment surface presents convexity as a consequence of the constraint ($N1'\lambda = 1$) in the model. The convexity condition essentially ensures that an inefficient DMU is only benchmarked against DMUs of similar size. This means the projected point (for that DMU) on the DEA frontier is a convex combination of observed DMUs [14].

So, an inefficient DMU can be made fully efficient by projection onto a point on the envelopment surface and this particular projected point location is dependent upon the DEA model employed in the analysis. DEA models provide various choices for the analyst, and can be employed to meet different demands corresponding to each situation.We have adopted here the input-oriented VRS DEA model. Input orientation is chosen because educational institutions have generally greater control over input quantities relative to output quantities [14].

The formal specification of Input-Oriented VRS model is given by the following set of equations.

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &\text{s.t.} \\ &Y\lambda \geq Y_i \\ &X\lambda \leq \theta X_i \\ &N1'\lambda = 1 \\ &\lambda \geq 0 \end{aligned} \qquad (1)$$

Where λ is the vector of relative weights ($N \times 1$) given to each Decision Making Unit (DMU) and N is the number of DMUs. Assuming that the DMUs have I inputs and O outputs: X represents the matrix of inputs ($I \times N$) and Y is the matrix of outputs ($O \times N$). The column vectors for the inputs and outputs for each DMU are represented as X_i and Y_i, respectively.

An additional restriction is inserted in the optimization problem if we want to evaluate the DMUs under Varible Returns to Scale (VRS), $N1'\lambda = 1$, where N1 is a ($N \times 1$) vector of ones. This restriction imposes convexity of the frontier, accounting for VRS. Dropping this restriction would mean Constant Returns to Scale (CRS).

Finally, the efficiency score (θ) is a scalar that measures the technical efficiency and takes values between 0 and 1. The efficiency score denotes the distance between the DMU under analysis and the efficiency frontier, defined as a linear combination of the "best practice" units. If $\theta < 1$, the DMU is inside the frontier and it will relatively inefficient; while under $\theta = 1$ the DMU will be on the efficiency frontier and it will be considered technically efficient.

For the implementation of DEA, we need to define some inputs and outputs. Following the literature on the measurement of efficiency of higher education institutes (HEIs), for our study we have here considered three inputs – (i) Full time teachers and student ratio (FTSR): Ratio of full time teachers and total enrolment of the college (ii) Part time teachers and student ratio (PTSR): Part-time teachers include regular part time teachers and contractual teachers and (iii) Non-teaching staff and student ratio (NTSR): Ratio of non teaching staff and enrolment. These inputs work as the main resources required for the normal performance of colleges. As regards to outputs of colleges, we have considered five outputs: (i) Average marks attained by passed honours students of all courses in the final examination (MARKS): It is calculated by taking the

ratio of aggregate marks achieved and the number of honours students passed. So, average marks denote the marks obtained on an average out of 800 by a student. (ii) Number of first class (above 60% in aggregate) achieved by honours students (1CLASS), (iii) Percentage of honours students passed in the final examination in relation to intake capacity (PERCENTP) and (iv) Number of Departments in the college (DEPT). The outputs reflect the teaching activity of HEIs. All these data refer to the year 2015-2016 and marks have been collected for the Honours students. Data on these variables have been collected from the office of Vidyasagar University and websites of individual colleges. Due to paucity of data, we could not take into research works of faculty members as output variable of a college.

We have presented in Table 1 the list of colleges under our study with their location, date of establishment, intake capacity of honours students and number of Departments.

Table-1: Colleges Affiliated to Vidyasagar University under Study

	College Name	Block	Date of Establishment	Intake capacity	Number of Departments
1	Bajkul Milani Mahavidyalaya	Bhagawanpur - I	1964	1112	18
2	Belda College	Narayangarh	1963	1446	20
3	Bhattar College	Dantan	1963	1028	14
4	Chaipat S.P.B. Mahavidyalaya	Daspur II	2007	259	4
5	Chandrakona Vidyasagar Mahavidyalaya	Chandrakona(M)	1985	621	9
6	Debra Thana S.K.S. Mahavidyalaya	Debra	2006	750	13
7	Deshapran Mahavidyalaya	Contai-III	2010	278	5
8	Egra Sarada Sashi Bhusan College	Egra	1968	896	13
9	Garhbeta College	Garhbeta 1	1948	1139	13
10	Gourav Guin Memorial College	Garhbeta II	2008	333	5
11	Haldia Government College	Haldia	1988	877	15
12	Hijli College	Kharagpur-I	1995	417	8
13	Jhargram Raj College	Jhaargram (M)	1949	903	14
14	K D College of Commerce	Midnapore (M)	1961	428	4
15	Kharagpur College	Kharagpur (M)	1949	1414	15
16	Khejuri College	Khejuri	1999	509	8
17	Maharaja Nandakumar Mahavidyalaya	Nandakumar	2007	387	6
18	Mahisadal Raj College	Mahisadal	1946	1503	19
19	Mahishadal Girls' College	Mahisadal	1969	1103	15
20	Midnapore College	Midnapore (M)	1873	1332	22
21	Moyna College	Mayna	1972	471	7
22	Mugberia Gangadhar Mahavidyalaya	Bhagawanpur - II	1964	935	14
23	Narajole Raj College	Daspur 1	1966	785	12
24	Panskura Banamali College	Panskura	1960	1960	21
25	Pingla Thana Mahavidyalaya	Pingla	1965	983	13
26	Prabhat Kumar College	Contai-I	1926	1710	18
27	Rabindra Bharati Mahavidyalaya	Kolaghat	2010	249	6
28	Rabindra Satabarshiki Mahavidyalaya	Ghatal (M)	1961	1222	16
29	Raja N.L.Khan Women College	Midnapore (M)	1957	1269	19
30	Ramnagar College	Ramnagar-II	1972	1181	16
31	Sabang Sajani Kanta Mahavidyalaya	Sabang	1970	1184	15
32	Sankrail A.B. Smriti Mahavidyalaya	Sankrail	2007	394	6
33	Santal Bidroha Satabarshiki Mahavidyalaya	Garhbeta III	2005	718	12
34	Seva Bharati Mahavidyalaya	Jamboni	1964	697	11
35	Silda Chandra Sekhar College	Binpur –II	1971	461	9
36	Sitananda College	Nandigram	1960	893	12
37	Subarnarekha Mahavidyalaya	Gopiballavpur-I	1988	476	8
38	Sukumar Sengupta Mahavidyalaya	Keshpur	2004	630	9
39	Tamralipta Mahavidyalaya	Tamluk	1948	1223	17
40	Vivekananda Mission Mahavidyalaya	Sutahata	1968	978	15
41	Vivekananda Satabarshiki Mahavidyalaya	Jhaargram	1964	735	13
42	Yogada Satsang Palpara Mahavidyalaya	Patashpur	1964	833	12

Source: Office, Vidyasagar Univeristy and Websites of Colleges

Following the DEA methodology for input oriented VRS model we have derived the efficiency score of each college. We have taken 42 colleges under Vidyasgar Univeriity as the sample for our study. We have prepared a statitcal summary of input and output variables of the colleges under our study and are presented in Table 2. The summary based on the collected is presented in the table 2. For example, summary measures for average marks obtained by Honours students (MARKS in column 6) are as follows: maximum – 454.2, minimum – 356.4, average – 397.2 and standard deviation is 17.2. We have shown statistical summary measures of other parameters in other columns of Table 2.

The correlation matrix of all the inputs and outputs is presented in Table 3. The correlation coefficients among the inputs are found not so high.

Table-2: Summary table of the Performance of the Colleges

	FTSR	PTSR	NTSR	PASS	MARKS	1CLASS	PERCENTP	DEPT
Max	0.0770	0.1126	0.0647	860.0	454.2	268.0	60.0	22.0
Min	0.0034	0.0089	0.0028	66.0	356.4	1.0	17.0	4.0
Average	0.0181	0.0444	0.0159	298.7	397.2	36.7	34.6	12.4
SD	0.0151	0.0239	0.0109	176.6	17.2	48.4	9.2	4.8

Source: Own Estimation

Table-3: Correlation Matrix Tables of Inputs and Outputs

	FTSR	PTSR	NTSR	PASS	MARKS	1CLASS	PERCENTP	DEPT
FTSR	1.000	0.137	0.514	0.327	0.513	0.462	0.017	0.487
PTSR	0.137	1.000	0.632	0.004	0.005	0.248	-0.218	0.124
NTSR	0.514	0.632	1.000	0.195	0.326	0.538	0.140	0.181
PASS	0.327	0.004	0.195	1.000	0.736	0.865	0.474	0.829
MARKS	0.513	0.005	0.326	0.736	1.000	0.807	0.515	0.634
1CLASS	0.462	0.248	0.538	0.865	0.807	1.000	0.532	0.670
PERCENTP	0.017	-0.218	0.140	0.474	0.515	0.532	1.000	0.026
DEPT	0.487	0.124	0.181	0.829	0.634	0.670	0.026	1.000

Source: Own Estimation

Given the DEA model (equation 1) and the data on inputs outputs, we have calculated efficiencies for our selected colleges. The efficiency scores and ranks have been reported in column 3 and column 4 of Table 4. Out of 42 colleges 11 colleges are of efficiency scores with value 1 and they are ranked same i.e. 1. The average efficiency score of the colleges under study has been calculated as 0.682 with the minimum efficiency score being 0.299 and standard deviation of scores being 0.262. Eleven colleges having achieved 100% efficiency are: Belda College, Debra Thana S.K.S. Mahavidyalaya, Deshapran Mahavidyalaya, Haldia Government College, K D College of Commerce, Midnapore College, Mahishadal Girls' College, Panskura Banamali College, Rabindra Satabarshiki Mahavidyalaya, Sabang Sajani Kanta Mahavidyalaya, Sankrail A.B. Smriti Mahavidyalaya and Sukumar Sengupta Mahavidyalay.

We have regressed efficiencies of colleges on different variables to find the significant factors affecting the efficiency using the following regression model (equation 2) with usual meaning.

$$\text{Efficiency score} = \text{intercept} + a\times \text{Variable} + u \qquad (2)$$

We have found that only significant factor is enrolment size of the college. The regression result is reported in the Table 4. The co-efficient of enrolment is found to be 0.00015 and the t statistic is 2.39. The value of F for the regression equation is 5.74 with level of significance being 2.1% and the value of adjusted R^2 is 10.3%.

Table-4: Efficiency Scores and Ranks of Colleges

No.	Decision Making Unit (College)	Score	Rank
1	Bajkul Milani Mahavidyalaya	0.94	14
2	Belda College	1.00	1
3	Bhattar College	0.53	26
4	Chaipat S.P.B. Mahavidyalaya	0.83	17
5	Chandrakona Vidyasagar Mahavidyalaya	0.54	25
6	Debra Thana S.K.S. Mahavidyalaya	1.00	1
7	Deshapran Mahavidyalaya	1.00	1
8	Egra Sarada Sashi Bhusan College	0.79	18
9	Garhbeta College	0.58	24
10	Gourav Guin Memorial College	0.86	15
11	Haldia Government College	1.00	1
12	Hijli College	0.31	41
13	Jhargram Raj College	0.42	32
14	K D College of Commerce	1.00	1
15	Kharagpur College	0.50	27
16	Khejuri College	0.46	29
17	Maharaja Nandakumar Mahavidyalaya	0.48	28
18	Mahisadal Raj College	0.74	19
19	Mahishadal Girls' College	0.36	39
20	Midnapore College	1.00	1
21	Moyna College	0.42	30
22	Mugberia Gangadhar Mahavidyalaya	0.32	40
23	Narajole Raj College	0.42	31
24	Panskura Banamali College	1.00	1
25	Pingla Thana Mahavidyalaya	0.39	34
26	Prabhat Kumar College	0.98	12
27	Rabindra Bharati Mahavidyalaya	0.69	21
28	Rabindra Satabarshiki Mahavidyalaya	1.00	1
29	Raja N.L.Khan Women College	0.97	13
30	Ramnagar College	0.67	22
31	Sabang Sajani Kanta Mahavidyalaya	1.00	1
32	Sankrail A.B. Smriti Mahavidyalaya	1.00	1
33	Santal Bidroha Satabarshiki Mahavidyalaya	0.86	16
34	Seva Bharati Mahavidyalaya	0.39	35
35	Silda Chandra Sekhar College	0.61	23
36	Sitananda College	0.30	42
37	Subarnarekha Mahavidyalaya	0.72	20
38	Sukumar Sengupta Mahavidyalaya	1.00	1
39	Tamralipta Mahavidyalaya	0.39	36
40	Vivekananda Mission Mahavidyalaya	0.41	33
41	Vivekananda Satabarshiki Mahavidyalaya	0.38	38
42	Yogada Satsang Palpara Mahavidyalaya	0.38	37

Source: Own Estimation

Table 4: Regression Result of efficiency on size of the College:

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.515039	0.079744	6.458688	1.07E-07
Enrolment	0.00015	6.26E-05	2.396008	0.021342

Source: Own Estimation

CONCLUSION

Using the secondary data, the present paper finds efficiency scores of colleges under Vidyasagar Univresity in West Bengal for the year 2015-16. The efficiency scores were calculated using the non-parametric technique of Data Envelopment Analysis (DEA). The study shows that there is wide variation in efficiency scores across colleges under our study in West Bengal. The best and the least efficient banks individually are identified. The literature on efficiency measurement of educational institutions through DEA suggests that efficiency outcomes differ according to the choice of technique, the specification and measurement of inputs and outputs, the level of data used and the assumptions of the model [15]. It should be mentioned that the present study does not include some important efficiency parameters such as research outputs like number of publication, satisfaction index of students and other stakeholders etc. which may change the efficiency scores of the colleges. So, these may be incorporated in future studies.

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