

Performance of Management Schools in Secondary School Examinations of Andhra Pradesh State by Data Envelopment Analysis



Statistics

KEYWORDS : DEA, Technical Efficiency, Performance, Peers , Management.

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ABSTRACT

In this Paper we analyse the Board of Secondary data by Data Envelopment Analysis for the Andhra Pradesh state for the academic years 2009-2010 and 2010-2011 to see the Pattern of Efficiencies and Performance of the Management wise Results in Prior to the division of state in to two separate states . The Performance of the Management wise schools are presented along with the Peer Management Schools performance of the state as whole.

1. Introduction

For decades, Many applied fields share common concern over design and action on how to improve the data analytics. The concepts of best practices is to deliberate action in Private and Government sectors for improvement. There are three important characteristics associated with a “ best practice” : a comparative process , an action and link between an action and some out comes or goals. From 1980’s on wards, researchers started to direct their efforts towards extending“ best practice” to Education. This led to school improvement initiatives and studies on the characteristics of School Environment conducive to learning (Rutter & Maughan, 2002). In various parts of the world Researchers like Rhodes , Cooper and Thanassoulis started seeking appropriate measurement methodologies for school efficiency. Rodhes and Southwick (1986) studied about the efficiency in U.S.A. Private Universities in comparison to the Public Universities, by applying Data Envelopment Analysis Model and they regarded as Decision Making Units on the university as whole and analysed the data.

Kwimbere (1987) also applied DEA model to assess the performance of Decision Making Units viz., Engineering, Mathematics and Physics departments of a set of universities in U.K.

In this study we analyse the case of Board of Secondary Education (SSC) in Andhra Pradesh to assess which Management School fares well for the data collected for two academic years 2009-10 and 2010-11 by DEA empirically.

2. Data Envelopment Analysis:

Data Envelopment Analysis is relatively “data oriented” approach for evaluating the performance of a set of peer entities called decision making entities, Which convert multiple inputs in to multiple outputs .In the recent years, the DEA has emerged in to a greater variety of application for using evaluating the performance of many different kinds of entities engaged in many different activities in many different contexts in many different countries world over.

In this study we attempt to deal with the issue of measuring the relative efficiency of the participating Management schools in Telangana and Andhra Pradesh to summarize the measure of efficiency of the data. These evaluations can be conducted not only at the organization level but also in sub units such as number of boys and girls appeared in examination and their results.

2.1 Educational Inputs: The resources or input indicators are units of measurement, which represent the factors used to carry out the delivery of services. The identification and measurement of these factors is crucial in a fair evaluation of the economy and efficiency in the programs and services management. Previous studies on other performance models (Johnes 1996) have shown that inputs of universities can be categorized in various ways.

Here Educational Inputs are Management wise number of Boys and Girls appeared in Public Examination.

2.2 Educational Outputs: Output indicators measure the level of activity of programs and services. Furthermore, it is always useful to disclose indicators that provide information about the quantity and the quality of the activity (Pina & Torres 1995). The quality, as an attribute that affects the user’s perception, can also modify the productive process input/output relation. For this reason, it must be considered to access the efficiency of the process. Subramanyam and Reddy (2008) constructed DEA methodology to measure risk of commercial Banks. Raju and Haragopal (2015) constructed Data Envelopment Analysis know the Performance of the districts in SSC Public Examinations for the years 2009 - 2011 of Andhra Pradesh .

3. Efficiency:

The Efficiency factor in economic analysis , where the process has a single input and single output , then Efficiency is defined as :

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}} \quad (1)$$

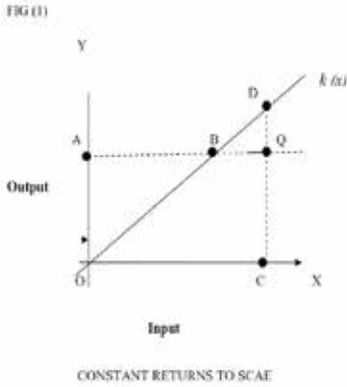
The theory of production from the economic point of view then can be considered as a formal model to link inputs and outputs, This theory has several strengths. First , some formal relationship between inputs and outputs exists and a “ best practice ” can be identified by comparing different units transforming in to inputs to output where all units are assessed relative to that of optimum.

The production process that occurs in schools seems to have the same characteristics of the above economic model in the business sector- utilization of physical and human resources as inputs to produce out as shown in bellow.



3.1 RETURNS TO SCALE:

The efficiency measures are based on Constant Returns to Scale technology (CRS). This implies that the production technology under consideration is such, that an increase in all the inputs by some proportion results in an increase in all the outputs by the same proportion. The variable returns to scale result in a non-proportionate change (increase or decrease) in the outputs. The Returns to scale and the difference between the input-reducing and the output-increasing measures are illustrated on figure by considering the Decision Making Units (DMUS) A,B,C& D.



From the above figure we understand that , a production of a single output is illustrated graphically. In fig (1) it can be seen that the function $k(x)$, where $k(x)$ is a straight line and has a single slope. Hence ,for every unit increase in the input that goes into the process, the output produced increases by a constant proportional quantity, hence it represents Constant Returns to Scale (CRS).

In this case, Q could be projected onto the frontier either under an input- reducing consideration or an output – increasing consideration. B and D are projected points on the frontier obtained for comparison. The input-reducing efficiency measure is given by .

In the case of CRS as in fig (1), the triangles ΔOAB and ΔOCD are similar. By the law of similar triangles.

$$\frac{AB}{CD} = \frac{OA}{OD} \tag{2}$$

$$\frac{AB}{AQ} = \frac{CQ}{CD} \tag{3}$$

3.3 The CCR Model: In Data Envelopment Analysis(DEA) the most widely used model is CCR Model (Banker et al., 1989; Charnes et al.,1993). A Constant Return To Scale relationship is assumed between Inputs and Outputs. It was the First Data Envelopment Analysis model to be developed CCR after Charnes, Cooper and Rhodes who introduced this model in article published in European Journal of Operations Research (1978).This model calculates the Overall Efficiency (OE) for each unit, Where the both Technical Efficiency and Scale Efficiency are aggregated in to one value.

The Primal CCR model is explained as follows

Decision Making Units DMU_j: The j^{th} Decision Making Unit $j=1,2,3,\dots,n$

x_{ij} : The amount of the i^{th} input of the j^{th} DMU $x_{1j}, x_{2j}, x_{3j}, \dots, x_{mj}$

y_{rj} : The amount of the r^{th} output of the j^{th} DMU $y_{1j}, y_{2j}, y_{3j}, \dots, y_{sj}$

u_r : The weight assigned to the r^{th} input $r=1,2,3,\dots,s$

v_j : The weight assigned to the j^{th} input $j=1,2,3,\dots,n$

$$\text{Maximize } Q = \frac{u_1 y_{1k} + u_2 y_{2k} + \dots + u_s y_{sk}}{v_1 x_{1k} + v_2 x_{2k} + \dots + v_m x_{mk}} \tag{4}$$

$$\text{Subject to } \frac{u_1 y_{1j} + u_2 y_{2j} + \dots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \dots + v_m x_{mj}} \leq 1 \quad j=1,2,\dots,n \tag{5}$$

$$u_1, u_2, u_3, \dots, u_s \geq 0 \quad v_1, v_2, v_3, \dots, v_m \geq 0$$

$$\text{Maximize } Q(u, v) = u_1 y_{1k} + u_2 y_{2k} + \dots + u_s y_{sk} \tag{6}$$

$$\text{Subject to } v_1 x_{1j} + v_2 x_{2j} + \dots + v_m x_{mj} = 1 \tag{7}$$

$$u_1 y_{1j} + u_2 y_{2j} + \dots + u_s y_{sj} \leq v_1 x_{1j} + v_2 x_{2j} + \dots + v_m x_{mj} \tag{8}$$

$$u_1, u_2, u_3, \dots, u_s \geq 0 \quad v_1, v_2, v_3, \dots, v_m \geq 0$$

Optimal Solution: (v^*, u^*, Q^*)

$$R_k = (j: \sum_{r=1}^s u_r y_{rj} = \sum_{i=1}^m v_i x_{ij} \quad j=1,2,3,\dots,n) \tag{9}$$

The reference set R_k is the Primal Problem . The Primal Problem becomes

$$\text{Maximize } Q^*(v^*, u^*) = \sum_{r=1}^s u_r y_{rk} \tag{10}$$

$$\text{Subject to } \sum_{r=1}^s u_r y_{rj} \leq 0 - \sum_{i=1}^m v_i x_{ij} \leq 0 \tag{11}$$

$$\sum_{i=1}^m v_i x_{ik} = 1 \tag{12}$$

$$v_i \geq 0 \quad u_r \geq 0$$

The above linear problems yield the Optimal Solution (O.S) Q^* , where efficiency score is called Technical Efficiency T.E or CCR Efficiency for the particular DMU_j and Efficiency scores for all of them are obtained by repeating them for each DMU_j, $j=1,2,\dots,n$. The value of Q^* is always less than or equal to unity. DMUs for which $Q^* < 1$ are relatively inefficient and those for which $Q^* = 1$ are relatively efficient, having their virtual input-output combination points on the frontier. The frontier itself consists of linear facts spanned by efficient units of the data, and the resulting frontier production function has no unknown parameters. As per the above model we implement empirical model evaluation for the data considered in the next section by explaining the Potential Improvement (P.I) and Reference Comparison (R.C) . We first explained about Potential Improvement (P.I) and Reference Comparison (R.C) .

3.4 Potential Improvement: An efficient study not only provides an efficiency score per each unit but also indicates by how much and in what areas an inefficient unit need to improve in order efficient. This information can enable targets to be set which could help inefficient units to improve their Performance.

3.5 Reference comparison: If the assessment of units was found as inefficient then it is felt to be justified then the information provided can be used as a basis for setting targets for the units .As a first step in setting targets, the inefficient unit should be compared with the units in its reference set.

3.6 Peer Group: Data Envelopment Analysis identifies for each inefficient unit a set of excellent units, called Peer Group, which includes those units that are efficient if evaluated with the optimal weights of inefficient unit. The Peer Group , made up of Decision Making Units which are characterized by Operating methods similar to the inefficient unit being examined , which is a realistic term of comparison which unit aim to imitate in order to improve its performance.

4. Empirical Study:

It is well known that every state in India holds a Public Examination at 10th

grade. This data was chosen to see the Efficiency/ Peer Performance of the Management wise Schools in 23 districts of Andhra Pradesh. The Secondary School Certificate (S.S.C) Public Examinations data for the academic years 2009-2010 and 2010-2011 of Andhra Pradesh for the 23 districts were considered as the data for measuring the efficiency of the Management schools in this state.

In SSC Public Examinations, March 2010, 13,62,403 Candidates have registered for the Examination. Both Regular and Private candidates put together **13,48,726** candidates have appeared for the SSC Public Examinations, March 2010. Out of **13,48,726** candidates, **10,62,812** Regular candidates and **2,85,914** Private Candidates have appeared for SSC Examinations.

In SSC Public Examinations, March 2011, **13,02,042** Candidates have registered for the Examination. Both Regular and Private candidates put together **12,87,211** candidates have appeared for the SSC Public Examinations, March 2011. Out of **12,87,211** candidates, **10,49,695** Regular candidates and **2,37,516** Private Candidates have appeared for SSC Examinations. There is an decrease of 13117 regular and 48398 in Private candidates in 2010-11 examination while comparing 2009-2010. Here we consider the data of different managements from which the Candidates appeared for the Examination and to see the efficiency of these management schools performance in the state.

The Results of Data Envelopment Analysis (DEA) for the data are presented below:

Technical Efficiency of Management wise Schools 2009-2010:

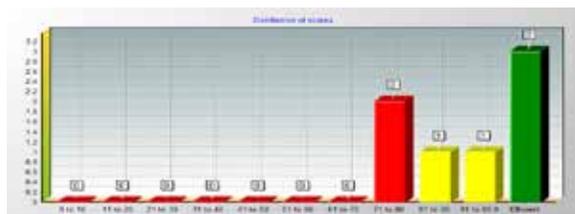
Table 1

S. No	Management	Score	Technical Efficiency (CCR)	References	Peers	Name of the Peers
1	APRESI	100%	1.000	5	0	APRESI
2	APSWRES	100%	1.000	1	0	APSWRES
3	APTWREIS	95.59%	0.956	0	2	APRESI, PRIVATE
4	GOVT	76.24%	0.762	0	2	APRESI, PRIVATE
5	MUNICIPAL	73.92%	0.739	0	2	APRESI, PRIVATE
6	PRIVATE	100%	1.000	5	0	PRIVATE
7	ZILLA PARISHAD	84.51%	0.845	0	2	APRESI, PRIVATE

From the above Table 1 the Technical Efficiency(T.E) variation for the 7 Management Schools has the following bound 0.7391.000. Also Three Management Schools has been emerged as efficient namely APRESI , APSWRES and PRIVATE the remaining management schools input loses due to Technical efficiency. From the Table 1 it is clear that APRESI , APSWRES and PRIVATE are Technically(CCR) Efficient when compared to the rest of the 7 Management Schools. It is noticed that the Peers to the all other Management Schools seems to be APRESI , APSWRES and PRIVATE.

The Distribution of Scores Graph for the Year 2009-2010 is presented below:

Figure 2



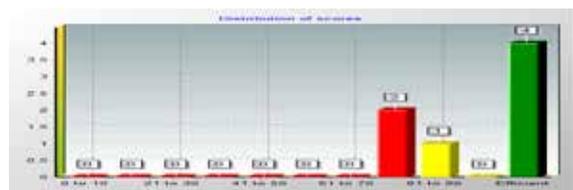
Technical Efficiency Management wise Schools 2010-2011: Table 2

S.No.	Management	Score	Technical Efficiency (CCR)	References	Peers	Name of The Peers
1	APRESI	100%	1.000	4	0	APRESI
2	APSWRES	100%	1.000	1	0	APSWRES
3	APTWREIS	100%	1.000	3	0	APSWREIS
4	GOVT	78.16%	0.782	0	3	APRESI, APSWREIS, PRIVATE
5	MUNICIPAL	76.36%	0.763	0	2	APRESI,PRIVATE
6	PRIVATE	100%	1.000	4	0	PRIVATE
7	ZILLAPARISHAD	87.33%	0.873	0	3	APRESI, APSWREIS, PRIVATE

From the above Table 2 the Technical Efficiency variation for the 7 Management Schools has the following bound 0.7631.000. Out of 7 Management Schools only Four has emerged as efficient namely APRESI, APSWRES, APTWREIS and PRIVATE the remaining Management Schools input loses due to Technical efficiency. It is Evident that from the Table 2 that Four Management Schools fared well as per the Technical Efficiency. When we compare 2009-2010 and 2010-2011 data, we notice that there is significant changes with respect to the APRESI, APSWRES and Private is faring well in both the academic Years. Even the bound differs with respect to the data for both years. We also tabulate in Table 3 the comparison of these two years how the Managements Performed.

The Distribution of Scores Graph for the Year 2010-2011 is presented below:

Figure-3



The Scores Distribution Comparison Table:

Table 3

	2009-2010	2010-2011
100% Efficiency	3	4
Scores 91-99.9	1	0
Scores 81-90	1	1
Scores 71-80	2	2
Scores below 70	0	0
Name of Efficiency Units	APRESI, APSWRES, PRIVATE	APRESI, APSWRES, APTWREIS PRIVATE

5. Conclusions:

From this Analysis we observe that in both the academic years three Management Schools commonly performed efficiently i.e APRESI, APSWRES, PRIVATE for the two consecutive academic years also while APTWREIS Performed well in 2010-2011. Remaining Management Schools are not maintained their performance consistency. For the academic year 2009-10 three Management Schools namely APRESI, APSWRES and PRIVATE Management schools Performed efficiently . Where as for the academic year 2010-2011 Four Management Schools Performed efficiently compared to the academic year 2009-10. With this pattern we can say that Four Management Schools shown above are performing well while there should be Potential Improvement is Required for Government and Municipal Management Schools which are inefficient units to improve in their Performance.

REFERENCE

- [1] Banker, R.D., R.F. Charnes, & W.W. Cooper (1984) "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis," *Management Science* vol. 30, pp. 1078–1092. | [2] Charnes, A., W. Cooper, & E. Rhodes (1978) "Measuring the Efficiency of decision making units" *European Journal of Operational Research* vol. 2, pp. 18–33. | [4] Kwimbere, F.J. (1987). "Measuring efficiency in not-for-profit organizations: an attempt to evaluate efficiency in selected UK university departments". M.Sc. thesis, School of Management, University of Bath. | [5] Pina V, Y Torres, L., (1995) 'Analyse through DEA Teaching activity of the Account Department in Spanish Public University.' | [6] Raju Nellutla, V.V. Haragopal,(2015) "Data Envelopment Analysis of SSC Public Examinations 2009 -2011 of Andhra Pradesh" *Global Journal for Research Analysis*,vol -4,issue 7,pp.141-144. | [7] Rhodes, E.Y. and Southwick, L. (1986) Determinants of Efficiency in Public and Private Universities, Department of Economics, University of South Carolina. | [8] Rutter, M. & Maughan, B. (2002) "School effectiveness findings 1970-2002" *Journal of School Psychology* ,vol.40, No.6, pp.451-475. | [9] Subramanyam, T., and C.S Reddy (2008) "Measuring the Risk Efficient in Indian Commercial Banking –DEA approach." *East West Journal of Economics and Business*, Vol XI(1&2) 76-105. | [10] Text book "Introduction to Data Envelopment Analysis and its Uses" by William W. Cooper, L M Seiford, Springer.