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Research Paper Statistics

Data Envelopment Analysis of SSC Public Examinations 2009 -2011 of Andhra Pradesh

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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 districts in Andhra Pradesh state Prior to the division of state in to two states . The Performance of the districts are presented along with the Peer Districts Performance of the state as whole.*

KEYWORDS : DEA, Efficiency, Performance, Peers ,SSC.

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 conductive 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 district fares well for the data collected for two academic years 2009-10 and 2010-11 by DEA.

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 consider Data Envelopment analysis (DEA) is used in an attempt to deal with the issue of measuring the relative efficiency of the participating schools district wise in Telangana and Andhra Pradesh . The technique DEA was employed for the Multiple inputs and outputs for evaluating the summary measure of efficiency of the data. These evaluation 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 district 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. In our case we give the Educational outputs of the Public Examination.

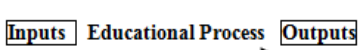
3. Efficiency:

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

$$\text{Efficency} = \frac{\text{Output}}{\text{Input}} \qquad (1)$$

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.

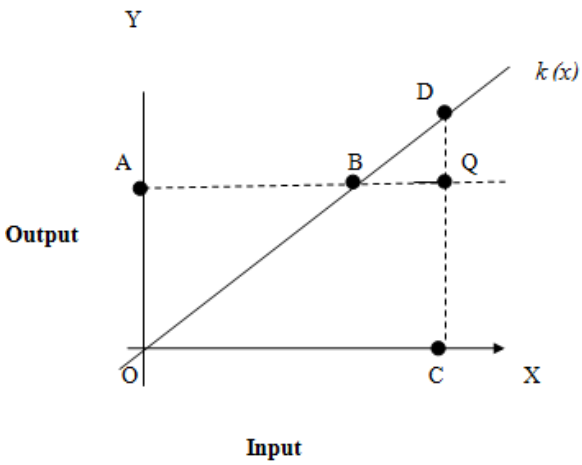
The production process that occurs in schools seems to have the same characteristics of the above economic model in the business sector- utilization of physical and human resources as inputs to produce out as shown in bellow.



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 three types of returns to scale and the difference between the input-reducing and the output-increasing measures are illustrated on figures by considering the Decision Making Units (DMUS) A,B,C& D.

FIG (1)



CONSTANT RETURNS TO SCAE

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 **Δ** OAB and **Δ**OCD are similar. By the law of similar triangles.

$$\frac{AB}{CD} = \frac{OA}{CD} \qquad (2)$$

$$\frac{AB}{AQ} = \frac{CQ}{CD} \qquad (3)$$

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 $j=1,2,3,\ldots\ldots n$

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

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

v_i: The weight assigned to the i^{th} input $i=1,2\,3,\ldots\ldots n$

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

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

$$\textit{Subject to } \frac{u_1 y_{1j} + u_2 y_{2j} + \cdots\cdots\cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots\cdots\cdots + v_m x_{mj}} \le 1 \qquad j=1,2\ldots\ldots n. \qquad (5)$$

$$u_1, u_2, u_3, \ldots\ldots\ldots\ldots u_s \ge 0 \quad v_1, v_2, v_3, \ldots\ldots\ldots\ldots v_m \ge 0$$

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

$$\text{Subject to } v_1 x_{1j} + v_2 x_{2j} + \cdots\cdots\cdots + v_m x_{mj} = 1 \qquad (7)$$

$$u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj} \le v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj} \qquad (8)$$

$$u_1, u_2, u_3, \ldots\ldots\ldots\ldots u_s \ge 0 \quad v_1, v_2, v_3, \ldots\ldots\ldots\ldots v_m \ge 0$$

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

$$R_k = \{ j : \textstyle\sum_{r=1}^{s} u_r^* y_{rj} = \sum_{i=1}^{m} v_i^* x_{ij} \;\; j = 1,2,3,\ldots, n \} \qquad (9)$$

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

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

$$\textit{Subject to } \textstyle\sum_{r=1}^{s} u_r y_{rj} \le 0 - \sum_{i=1}^{m} v_i x_{ij} \le 0 \qquad (11)$$

$$\textstyle\sum_{i=1}^{m} v_i x_{ik} = 1 \qquad (12)$$

$$v_i \ge 0 \quad u_r \ge 0$$

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,….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 23 districts of Andhra Pradesh. The S.S.C Public Examinations data for the academic years 2009-2010 and 2010-2011 of Andhra Pradesh in the 23 districts were considered the data further divided in to Andhra Pradesh 13 districts and Telangana 10 Districts for Measuring the Efficiency of the Two States. 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. The Nine point grading system of CBSE has been introduced for this Public 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

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

Technical Efficiency 2009-2010:
Table 1

S.No	District	Score	Technical Efficiency (CCR)	References	Peers	Name of The Peers
1	Adilabad	91.10%	0.911	0	2	Nizambad, Karimnagar
2	Anantapur	80.30%	0.803	0	2	Nizambad, Karimnagar
3	Chittoor	90.80%	0.908	0	1	Nizambad
4	East Godavari	90.20%	0.902	0	1	Karimnagar
5	Guntur	96.80%	0.968	0	1	Nizambad
6	Hyderabad	84.90%	0.849	0	1	Karimnagar
7	Kadapa	99.80%	0.998	0	1	Nizambad
8	Karimnagar	100.00%	1.000	7	0	Karimnagar
9	Khammam	86.90%	0.869	0	2	Nizambad, Karimnagar
10	Krishna	91.00%	0.910	0	1	Nizambad
11	Kurnool	99.20%	0.992	0	1	Nizambad
12	Mahaboobnagar	97.90%	0.979	0	1	Nizambad
13	Medak	94.50%	0.945	0	1	Nizambad
14	Nalgonda	99.40%	0.994	0	1	Nizambad
15	Nellore	88.30%	0.883	0	1	Nizambad
16	Nizamabad	100.00%	1.000	19	0	Nizambad
17	Prakasam	94.00%	0.940	0	1	Nizambad
18	Ranga Reddy	85.90%	0.859	0	1	Nizambad
19	Srikakulam	85.70%	0.857	0	1	Nizambad
20	Visakhapatnam	86.90%	0.869	0	1	Nizambad
21	Vizianagaram	92.80%	0.928	0	1	Nizambad
22	Warangal	89.90%	0.899	0	1	Nizambad
23	West Godavari	98.30%	0.983	0	1	Karimnagar

From the above Table 1 The Technical Efficiency variation for the 23 districts has the following bound 0.8031.000. Also Two Districts has been emerged as efficient namely Nizamabad and Karimnagar and the remaining districts input loses due to Technical efficiency. From the Table 1 it is clear that Karimnagar and Nizambad are Technically-(CCR) Efficient when compared to the rest of 21 districts. Which also indicated that during 2009-2010 Talangana State has High amount of Technical Efficiency while AP lagging behind. It is also noticed that the Peers to the all other districts of AP&TS seem to be Nizambad and Karimnagar.

The Distribution of Scores Graph for the Year 2009-2010 is presented below:
Fig-1

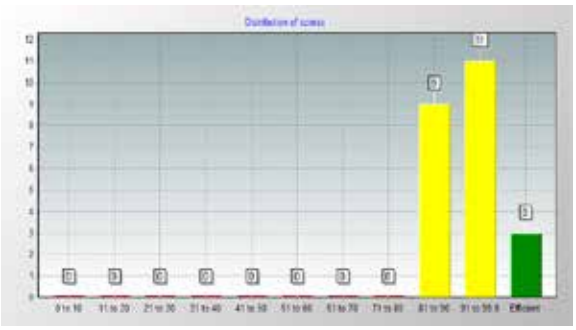
Technical Efficiency 2010-2011:
Table 2

S.No	District Name	Score	Technical Efficiency (CCR)	References	Peers	Name of The Peers
1	Adilabad	89.30%	0.893	0	2	Guntur, Karimnagar
2	Anantapur	82.80%	0.828	0	2	Guntur, Karimnagar
3	Chittoor	98.20%	0.982	0	2	Guntur, Karimnagar
4	East Godavari	91.60%	0.916	0	1	Karimnagar
5	Guntur	100.00%	1.000	18	0	Guntur
6	Hyderabad	87.50%	0.875	0	1	Karimnagar
7	Kadapa	98.30%	0.983	0	2	Guntur, Karimnagar
8	Karimnagar	100.00%	1.000	14	0	Karimnagar
9	Khammam	89.40%	0.894	0	2	Guntur, Karimnagar
10	Krishna	93.80%	0.938	0	2	Guntur, Karimnagar
11	Kurnool	98.70%	0.987	0	1	Mahoobnagar
12	Mahaboobnagar	100.00%	1.000	6	0	Mahoobnagar
13	Medak	94.50%	0.945	0	2	Guntur, Karimnagar
14	Nalgonda	99.20%	0.992	0	2	Guntur, Mahoobnagar
15	Nellore	88.60%	0.886	0	2	Guntur, Karimnagar
16	Nizamabad	93.50%	0.935	0	2	Guntur, Karimnagar
17	Prakasam	95.80%	0.958	0	2	Guntur, Karimnagar
18	Ranga Reddy	83.70%	0.837	0	2	Guntur, Karimnagar
19	Srikakulam	88.80%	0.888	0	2	Guntur, Karimnagar
20	Visakhapatnam	90.40%	0.904	0	1	Guntur
21	Vizianagaram	90.80%	0.908	0	1	Guntur
22	Warangal	92.50%	0.925	0	2	Guntur, Karimnagar
23	West Godavari	95.10%	0.951	0	2	Guntur, Karimnagar

From the above Table 2 the Technical Efficiency variation for the 23 districts has the following bound 0.8281.000. Out of 23 districts only Three has emerged as efficient namely Guntur, Karimnagar and Mahoobnagar the remaining districts input loses due to Technical efficiency. It is Evident that from the Table 2 that one district in AP

that is Guntur and two district in TS fared well as per the Technical Efficient. When we compare 2009-2010 and 2010-2011 data, we notice that there is significantly w.r.t the Karimnagar district is faring well in both the academic Years. Even the bound differs w.r.t the data for both years. We tabulated in Table 3 the comparision of these two years.

The Distribution of Scores Graph for the Year 2010-2011 is presented below:
Fig-2



The Scores Distribution Comparision Table:
Table 3

	2009-2010	2010-2011
100% Efficiency	2	3
Scores 91-99.9	11	11
Scores 81-90	9	9
Scores 71-80	1	0
Scores 0- 70	0	0
Name of Efficiency Units	Nizamabad , Karimnagar	Guntur, Karimnagar ,Mahoobnagar

5. Conclusion:

In this Analysis we observe that only one district is performing efficiently i.e Karimnagar for the two consecutive academic years. Remaining districts are not maintained their performance consistency. In the academic year 2009-10 two districts namely Nizambad and Karimnagar performing efficiently . Where as for the academic year 2010-2011 three districts performed efficiently compared to the academic year 2009-10.

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