Volume-4, Issue-8, August-2015 • ISSN No 2277 - 8160

Research Paper Statistics

Hospital Efficiency in Andhra Pradesh by Data Envelopment Analysis

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ABSTRACT

Healthcare plays important role in the government. Now, the consolidation of nation's health is primary objective. The efficiency of hospitals is judged on the basis of efficiency. A great change in recent years in hospitals for the patients. Even the government has to compete with private hospitals. It is an important to find the appropriate resource allocation to the maximum. This study focuses the changes in health sector. It studies the hospital efficiency at district level government hospitals. Government should analyze about the efficiency regularly on quality of health care. The number of hospitals, Primary Health Centers and beds are taken for analysis in Andhra Pradesh and Telangana region. As it is input oriented and constant return to scale, Data Envelopment Analysis (DEA) is used to find out the relative efficacy.

KEYWORDS : Health Care, Globalization and Liberalization, Efficiency, Data Envelopment Analysis

1. Introduction

The main Objective of this study is to evaluate the efficiency factor of the jurisdiction of the 23 districts of Andhra Pradesh. We now explain efficiency in economic. The process has a single input and single output, Efficiency is defined as :

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

The theory of production from economic 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 inputs to output where all units are assessed relative to that optimum.

The production process that can occur in hospitals 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 below.

Inputs → Hospital Process → Outputs

Inputs Hospital Process Outputs

2. Data and variables

Several variables are defined here to conduct the analysis from the secondary data collected from the various Government hospitals the Andhra Pradesh state. These variables are categorized as of two types such as input and output variables. These variables clearly are shown in Table 1.

2.1. Selection of variables

Once the various measures (or variables) and the measurement scales for input and output were derived from the data, the next step involved is to identify the relevant input and output variables, which contribute towards explaining the right input and output measures of the hospitals.

2.2. Input variables

The input variables are number of beds, number of regular doctors and contractual doctors, Number of General Hospitals, Number of Dispensaries, Number of Primary health centres. Six variables are taken to assess input variable, which is common to all hospitals. The level of aggregation or disaggregation of staff depends on the information available. For example, the input variable of 'staff' could consist of total staff strength of a particular hospital. The break-up of the total staff strength in terms of the number of regular doctors, number of contract doctors, are available. (Magnussen.J:1996)

2.3. Output variables Hospitals provide three major services: out-patient services, in-patient services, Total cases (Men, Women). Given this homogeneity in types of services provided, the number of cases treated/handled under each category was chosen as a representative measure of the three output variables. (MershaT: 1989)

In this study we choose 6 inputs and 3 outputs. (Butler JR: 1995)

i. The 6 inputs variables considered are:

i. Number of General Hospitals
ii. Number of Dispensaries
iii. Number of Primary Health Centres
iv. Number of Regular Doctors
v. Number of Contract Doctors
vi. Number of Beds available

ii. The Three Outputs variables are;

i. Out patients (Men, Women)
ii. In patients (Men, Women)
iii. Total Cases (Men, Women)

Variables	Definition
Inputs	
i .Number of Hospitals:	Number .of Hospitals available in districtwise.
ii. Number .of Dispensaries:	Number of Dispensaries available in districtwise.
iii. Number of Primary Health Centres:	Number of Primary Health Centres availableIn district wise.
iv. Number of Regular Doctors:	Number of Regular Doctors available in district wise.
v. Number of Contractual Doctors:	Number of Contractual Doctors availablein district wise.
vi. Number of Beds available:	Number of Beds available in district wise.
Outputs	
OUTPA	Number of patient visits to Outpatient Department
INPA	Number of patient visits to Inpatient Department
Total Cases	The number of Out- Patients (Men & Women) In-Patients (Men & Women)

Table-1

3. Methodology

For this study we consider the data of district level hospitals with the above mentioned Input/output variables for the 2013 year of the Andhra Pradesh state. For this data we employ the technique of DEA to measure the efficiency of the targeted organisation in a group relative to the best performing organisation in that group. It basically measures the status of efficiency of among all the district hospitals. (Charnes& Cooper: 1985)

These individual hospitals units analysed are also referred to as decision-making units (DMUs) in DEA. The DMUs for which efficiency score are measured can be a whole agency such as hospitals, banks or units within organizations such as separate wards in a hospital. To begin with it is very essential to understand the concepts DEA.

4. Data Envelopment Analysis:

Data Envelopment Analysis (DEA) was initially proposed by Charnes (1978) based on the concept Technical Efficiency by Farrel (1957). Basically, it consists of two models: The Input Oriented Model and the Output Oriented Model. The Input Oriented Model is to maximise inputs for a given outputs, while the Output oriented model is to maximize outputs at given inputs. In general, the Technical Efficiency obtained from the Output oriented models differs from that acquired, from the input-oriented model unless the profit is constant return to scale.

In Recent year we have seen a greater variety of applications of DEA for use in evaluating the performances of many different kinds of entitles engaged in many different activities in many different contexts in many different countries.

Presently in this paper, Data envelopment analysis (DEA) is used in an attempt to deal with the issue of measuring the relative efficiency of the participating total hospitals in Andhra Pradesh by district wise (Telangana and Andhra Pradesh).. This evaluation can be obtained not only at the organization level but also in sub units such as number of regular doctors, contractual doctors, in patients and out-patients appeared in the hospitals.

The basic DEA model helps to find answers to questions such as:

(i) Which district hospitals (or hospital departments) are the most efficient?
(ii) If all district hospitals are to perform according to best practice (i.e. the efficient peer hospitals), by how much could inputs/resources be reduced to produce the current output levels; or alternatively, by how much puts be increased with the current input levels?
(iii) How much resources can be potentially saved if all district hospitals are operating at an optimal scale?

Also, DEA makes a particular input and output targets that would make an inefficient hospital efficient. It also acknowledges resourceful peers for the hospitals, which are not efficient. It also helps the inefficient hospitals to imitate the functional organisation of their peers so as to improve their proficiency. (Grosskopf S.&Valdamanis V.1987.)

4.1. The CCR Model:

In Data Envelopment Analysis (DEA) 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 the Journal of Operational Research (1978). Given the data, we measure the efficiency of each DMU once and hence optimisations, one for each DM to be evaluated. Let the DM to be evaluated on any trial be designated as DMwhere j = 1,2,3,…n.We solve the following fractional programming problem to obtain values for the input weights () (i= 1,2…m) and output weights () (r=1,2…s) as variables.

The primal CCR model is explained as follows

Decision Making Units DMU_j: The j^{th}Decision Making Unit j= 1,2,3,……..n

$\boldsymbol{x_{ij}}$: The amount of the i^{th} input of the j^{th} DMU x_{1j}, x_{2j}, x_{3j}……..x_{nj}

$\boldsymbol{y_{ij}}$: The amount of the j^{th} out of the j^{th} DMU y_{1j}, y_{2j}, y_{3j}……..y_{sj}

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

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

$$\text{Maximize } Z = \frac{u_1y_{1j}+u_2y_{2j}+\text{----------}+u_sy_{sj}}{v_1x_{1j}+v_2x_{2j}+\text{----------}+v_sx_{mj}} \quad \text{..... (1)}$$

$$\textit{Subject to } \frac{u_1y_{1j}+u_2y_{2j}+\text{----------}+u_sy_{sj}}{v_1x_{1j}+v_2x_{2j}+\text{----------}+v_mx_{mj}} \leq 1 \qquad j=1,2\ldots\ldots n \quad \text{..... (2)}$$

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

$$\text{Maximize } Z(u,v) = u_1y_{1j}+u_2y_{2j} + \text{----------}+u_sy_{sj}\ldots\ldots\ldots\ldots \quad (3)$$

$$\text{Subject to } v_1x_{1j}+v_2x_{2j} + \text{----------}+v_mx_{mj} = 1\ldots\ldots\ldots\ldots \quad (4)$$

$$u_1y_{1j}+u_2y_{2j} + \text{---}+u_sy_{sj} \leq v_1x_{1j}+v_2x_{2j} + \text{---}+v_mx_{mj}\ldots\ldots\ldots\ldots \quad (5)$$

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

Optimal Solution: (v*, u*, Z*)

$$P_k = \{j: \sum_{r=1}^{s} u_r^* y_{rj} = \sum_{i=1}^{m} v_i^* x_{ij} \quad j = 1,2,3,\ldots,n\} \quad (6)$$

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

$$Maximize\ Z^*(v^*,u^*) = \sum_{r=1}^{s} u_s y_{sj} \quad (7)$$

$$Subject\ to \sum_{r=1}^{s} u_s y_{sj} \leq 0 - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \quad (8)$$

$$\sum_{i=1}^{m} v_i x_{ij} = 1 \quad (9)$$

$$V_i \geq 0 \qquad u_r \geq 0$$

(Rajunellutla, V.V.Haragopal 2015)

The above linear problems yield the Optimal Solution (O.S) Z*, which 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 Z* is always less than or equal to unity. DMUs for which Z* < 1 are relatively inefficient and those for which Z* = 1 are relatively efficient, having their virtual input-output combination points on the frontier. The frontier itself consists of linear facts spanned by efficient hospitals of the data, and the resulting frontier production function has no unknown parameters.

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

4.3. Reference comparison: If the assessment of hospitals as inefficient 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 hospitals should be compared with the hospitals in its reference set

5. Empirical Study:

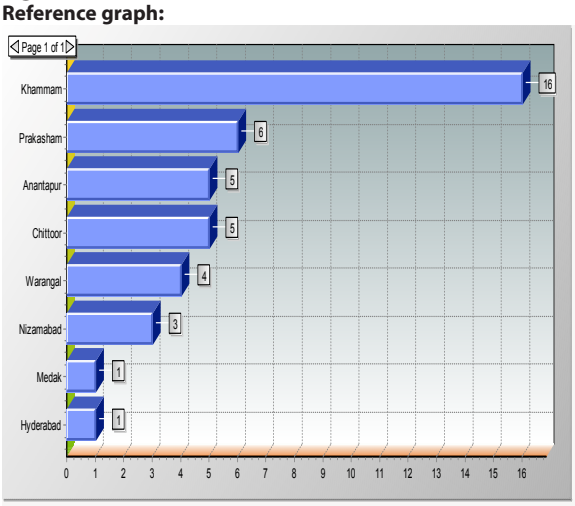
Hospital data was collected from year 2013 in Andhra Pradesh State (Andhra Pradesh &Telangana) in 23 districts. Whereas 13 districts in Andhra Pradesh and 10 districts in Telangana state respectively to analysis the efficiency of hospitals. As part of the data, collected in year 2013 in Andhra Pradesh state are i.e., Number of General Hospitals, Number of Dispensaries, Number of Primary Health Centres, Number of Regular Doctors, Number of Contractual Doctors and Number of Beds were taken into consideration for this empirical investigation.

Technical Efficiency: Year- 2013
Table-2

Sl. No.	District	Score	Technical Efficient (CCR)	References	Peers	Name of the peers
1	Adilabad	95.83%	0.9583	0	2	Chittoor, Khammam
2	Anantapur	100.00%	1.0000	5	0	Anantapur
3	Chittoor	100.00	1.0000	5	0	Chittoor
4	East Godavari	60.49%	0.6049	0	2	Khammam, Prakasham
5	Guntur	86.47%	0.8647	0	1	Khammam
6	Hyderabad	100.00%	1.0000	1	0	Hyderabad
7	Kadapa	94.13%	0.9413	0	1	Khammam
8	Karimnagar	70.15%	0.7515	0	3	Anantapur, Khammam, Warangal
9	Khammam	100.00%	1.0000	16	0	Khammam
10	Krishna	42.17%	0.4217	0	2	Khammam, Prakasham
11	Kurnool	46.71%	0.4671	0	2	Khammam, Prakasham
12	Mahaboob-nagar	78.23%	0.7823	0	2	Khammam, Prakasham
13	Medak	100.00%	1.0000	1	0	Medak
14	Nalgonda	16.87%	0.1687	0	4	Anantapur,-Chittoor, Khammam, Warangal
15	Nellore	78.88%	0.7888	0	1	Khammam
16	Nizamabad	100.00%	1.0000	3	0	Nizambad
17	Prakasam	100.00%	1.0000	6	0	Prakasham
18	Ranga Reddy	87.79%	0.8779	0	3	Ananta-pur,Kham-mam, Nizambad
19	Srikakulam	67.16%	0.6716	0	3	Chittoor, Khamman, Prakasam
20	Visakhapat-nam	7.20%	0.0720	0	2	Khammam, Warangal
21	Vizianagaram	76.11%	0.7611	0	3	Anantapur, Khammam, Nizambad
22	Warangal	100.00%	1.0000	4	0	Warangal
23	West Go-davari	17.01%	0.1701	0	2	Chittoor, Khammam

The technical efficiency variation for the 23 district has the following bounds 0.07201.000.Out of 23 districts only. Eight has been emerged as efficient namely Anatapur, Chittoor, Hyderabad, Kammam, Medak, Nizamabad Prakasam and Warangal and the remaining districts input losses due to Technical efficiency.

Figure-2
Reference graph:



Conclusions:

The findings indicate a wide variation in the district hospitals as indicated by the authorized number of hospitals, number of dispensaries, number of primary health centres, number of regular doctors and number of contractual doctors.

On the basis of the table, which highlighted the year 2013, considered that the half of the district hospitals were revealed that there are hospitals, whose efficiency scores are extremely low.

Efficiency ranging from 0.0720 to 1.000. The low level performance districts such as Visakhapatnam (0.07020), West Godavari (0.1701), Krishna (0.4217), Kurnool (0.4671) and Nalgonda (0.1687) are showed. With DEA, in which the Technical Efficiency of all hospitals are measured is defined by those hospitals in the group with a Technical Efficiency score of 100%. These hospitals are giving the good performance.

The results of this study indicate that many of the district hospitals operate at Technical Efficiency Level well below. The study further reveal that the dominant scale inefficiency is increasing return to scale in the presence of increasing return to scale, increasing the level outputs requires an increasing in the number of hospitals, number of dispensaries, number of primary health centres, number of regular doctors and number of contractual doctors in the inefficient districts

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