Efficiency in Health Care Sector in Bihar (India): An exploratory Analysis using DEA

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Abstract

Keeping in view global awareness about resource utilization in healthcare sector, we focus on efficiency of health care system at sub-state level (i.e., district level) in India using Bihar state and its district level data for 2012-13. In spite of being an economically and socially disadvantaged state, the IMR in Bihar is very close to the all-India average. We explore the reasons for relative performance of different districts with Data Envelopment Analysis. We used IMR as output variables. Using Principal component analysis, we tried a sub-set of variables which had low correlations. Four factor scores relating to safe delivery, less than 24 hours stay in institution after delivery, total numbers having post-natal care, and total numbers having immunization card were used for DEA. We have focused on constant returns to scale technical efficiency.

Our results for district level health system efficiency in Bihar indicate that some of the districts have low efficiency in utilization of inputs like doctors, beds and workload per health institutions. There are also other districts which need more of these inputs to enhance their output and efficiency. A mix of inefficiency and inadequacy of inputs is reflected in our results. The funds from national rural health mission (NRHM) towards low performing districts seem to have been optimally targeted. Further exploration in terms of per health institution to observe individual input utilization along with training inputs to health personnel for optimal use of time, manpower and material inputs may help to enhance state health system efficiency.

Keywords: Efficiency, healthcare system, district level, IMR.

Introduction

Healthcare systems are integrated combinations of several activities intended to promote, restore, and maintain health [23] and the evaluation of the efficiency to produce multiple types of outputs to accomplish these objectives frequently is largely subjective. In this paper our approach of measuring efficiency has a focus on mainly two attributes namely, effectiveness (or health care output) and access (type of facility available or used). Our paper does not aim to focus explicitly either on quality or cost of care due to different data limitations for the geographical unit of analysis focused by us, namely, sub-state or district in an Indian state.

Literature Review

Review of literature on importance of efficiency in resource utilization in healthcare sector indicates that a number of empirical studies has laid emphasis on the overall health system performance and its impact on health outcomes [19, 28]. Some studies have also concentrated on hospitals, nursing homes, HMOs and district health authorities. [13,17-18, 24-25, 27, 29]

Other notable studies include a comparison of the performance of 6 countries (Australia, Canada, Germany, New Zealand, the United Kingdom, and the United States) using a ranking methodology based on 37 indicators in 5 key areas: health outcomes, quality, access, efficiency, and equity. [8-9] Attempts have also been made to compare 18 healthcare systems using five categories: healthcare expenditures, physician services, pharmaceutical services, life expectancy, and infant mortality. Another study has also used the data envelopment analysis (DEA) to evaluate and rank the relative performance of all countries, and to identify combinations of achievable targets that would cause poorly performing countries to become world-class.[2] DEA has been successfully used to study other healthcare issues, such as hospital performance, public policy efficiency [8], and cardiac surgeon performance. [6]

More often some non-parametric or parametric methods are employed. Among the former, data envelopment technique is usually deployed. Among the later methods, an idealized yardstick is developed which is used to evaluate economic performance of health system. These methods provide a production possibility frontier depicting a locus of potentially technical efficient output combination that an organization or health system is capable of producing at a point of time. An output combination below this frontier is termed as technically inefficient. [3, 7,14] Despite its relatively recent application in healthcare sector, there exists an exhaustive review of studies which provides us in detail the steps and empirical problems that have been highlighted by researchers [16, 29]. There are also very few studies in the developing countries' context and focus of these studies particularly in the Indian context mostly has remained either all-India rural or urban sector or the analysis has been carried out up to state level aggregates only. District level analysis has been also attempted for few states including Punjab, Maharashtra, Karnataka, West Bengal and Madhya Pradesh. [21] However, so far there has not been any attempt to analyze efficiency at sub-state level particularly focusing on Bihar state. Our attempt in this paper is to fill this gap. Thus we extend our analysis in this paper to focus on efficiency of health care system at sub-state level (i.e., district level) in India using Bihar state and its district level data. We explore the reasons for relative performance of different districts with Data Envelopment Analysis.

With a population of 104.0 million in 2011, Bihar is a densely populated state, with 1106 persons living per sq. km. of its area. As per the Planning Commission figures, in 2009-10, 53.5 percent of its population lived below the poverty line in Bihar. Nearly nine-tenths of its population lives in the villages and the poverty ratio is higher in rural areas at 55.3 percent. The state has a per capita income of Rs. 16,537 at constant prices.

Life expectancy at birth (LEB) both for Bihar and India is presented in Table 1. It emerges from the Table that the gap between India and Bihar which was 2.1 years in 2001-05 has narrowed down to 0.3 years in 2006-10. When one compares the LEB for male and female, it is usually found to be higher for females. In case of India, this general pattern was observed, in both 2001-05 and 2006-10.

Besides LEB, three other indicators of health for which there exists comparable data are: Crude Birth Rate (CBR), Crude Death Rate (CDR) and Infant Mortality Rate (IMR). The relevant data on these three indicators, for both Bihar and India, is presented in Table 2, covering the period 2007-08 to 2011-12. For Crude Birth Rate (CBR), the figures are consistently higher for Bihar; in 2011-12, it was 27.7 for Bihar compared to 21.6 for India, registering a difference of 6.1. When one compares the Crude Death Rate (CDR), quite interestingly, it emerges that, in 2011-12, it was lower in Bihar (6.6) than in India (7.0). Earlier, in 2007-08, the CDR in Bihar (7.5) was marginally higher than that for India (7.4). A low CDR obviously implies a better health status. The third indicator of health, included in Table 2 is Infant Mortality Rate (IMR). It is interesting to note that, in spite of being an economically and socially disadvantaged state, the IMR in Bihar is very close to the all-India average. Further, the improvement in the IMR during the recent years has been as fast in Bihar as in India as a whole. In 2012, the IMR in Bihar was — male (42), female (45) and overall (43). The corresponding figures for India are — male (41), female (44) and overall (42).

Table 1: Life Expectancy at Birth of Bihar and India

State/India	2001-05			2006-10		
	Male	Female	Total	Male	Female	Total
Bihar	62.0	60.1	61.0	65.5	66.2	65.8
India	62.3	63.9	63.1	64.6	67.7	66.1

Source: Sample Registration System (SRS), Office of the Registrar General, India, Ministry of Home Affairs, GOI; Government of Bihar Economic Survey 2013 – 14, Finance Department.

As expected, the health status in various districts of Bihar varies considerably. The relative position of different districts in terms of Infant Mortality Rate (IMR), often considered as the most sensitive indicator of health status, varies from 31 in Patna to 64 in Madhepura. [14]

Given the above basic idea of health status in Bihar, in this paper, we make an attempt to find out technical efficiency of health system in the state using a non-parametric approach known as Data Envelopment analysis (DEA).

Table 2: Selected Health Indicators for Bihar and India (2007-2012)

Category		2007-08	2008-09	2009-10	2010-11	2011-12
		Crude Birth Rate				
Bihar	Rural	30.2	29.7	29.3	28.8	28.4
	Urban	22.9	22.5	22.2	22	21.6
	Combined	29.4	28.9	28.5	28.1	27.7
India	Rural	24.7	24.4	24.1	23.7	23.1
	Urban	18.6	18.5	18.3	18	17.4
	Combined	23.1	22.8	22.5	22.1	21.6
		Crude Death Rate				
Bihar	Male	7.6	7.6	7.2	7.1	6.7
	Female	7.4	6.9	6.8	6.6	6.5
	Total	**7.5**	**7.3**	**7**	**6.8**	**6.6**
India	Male	8	8	7.8	7.7	7.7
	Female	6.9	6.8	6.7	6.7	6.4
	Total	**7.4**	**7.4**	**7.3**	**7.2**	**7**
		Infant Mortality Rate				
Bihar	Male	57	53	52	46	42
	Female	58	58	52	50	45
	Total	58	56	52	48	43
India	Male	55	52	49	46	41
	Female	56	55	52	49	44
	Total	**55**	**53**	**50**	**47**	**42**

Source: Sample Registration System (SRS), Office of the Registrar General, India, Ministry of Home Affairs, GOI

Methods

The DEA methodology, originating from Farrell's (1957) seminal work and further by [5] assumes the existence of a convex production frontier. The production frontier in the DEA approach is constructed using linear programming methods. The term "envelopment" stems from the fact that the production frontier envelops the set of observations[1]. The general relationship that we consider is given by the following function for each district i:

$$Y_i = f(X_i), i = 1...n \quad (1)$$

where we have Y_i – our output measure; X_i – the relevant inputs.

If $Y_i < f(X_i)$, it is said that unit i exhibits inefficiency. For the observed input levels, the actual output is smaller than the best attainable one and inefficiency can then be measured by computing the distance to the theoretical efficiency frontier.

The analytical description of the linear programming problem to be solved in the variable-returns to scale hypothesis is sketched below for an output-oriented specification. Suppose there are k inputs and m outputs for n Decision Management Units (DMUs). For the ith DMU, we can define X as the $(k\ x\ n)$ input matrix and Y as the $(m\ x\ n)$ output matrix. The DEA model is then specified with the following mathematical programming problem, for a given ith DMU:

Max $\delta, \lambda\ \delta$

Subject to:

$$-\delta Y_i + Y\lambda \geq 0$$

$$X_i - X\lambda \geq 0$$

$$n1'\lambda' = 1 \quad (2)$$

$$\lambda \geq 0$$

In problem (2), δ is a scalar (that satisfies $1/\delta \leq 1$), more specifically it is the efficiency score that measures technical efficiency. It measures the distance between a unit and the efficiency frontier, defined as a linear combination of the best practice observations. With $1/\delta < 1$, the unit is inside the frontier (i.e. it is inefficient), while $\delta = 1$ implies that the unit is on the frontier (i.e. it is efficient).

The vector λ is a $(n \times 1)$ vector of constants that measures the weights used to compute the location of an inefficient DMU if it were to become efficient, and n1 is an n-dimensional vector of ones. The inefficient DMU would be projected on the production frontier as a linear combination of those weights, related to the peers of the inefficient DMU. The peers are other DMUs that are more efficient and are therefore used as references for the inefficient DMU. The restriction $n1'\lambda' = 1$ imposes convexity of the frontier, accounting for variable returns to scale. Dropping this restriction would amount to admit that returns to scale were constant. Problem (2) has to be solved for each of the n DMUs in order to obtain the n efficiency scores.

Figure 1 presents the DEA production possibility frontier in the simple one input-one output case. States A, B and C are efficient States. Their output scores are equal to 1. State D is not efficient. Its score $[d2/(d1 + d2)]$ is smaller than 1.

[1] Charnes [5], [7, 26] offer introductions to DEA.

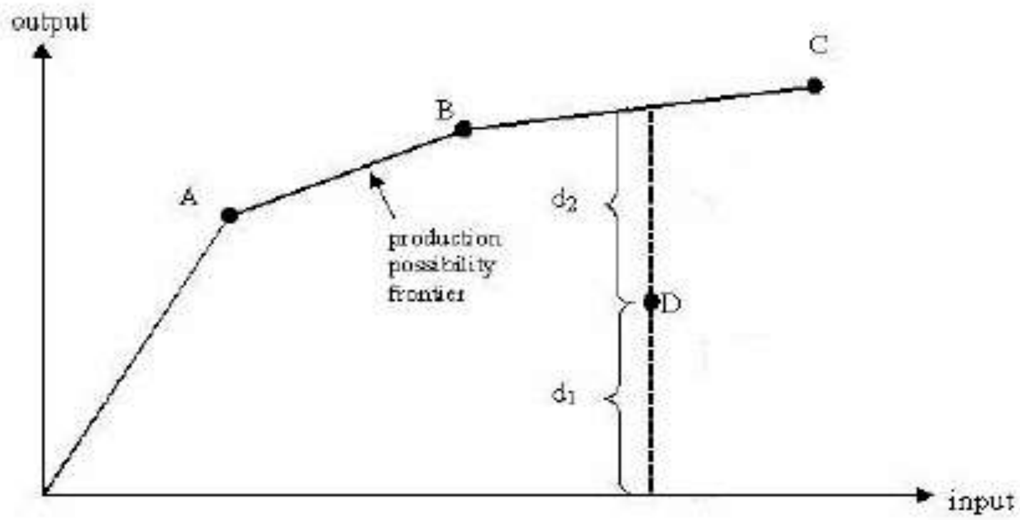

Figure 1: DEA production possibility frontier in one input-one output case

There are some advantages in using DEA relative to a parametric method. This framework of estimation has the ability, for instance: i) to incorporate inputs and outputs that have different units; ii) to capture multiple input outputs; iii) to not necessitate specification of functional form relating inputs and outputs; and iv) to make a direct comparison between a DMU and other peers easily possible.

Despite the advantages DEA imbibes some limitations in it. These include: i) it is a relative efficiency measure of a DMU and does not provide a theoretical maximum; ii) it is a non-parametric approach in DEA and thus a statistical hypothesis test may be difficult; and iii) it involves large computational problems as it creates for each DMU a linear program separately.

We used the IMR as an output variable. This measure is chosen as an indicator of output at district level for three reasons. First, it is presumed that given a normal circumstance (of no calamities, etc.), the allocation of Government budget at district level within the state might get reflected in better budgetary allocation at district level. Second, since district level budgetary estimates for life expectancy or budgetary allocation are not available, we presume that IMR is related to survival rate [since infant survival rate = (1000-IMR)/(IMR)], and thus it is a representative output variable for the health sector and it captures the impact of economic development as well. Third, it is necessary to keep in view the trend in health efficiency literature, which has focused on either life expectancy or IMR as output at country, state, or district levels. [22]

Results

We used IMR as output variables. First we tried to find out a set of variables which had low correlation among themselves. This is done by using a correlation matrix. This is followed by Principal component analysis which tries to incorporate factors or components which have higher eigen values (or overall importance) as determinants of output variable under consideration.

Thus we tried a sub-set of variables which had low correlations. These included total safe delivery, less than 24 hours stay in institution after delivery (%), total numbers post-natal care, total numbers having immunization card, total numbers with three doses of polio vaccine, total numbers receiving vitamin A doses, ANMs per ten thousand population, all medical institutions per ten thousand populations, total numbers who received three ANC, delivery in private institutions, and total numbers of doctors per 10 thousand populations.

Table 3: Correlation Matrix (Bihar)

Total safe delivery	**1**			
Less than 24 hrs. stay in institution after delivery (%)	0.2027	1		
Total no postnatal care	-0.0164	0.1172	1	
Total having immunization card	0.1176	-0.2528	0.0679	1

Total numbers with three doses of polio vaccine	0.5366	-0.0344	0.1015	0.5211	1						
Total numbers with vitamin A doses	-0.1696	-0.3354	-0.1115	0.5039	0.4568	1					
ANMs per ten thousand population	0.4834	0.2705	0.0213	0.0166	0.2109	-0.1677	1				
All medical institutions per ten thousand population	0.3092	0.2087	-0.0071	-0.2355	0.0854	-0.1386	0.4321	1			
total numbers who received three ANCs	0.4142	0.1786	0.0806	-0.065	0.073	-0.2318	0.1073	0.1019	1		
delivery in private institutions.	0.5554	0.2223	0.0007	0.0759	0.2925	-0.3607	0.2607	-0.025	0.4164	1	
total no of doctors per ten thousand population	0.4155	0.2241	0.0678	0.1235	0.2695	-0.2001	0.587	0.0333	-0.0136	0.2726	1

Source: Estimated

Table 4: Principal Components for Bihar

Components	Eigen value	Difference	Proportion	Cumulative
Comp1	3.0217	0.8312	0.2747	0.2747
Comp2	2.1906	0.8838	0.1991	0.4738
Comp3	1.3067	0.2099	0.1188	0.5926
Comp4	1.0968	0.0855	0.0997	0.6923
Comp5	1.0113	0.3090	0.0919	0.7843
Comp6	0.7023	0.1666	0.0638	0.8481
Comp7	0.5356	0.1070	0.0487	0.8968
Comp8	0.4287	0.1059	0.0390	0.9358
Comp9	0.3228	0.0801	0.0293	0.9651
Comp10	0.2427	0.1019	0.0221	0.9872
Comp11	0.1409	.	0.0128	1.0000

Source: Estimated

The Correlation matrix for these variables is presented below in Table 3. Based on these results we calculated principal components or factors and criteria of Eigen value greater than one to select the factors for Data Envelopment Analysis and these are presented in Table 4. Thus for four factor scores relating to safe delivery, less than 24 hours stay in institution after delivery (%), total numbers post-natal care, and total numbers having immunization card were used for DEA[2].

The results of data envelopment analysis (DEA) are presented in Table 5. These results pertain to variable returns to scale. However, the constant returns-to-scale (the CCR, or Charnes, Cooper, and Rhodes score) is a kind of "global" efficiency measurement which can be decomposed as:

$$CCR\ score\ =\ (pure)\ efficiency\ score\ \times\ scale\ efficiency\ =\ VRS\ score\ \times\ scale\ efficiency.$$

The results in this sheet show CCR scores and the scale efficiencies as defined above. Note that if a unit is fully efficient under the constant returns-to-scale assumption, it is also fully efficient under the variable returns-to-scale one, but the converse is not necessarily true.

The "Returns-to-scale" column contains the characterization of the area where each unit operates, that is, whether scale inefficiencies are due to increasing or decreasing returns-to-scale. Thus in

[2] In order that these factors do not generate too many DMUs as efficient, in further calculations we subtract mean from each of the data dimensions. This produces a data set whose mean is zero. However, in DEA it is necessary that inputs and outputs should be strictly positive, the PCA results are increased by the most negative value plus one to get strictly positive data. [1, 10]

the Table 5 we have focused on CCR scores (or constant returns to scale technical efficiency, CRST score) and efficiency rankings based on these are discussed. In order to explain these deviations of CCR scores we attempted second stage regressions. Prior to it, we calculated rank correlations of different variables with CCR scores. These are presented in Annexure Table 1.

Total number of variables for which this correlation was calculated included CCR Ranks, Literacy Total, Literacy Rural, Literacy Urban, Literacy Male, Literacy Female, Literacy Persons, population covered by individual household latrines (IHHL), Above Poverty level IHHL, Below poverty level IHHL, Total IHHL, Population per health institutions., doctors per lakh[3] population 2013, Urbanization (as per 2011 census), population density (as per 2011 census), Inpatient bed occupancy 2012-13, average no of outpatient (OPD) visits per day, road length under: National Highways, State highways and Municipal development roads, per capita GDP at constant prices 2010-11, Total funds to health societies[4] 2011-12, Total funds to health societies 2012-13. Out of these, statistically significant rank correlation at 5 percent level with CCR ranks was observed only for Literacy Total, Literacy Rural, Literacy Male, Literacy Female, population density 2011 and per capita GDP in 2010-11 at constant prices.

[3] 1 lakh= 100 thousands
[4] These funds directly flow under national rural health mission (NRHM) and by pass state approval

Annexure Table 1: Correlation Matrix for Ranks and significance at 5 percent levels denoted by *

Spearman rank correlation	CCR Ranks	Literacy Total	Literacy Rural	Literacy Urban	Literacy Male	Literacy Female	Literacy Persons	population IHHL	APL IHHL	BPL IHHL	Total IHHL
CCR Ranks	1.000										
Literacy Total	-0.584*	1.000									
Literacy Rural	-0.569*	0.977*	1.000								
Literacy Urban	-0.280	0.589*	0.548*	1.000							
Literacy Male	-0.558*	0.981*	0.984*	0.571*	1.000						
LiteracyFemale	-0.559*	0.962*	0.937*	0.604*	0.926*	1.000					
Literacy Persons	0.271	-0.558*	-0.479*	-0.527*	-0.522*	-0.501*	1.000				
population IHHL	-0.197	-0.043	-0.074	0.141	-0.031	-0.040	-0.013	1.000			
APL IHHL	-0.166	-0.061	-0.055	0.043	-0.017	-0.054	0.112	0.568*	1.000		
BPL IHHL	-0.021	-0.272	-0.262	-0.039	-0.246	-0.250	0.376*	0.556*	0.715*	1.000	
Total IHHL	-0.078	-0.200	-0.195	0.020	-0.174	-0.177	0.291	0.586*	0.843*	0.971*	1.000
Population per health inst.	-0.002	-0.221	-0.245	-0.168	-0.234	-0.169	0.209	0.305	0.284	0.384*	0.395*
Doctors per lakh pop2013	-0.278	0.363*	0.322	0.046	0.306	0.359*	-0.415*	-0.315	-0.028	-0.216	-0.163
Urbanisation 2011	-0.073	0.403*	0.290	0.148	0.331*	0.391*	-0.627*	-0.010	-0.052	-0.190	-0.133
Pop density 2011	-0.473*	-0.012	-0.042	-0.044	-0.057	0.026	0.003	0.431*	0.269	0.383*	0.347*
Inpatient bed occupancy2012-13	0.154	-0.283	-0.300	-0.027	-0.306	-0.271	0.282	0.074	-0.144	0.154	0.068
Average no of opd visits per day	-0.254	-0.012	0.015	0.371*	-0.012	-0.034	-0.028	0.208	0.066	0.154	0.150
NH	-0.126	0.085	0.033	0.088	0.046	0.085	-0.159	0.513*	-0.119	-0.024	-0.047
SH	-0.244	0.204	0.205	0.313	0.264	0.088	-0.275	0.551*	0.3604*	0.253	0.319
MDR	-0.136	0.034	0.001	0.217	0.072	-0.040	-0.009	0.688*	0.324	0.305	0.335*
per capita gdp constant prices 2010-11	-0.3429*	0.432*	0.345*	0.429*	0.373*	0.450*	-0.462*	0.303	0.165	0.074	0.140
Total funds to health societies 11-12	-0.260	0.071	0.042	0.171	0.062	0.062	-0.097	0.846*	0.3439*	0.417*	0.420*
Total funds to health societies 12-13	-0.142	-0.046	-0.061	0.145	-0.046	-0.009	0.085	0.883*	0.4914*	0.567*	0.583*

Source: Estimated

Table 5: DEA Results for Bihar using IMR (as output) and Factor scores (as Inputs)

	IMR	Scale efficiencies	Returns-to-scale	CCR score	Ranks	Deviation from average
Patna	31	1.0000	constant	1.0000	1	0.3834
Nalanda	47	0.7272	decreasing	0.6063	23	- 0.0103
Bhojpur	41	0.7928	decreasing	0.7067	12	0.0900
Buxar	48	0.7122	decreasing	0.5296	28	- 0.0870
Rohtas	44	0.7975	decreasing	0.6154	20	- 0.0012
Kaimur	48	0.7542	decreasing	0.6133	21	- 0.0033
Gaya	49	0.7425	decreasing	0.4875	30	- 0.1292
Jehanabad	47	0.7636	decreasing	0.7636	9	0.1469
Nawada	46	0.7807	decreasing	0.4598	31	- 0.1568
Aurangabad	40	0.8907	decreasing	0.7958	7	0.1791
Saran	49	0.8042	decreasing	0.8042	4	0.1876
Siwan	43	0.8901	decreasing	0.8901	3	0.2735
Gopalganj	46	0.8200	decreasing	0.6832	13	0.0665
West Champaran	48	0.7555	decreasing	0.6116	22	- 0.0050
East Champaran	48	0.7519	decreasing	0.2309	37	- 0.3857
Muzaffarpur	55	0.7033	decreasing	0.6212	17	0.0046
Sitamarhi	60	0.6562	decreasing	0.4449	32	- 0.1718
Sheohar	43	0.8901	decreasing	0.6488	14	0.0321
Vaishali	40	0.9027	decreasing	0.8993	2	0.2826
Darbhanga	44	0.8742	decreasing	0.7751	8	0.1584
Madhubani	48	0.8170	decreasing	0.7964	6	0.1798
Samastipur	49	0.8012	decreasing	0.8012	5	0.1846
Begusarai	40	0.8640	decreasing	0.6352	15	0.0185
Munger	43	0.7716	decreasing	0.7354	10	0.1188
Sheikhpura	51	0.7236	decreasing	0.7236	11	0.1070
Lakhisarai	45	0.7412	decreasing	0.5665	25	- 0.0502
Jamui	51	0.7236	decreasing	0.3671	34	- 0.2495
Khagaria	59	0.6359	decreasing	0.5554	26	- 0.0612
Bhagalpur	49	0.7564	decreasing	0.6169	19	0.0003
Banka	44	0.8172	decreasing	0.6181	18	0.0015
Saharsa	55	0.7149	decreasing	0.5680	24	- 0.0487
Supaul	58	0.6794	decreasing	0.6245	16	0.0079
Madhepura	64	0.6112	decreasing	0.3812	33	- 0.2354
Purnea	53	0.7267	decreasing	0.5446	27	- 0.0721
Kishanganj	56	0.7028	decreasing	0.2489	36	- 0.3678
Araria	52	0.7497	decreasing	0.3565	35	- 0.2601
Katihar	52	0.7429	decreasing	0.4889	29	- 0.1277
			Average	**0.6166**		**0.0000**

Source: Estimated and basic data from Office of the Registrar General & Census Commissioner ANNUAL HEALTH SURVEY

2012-13 FACT SHEET, Vital Statistics Division, India New Delhi; Website: www.censusindia.gov.in

Thus we used these variables to explain deviations from mean of individual district CCR scores. The results presented in Table 6 below indicate that increasing total literacy and population density has led to positive deviations across districts with a very small magnitude (coefficients are low; Table 6).

Table 6: Second Stage Regression for Deviation from mean as dependent variable

Deviation from average	Coefficient	t value	P>|t|
Total literacy	0.016	5.060	0.0000
population density 2011	0.000	4.020	0.0000
constant	-1.246	-6.000	0.0000

Source: Estimated

Thus the major variations as seen in CCR scores in Table 5 are due to differences in efficient utilization of major health inputs. Thus 17 districts which have CCR scores lower than the group average of 0.6166 need to improve their input effectiveness to come up to an average level. The other 18 districts which are above the group average should aim towards bridging the gap between them and top ranking district.

Table 7: Ranks of Districts (selected inputs and workloads)

	CCR Ranks	per capita GDP at constant prices 2010-11	Total funds to health societies in 2012-13	Doctors per lakh population2013	Population per health institutions	Inpatient bed occupancy In 2012-13	average no of OPD visits per day
Patna	1	1	9	4	6	11	16
Nalanda	23	11	12	7	33	8	26
Bhojpur	12	9	20	9	27	23	14
Buxar	28	20	30	6	13	25	21
Rohtas	20	6	22	27	5	33	21
Kaimur	21	23	29	15	30	22	21
Gaya	30	17	5	22	20	18	15
Jehanabad	9	25	31	1	24	34	10
Nawada	31	31	27	34	36	30	35
Aurangabad	7	26	19	17	18	10	2
Saran	4	22	14	21	25	29	18
Siwan	3	27	18	35	29	13	8
Gopalganj	13	18	25	25	9	31	34
West Champaran	22	16	3	26	14	27	30
East Champaran	37	29	1	17	3	9	36
Muzaffarpur	17	5	4	32	23	24	1
Sitamarhi	32	33	26	11	2	32	11
Sheohar	14	37	35	2	1	21	28
Vaishali	2	8	6	10	16	14	12
Darbhanga	8	12	15	31	4	35	9
Madhubani	6	15	13	33	21	20	17
Samastipur	5	14	2	19	11	12	5
Begusarai	15	3	11	14	17	37	37
Munger	10	2	34	5	31	19	25
Sheikhpura	11	32	36	3	35	17	33
Lakhisarai	25	7	37	8	26	36	32
Jamui	34	19	23	23	37	28	20
Khagaria	26	21	24	19	22	16	4
Bhagalpur	19	4	7	12	15	1	21
Banka	18	36	16	24	32	26	29
Saharsa	24	10	28	29	12	4	13
Supaul	16	34	21	15	10	5	7
Madhepura	33	35	33	30	34	2	27
Purnea	27	24	8	13	19	6	6
Kishanganj	36	28	32	37	8	7	3
Araria	35	30	17	36	7	3	31
Katihar	29	13	10	28	28	15	19
Top ranking district	Patna	Patna	East Champaran	Jehanabad	Sheohar	Bhagalpur	Muzaffarpur

Lowest ranking district	East Champaran	Sheohar	Lakhisarai	Kishanganj	Jamui	Begusarai	Begusarai

Source: Estimated

In fact, as depicted by Table 7 above, the top ranking district of Patna is highest only in terms of per capita GDP and not in any of the other variables denoting direct inputs. By contrast Sheohar district seems to have the lowest per capita income but not the lowest rank in CCR (its rank 14).

Discussions

As presented in Table 5, except Patna (the state capital) all other districts fall below CRST score of one. Thus the districts are compared to their peers using rank one as highest efficiency and numerical higher values of ranks indicate relatively more inefficient district. To explore further this efficiency aspect, we considered all districts (37 districts) group average (or mean) and compared with the individual district's CCR. We also present group averages for CCR scores in last row (column 5) of Table 5. Using deviations from these group averages it can be observed that there is a substantial scope for improvement in efficiency of low ranking districts. There are 17 districts which have CCR scores lower than the group average of .6166. Lowest among these remain East Champaran followed by Kishanganj. Thus among all the districts there seems to be the highest need for these districts to enhance their efficiency even to catch up with the all district average. There are another 18 districts which are above the group average. Vaishai district followed by Siwan are thus among those which remain better ones and higher than other 16 in the above average group.

In terms of inputs like total funds flowing to health societies lowest funds are flowing to Lakhisarai but its CCR is 25 and East Champaran which has the highest funds flowing has a CCR rank which is lowest. This is however keeping in view of NRHM objective to help the districts with inadequate infrastructure and inputs. Thus it is in desirable direction of helping a low performing district. In terms of doctors per lakh population in 2013, Jehanabad's ranking is highest but its CCR rank is 9 only. By contrast, Kishanganj ranking is lowest but its CCR rank is also very low at 36. Thus in this district there seems to be more requirement for doctors to enhance its rank. In terms of work load, for instance Population per health institutions, Sheohar is highest but its CCR rank is 14. Relative to this Jamui has lowest workload yet very low CCR. Thus here inefficient utilisation needs to be overcome by better training inputs of health personnel at different health institutions and it may require some health institutions unit level studies in the district. In terms of Inpatient bed occupancy in 2012-13, Bhagalpur tops and yet its CCR score rank is not low and remains at 19. Whereas in this regard Begusarai with lowest bed occupancy has CCR score rank at 15. This in turn indicates that bed capacity remains less than optimally used in the district. In terms of average no of OPD visits per day, Muzaffarpur tops but its CCR rank is 17. Compared to this, Begusarai with lowest OPD load has a CCR score rank at 15. Probably OPD work load does not reflect clearly on CCR ranks. Thus except for NRHM funds flowing to health societies there is a mismatch of inputs utilisation and work load indicating an efficiency gap.

Conclusions

The results indicate that some of the districts have low efficiency in utilization of inputs like doctors, beds and workload per health institutions. There are also other districts which need more of these inputs which may enhance their output and efficiency. Thus there is a mix of both inefficiency and inadequacy of inputs which is reflected in our results. The funds flowing in recent years under national rural health mission (NRHM) towards low performing districts seems to be optimally targeted as reflected by our results. Further exploration in terms of per health institution to observe individual input utilization efficiency may help the state health system and this followed by training inputs to health personnel to provide necessary knowhow pertaining to use of time, manpower and material inputs more cost effectively could further help in achieving more efficient health outcomes.

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