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EFFICIENCY IN EXPENDITURE ON HEALTHCARE SYSTEM AT STATE LEVEL IN INDIA

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Abstract: *Efficiency of public expenditure has attained utmost importance in current years, particularly in social sectors like health and education. Since higher expenditure on such sectors is expected to result in better outcomes. The present paper aims to measure the efficiency of expenditure of health care system at the state level in India using Stochastic Frontier Model. The time period considered for the analysis is from 2000-01 to 2016-17 for 17 major states. The results from inefficiency model indicate that inefficiency came down during the study period and99 per cent variations in the performance are due to the technical inefficiency. Highest mean efficiency is obtained by Jharkhand with efficiency score of 83 per cent. It was followed by Orrisa, Tamil Nadu, Uttrakhand. Beside it states like Madhya Pradesh, Haryana, Punjab, Uttar Pradesh and Rajasthan were among the poorer performing states.*

Keywords: *Efficiency, expenditure, stochastic frontier model, healthcare*

INTRODUCTION

Efficiency of public spending is an elusive empirical issue that has a direct bearing on outcomes. There has been growing recognition of the need to measure the efficiency of public spending, particularly in social sectors like health and education. Since health care and education are generally believed to influence human development, higher expenditure on such sectors is expected to result in better outcomes. Public expenditure on health and education has increased significantly in absolute terms within the current decade but social outcomes have not followed the same trend. Public policy stance on the provision of basic services also depends on the efficiency of expenditure.

This paper aims to quantify the efficiency of expenditure of health care system at the state level in India using Stochastic Frontier Model. Special attention has been given to compare the performance of Haryana and Punjab with that of other states. Haryana and Punjab are among the leading economic developed states. But they are lagging behind many other states in terms of social indicators. So, here we try to compare the performance of Haryana and Punjab with that of other states, in terms of health sector outcomes. We also try to unravel whether it is only higher income and public expenditure that results in better

outcomes. The analysis covers the health sector because this sector greatly impacts the human resource development.

A comparison of key socio-economic indicators is presented in Table 1. It is clear from the Table that despite the high per capita income of Haryana and Punjab than all states' average and investment in health care sector, health outcome i.e. Infant Mortality Rate (IMR) of Haryana is high than all states' average. Specifically for Haryana, this is having highest per capita income among the major states. Infrastructure availability in Haryana and Punjab including number of primary health care centers (PHCs), sub-centers (SCs), and doctors per lakh of population also cannot said to be poor. Nonetheless, Haryana' position is approximate to Bihar and Andhra Pradesh, Bihar is lowest income state and expenditure on health by these states is also about half of expenditure incurred by Haryana. West Bengal also ranks much better than Haryana in terms of health outcome which is counted among low-income states.

Table-1: Socio-Economic Indicators of Health Care System

	PHCs*	Sub Centres*	Doctors*	PCI	PCHE	LIT	RORP	IMR
Andhra Pradesh	6	4.5	1.2	122376	625	71.12	13	34
Bihar	4.2	2.2	5.8	36956	902	72.35	19.5	38
Chattisgarh	7.9	5.3	1.8	91772	1806	73.66	17	39
Gujarat	6.8	4.3	5.7	151368	1428	84.14	10.5	30
Haryana	**5.3**	3.3	**5.5**	**180174**	1765	**81.06**	11	**34**
Jharkhand	2.7	3.2	3.9	68895	1102	74.56	17	29
Karnataka	1.2	4.9	1.4	159952	1132	80.1	12	24
Kerala	9.2	5	1.3	166880	1560	95.36	4.5	10
Madhya Pradesh	4.5	3.4	4.9	72599	1122	73.94	16.8	47
Maharashtra	6	3.5	9.8	173459	1000	85.88	13	19
Odisha	7.5	3.8	7.5	75223	1193	78.53	20.2	44
Punjab	**5.17**	3.57	**7.79**	158601	1250	80.15	13.4	**21**
Rajasthan	8.3	5.7	1.2	103468	1135	70.31	16	41
TamilNadu	1.9	4.7	1.2	157116	1100	83.65	5	17
UttarPradehs	3.4	0.000276	3.6	53179	7656	76.37	16.4	43
Uttrakhand	7.3	5.2	5.9	167564	2166	83.62	15.2	38
West Bengal	2.9	3.4	2.7	96566	820	80.64	13.2	25
All States Average	5.1	3.8	3.9	119773	1633	79	14	32

Source: Bulletin on Rural Health Statistics in India, 2016.

Sample Registration System Bulletin, 2016.

RBI's State Finances: A study of Budgets.

Economic Survey, Ministry of Finance, Government of India.

Note: '' indicates per one lakh population.*

Doctors refer to the Specialists in PHCs and the Specialists in CHCs.

Although Punjab is in the better position than many other states including Haryana. It still lags behind some states like Maharashtra and Tamil Nadu incurring lower expenditure on health as compared to Punjab. On the basis of above discussion, it can be stated that it is not only higher income and public expenditure that results in better outcomes. Expenditure however significantly impacts the outcomes but there are other factors also that influence the outcomes. Specifically, the efficiency of expenditure greatly impacts the performance. Given the specific amount of expenditure, it is efficiency with which it is spent that influences the results. Even with the higher expenditure amount if a state is performing poor than the states with low expenditure, then it can be said to be its inefficiency. So, the efficiency of expenditure is also needed to be studied for a better understanding of the relationship of expenditure and health outcomes. The study tried to analyse the efficiency of health care system using Stochastic Frontier Approach (SFA).

RESEARCH METHODOLOGY

Stochastic frontier analysis measures the efficiency of a decision-making unit (i.e. state in this study). According to Koopmans (1951) a decision-making unit is technically efficient if and only if it is impossible to produce more of any output without producing less of some other output or using more of some input. In the context of stochastic frontier analysis, technical efficiency can be measured as a ratio of actual output to total output. Stochastic frontier analysis introduced a composed error term which consists of a noise V and an inefficiency term U. The first error component V captures the exogenous shocks beyond the control of the firm while second error term U measures the technical inefficiency. The error term U is zero when actual outcome is equal to potential outcome. It is greater than zero when the actual outcome is below the potential outcome. There is an additional benefit of Stochastic Frontier Approach over other techniques measuring efficiency like Data Envelopment Analysis (DEA). It is that SFA provides additional information on noise component and inefficiency as well as the variation in these error estimates due to noise component as indicated by the ratio of variance of error component and overall variance (Purohit, Brijesh C. 2008).

This paper intends to measure the efficiency of health care system at state level in India using balanced panel dataset. Use of panel data facilitates the estimation of State-specific

technical efficiency since it does not impose any strong distributional assumption about error term. It also obviates the need of assumption that technical efficiency is independent of factor inputs (Kathuria and Sankar, 2005). The time period considered for the analysis is from 2000-01 to 2016-17 for 17 major states. Here, Infant Mortality Rate (IMR) has been used as the health outcome indicator which is considered as a good indicator of the availability of health and sanitation facilities. A set of explanatory variables like per capita income, number of primary health care centers (PHCs), number of Sub centers (SCs), number of doctors (DOC), per capita health expenditure (PCHE) are used to explain the Infant Mortality Rate (IMR) at state level in India. Instead of using Infant Mortality Rate as health outcome, performance index (PI) has been constructed. Since IMR is a negative indicator and is inversely related to per capita income. The formula used to construct PI is as follow:

$$(IMR_{max} - IMR_{it}) / (IMR_{max} - IMR_{min})$$

Where IMR_{max} is the highest IMR and IMR_{min} is the lowest IMR over the years. IMR_{it} is the actual value of IMR for state i in time t.

The estimation of health system efficiency is based on general stochastic frontier model, which is presented as:

$$Q_{it} = f(X_{it}; \beta) + v_{it} - u_{it}$$

Where:

Q_{it} is the actual health outcome measured in terms of the performance indicator for state-level health system in state 'i' at time't'.

X_{it} is vector of factor inputs like per capita income, number of primary health care centers (PHCs), and number of Sub centers (SCs) used to determine the health outcome.

β is vector of parameters to be estimated.

v_{it} is the stochastic error term which captures the effects of omitted variables and measurement errors. It is assumed to be independent and symmetrical distributed N (0, σ_v^2).

u_{it} is a one side error term representing the technical inefficiency of the health system.

Following Battese and Coelli, the efficiency term u_{it} is assumed to be independently distributed as truncations of N (m_{it}, σ_u^2). m_{it} is state and time-varying mean which can be specified as:

$$m_{it} = Z_{it}\,\delta$$

Z_{it} is a vector of variables like literacy rate and proportion of rural population which are associated with efficiency.

δ is vector of parameters in inefficiency model to be estimated.

Thus the efficiency term is given by:

$$u_{it} = m_{it} + w_{it}$$

w_{it} reflects the unobserved random variables.

The maximum likelihood estimation technique is used to estimate the frontier model and inefficiency effect model in Stata. The likelihood function is parameterized in terms of variances in the model and variance ratio $\gamma = \sigma_u^2 / \sigma^2$ where, $\sigma^2 = \sigma_v^2 + \sigma_u^2$. The γ reflects the relative magnitude of the inefficiency variance to the total variance in the model and lies between 0 and 1. If it is zero, then the variance of the inefficiency effect is 0 and the model would reduce to the regular OLS model in which the variables in Z are included in the production function. In this case δ cannot be identified. (Prachitha and Shanmugam, 2012)

EMPIRICAL MODEL

Following Prachitha and Shanmugam (2012), Cobb-Douglas form of the stochastic frontier production function has been specified as follows for any given state i in period t :

$$Ln\,(PI)_{it} = \beta_0 + \sum \beta_j\, Ln\, X_{jit} + \emptyset Time + (v_{it} - u_{it})$$

Maximum likelihood estimation of equation provides the estimators for ***β's and*** variance parameters σ^2 and γ. The inefficiency equation specified to estimate inefficiency model is as:

$$u_{it} = \delta_0 + \delta_1\, Ln(RORP)_{it} + \delta_2\, Ln(LIT)_{it} + \delta_3\,(TIME) + w_{it}$$

Where Ln refers to natural logarithm , PI is health outcome i. e. performance index constructed from IMR X_{jit} includes, number of primary health care centers (PHCs), number of Sub centers (SCs), number of doctors (DOC), per capita health expenditure (PCHE), per capita income (PCI). RORP is the proportion of rural population in total population, LIT is literacy rate and TIME is trend variable.

RESULTS

The maximum likelihood estimates (MLE) of the parameters of the stochastic frontier model and inefficiency model are obtained using frontier in Stata. The Table 2 depicts the maximum likelihood estimates of the parameters of stochastic frontier model and those of technical inefficiency model. Among the infrastructural variables, number of sub centers has positive impact on the health performance, statistically significant at 5 per cent level. The

impact of other infrastructural variables namely, doctors and primary health centers on health performance is negative and these variables are statistically significant at 5 per cent level. This is not up to the expectation. It may be due to the fact that number of doctors and primary health centers exceeded the required level as per population in some states. Per capita income and per capita health expenditure have positive impact on health performance as per expectations, significant at 5 per cent level. Time variable has positive coefficient and statistically significant at 5 per cent level. It implies that average health performance has improved during the time period under study.

Table-2: Maximum Likelihood estimates of Stochastic Frontier Health Performance and Inefficiency Functions, Major Indian States (2000-01 to 2016-17)

	Coefficients	**Standard error**	**z**	**P>|z|**
LN PHC	-.0312835	.0565171	-4.66	0.000
LN SC	.0315127	.0103705	7.17	0.000
LN DOC	-.0091129	.0329389	-5.23	0.000
LN PCI	.0280278			
LN PCHE	.0308102	.0299924	5.71	0.000
TIME	.0035896	.0020356	23.71	0.000
Constant	-.3139094	.0733541	-49.15	0.000
Inefficiency Model				
LNLIT	-1.464093	.5545088	-1.95	0.051
LNRORP	.5657706	.5267891	2.88	0.004
TIME	-.1749159	.0387464	-0.18	0.859
cons	5.070499	4.078239	0.28	0.778
sigma2	**.1091378**	.0041565		
gamma	**0.99945**	7.92e-12		
sigma_u2	.3058100	.0041565		
sigma_v2	.000145	2.61e-12		
Log-likelihood Function	-43.251112			
Number of Iterations	40			
Number of Observations	289			
Mean Efficiency	61			

The results from inefficiency model indicate that literacy rate has negative coefficient while the ratio of rural population has positive coefficient. It may be inferred that higher literacy rate reduces the inefficiency and the higher ratio of rural population in total population leads to higher inefficiency. The negative coefficient of time variable shows that inefficiency came down during the study period.

The value of γ is equal to 0.99 which implies that 99 per cent variations in the performance are due to the technical inefficiency.

The stochastic frontier model also allows us to obtain efficiency estimates for each state. Technical efficiency defines the extent to which production can be increased from the current level of technology and input use. The mean efficiency scores for each state during 2000-01 to 2016-17 are given in Table-3. It is observed that Jharkhand has highest mean efficiency having efficiency score of 83 per cent. It was followed by Orrisa, Tamil Nadu, Uttrakhand. Beside it states like Madhya Pradesh, Haryana, Punjab, Uttar Pradesh and Rajasthan were among the poorer performing states.

Table-3: Mean Efficiency Score (in per cent)

States	(2000-2016)	(2000-2008)	(2009-2016)
Andhra Pradesh	73	56	92
Bihar	63	37	93
Chattisgarh	77	68	86
Gujarat	74	58	91
Haryana	71	53	90
Jharkhand	83	73	94
Karnataka	71	54	91
Kerala	77	67	77
Madhya Pradesh	71	51	92
Maharashtra	77	62	94
Odisha	78	63	95
Punjab	68	48	91
Rajasthan	71	52	92
TamilNadu	78	62	96
UttarPradehs	69	51	90
Uttrakhand	78	65	92
West Bengal	76	61	94
All States Average	74	58	91

Source: Calculated

It is worrisome for Haryana and Punjab that states like West Bengal, even Jharkhand are performing in much better way and surpassed them (Haryana and Punjab). The mean efficiency score (2000-16) of Punjab is 68 per cent, indicating that there is scope for improvement in its efficiency with existing resource use. Haryana, having some better position than Punjab, obtained efficiency score of 71 per cent deciphering that it is possible to increase efficiency by 29 per cent from current level of resources. The mean efficiency score of all states on an average is 74 per cent. It depicts that there is an opportunity of

improvement in technical efficiency among the states by about 26 per cent. The figures speak for themselves in explaining that Haryana is among most inefficient states with mean efficiency score of 15th. Here, Punjab is able to get better position as compared to Haryana.

CONCLUSION

It can be concluded that it is not only high expenditure that ensures better outcomes. Efficiency in expenditure is even more important. Results from the analysis discussed above clearly pointed out that states having much better economic conditions are not front runner in efficiency. States like Haryana and Punjab which are among leading economically developed states, doesn't occupy same position in terms of efficiency in health expenditure while Jharkhand, having much lower per capita income than Haryana and Punjab, has highest efficiency score. Beside it the analysis revealed that all states have scope for improvement in technical efficiency with current level of resources.

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