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Prachitha J.
and
K. R. Shanmugam

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

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Prachitha J.
Research Scholar, Madras School of Economics
prachitha@mse.ac.in

and

K. R. Shanmugam
Professor, Madras School of Economics
shanmugam@mse.ac.in
(Corresponding Author)

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MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

Phone: 2230 0304/2230 0307/2235 2157
Fax : 2235 4847/2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

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Abstract

As health is a state subject and merit good, the state Governments in India spend increased amounts on it. However, the health outcomes vary across the states. This study measures the efficiency of Indian states in raising health outcomes, using the stochastic frontier methodology for panel data for the period 2000-2009. The average efficiency is estimated at 72.7 per cent, implying that there is a scope for improving health performances, without additional resources. In 7 out of 17 states, the efficiency is below the average efficiency. These states can improve their performance significantly by following the best practices. The results also indicate that the states can improve their health performance by increasing their expenditure on health, providing more medical doctors/specialists, educating people and create health awareness.

Keywords: *Public health expenditure, Indian States, Stochastic frontier, panel data*

JEL Codes: *I12, I18, O15*

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INTRODUCTION

In India, the 7th Schedule of the Constitution entrusts the health responsibilities like public health service delivery, hospitals and sanitation to the states. Other responsibilities with wider ramifications at the national level are entrusted to both centre and states. The centre intervenes through financing key policies and schemes relating to family welfare, population control, medical education, prevention of food adulteration, quality control in manufacturing of drugs etc. It can also plays a role of monitoring and facilitating the states by developing norms and regulations linking states with funding agencies and sponsoring various flagship schemes such as National Rural Health Mission (NRHM), Integrated Child Development Scheme (ICDS) and Central Rural Sanitation Programme (RSP) that are implemented by the states.

People also spend on their health. According to NHA (2005, 2009), the private expenditure on health increased from Rs. 81,810 crore in 2001-02 to Rs. 1,04,414 crore in 2004-05[1]. Its share in total health expenditure remained more or less 81 per cent in both years. The private expenditure on health increased to Rs. 1,57,394 crore in 2008-09 and its share declined to about 76 per cent. The share of public expenditure on health incurred by both centre and states increased from 19.2 per cent in 2001-02 to 23.4 per cent in 2008-09. The per capita public expenditure on health (in 1999-2000 prices) increased from Rs. 176 in 2001-02 to Rs. 264 in 2008-09, clearly indicating that the Government has been spending increased amounts on health over the years (Table 1).

[1] The private sector health expenditure includes Out of Pocket (OOP) expenditure incurred by households for availing health care services, health expenditure through insurance mechanism and expenditure by corporate bodies on their employees and families.

Table 1: Health Expenditures in India: Public and Private

(Rs. Crore)

Details		2001-02	2004-05	2008-09
a. Revenue Expenditure on Health	States (S)	15904	18456	30649
	Centre (C)	2798	4263	13159
	Combined S & C	18702	22719	43808
b. Capital Expenditure on Health	State	723	1161	3705
	Centre	29	49	592
	Combined S & C	752	1210	4297
I. Total Public (Revenue and Capital) Expenditure on Health (a+b)	State	16627	19617	34354
	Centre	2827	4311	13751
	Combined S & C	19454	23928	48104
II. Private Expenditure on Health	All	81810	104414	157394 *
III. Total Health Expenditure (I+II)	All	101264	128342	205498
Share of Public Expenditure on Health	Per cent	19.21	18.64	23.41
Share of Private Expenditure on Health	Per cent	80.79	81.36	76.59
Population	Crore	103.8	108.9	115.4
Per capita Public Expenditure on Health	Rupees	187	220	417
Per capita Private Expenditure on Health	Rupees	788	959	1364
Deflator		1.065	1.195	1.582
Per capita Public Expenditure on Health at 1999-2000 prices	Rupees	176	184	264
Per capita Private Expenditure on Health at 1999-2000 prices	Rupees	740	802	862

Note: * indicates the provisional figures as provided in National Health Accounts, 2009

Source: Budget documents (various years) for the Central Government expenditures; State Finances: A Study of Budgets, Reserve Bank of India (various years) for State Government expenditures; National Health Accounts 2005 & 2009 for the private expenditures on health; National Accounts Statistics, Central Statistical Organization, for population and deflator

However, wide variations exist in per capita health expenditure among the major state governments in India. For instance, Uttaranchal Government spent Rs 351 (in 1999-2000 prices) on public health in 2008-

09 while Bihar Government spent only Rs. 100 (Table 2). Health facilities also vary among the states. In 2008-09, Uttar Pradesh had 3690 primary health centres (PHCs) while Uttaranchal had only 239 PHCs. In the same year there were 3837 doctors in Karnataka and only 165 doctors in Uttaranchal. Health outcome measured by Infant Mortality Rate (IMR) and the rate of reduction of IMR also vary across the states. For instance, Kerala ranked first in reducing IMR to 12 in 2009 followed by Tamil Nadu (28) and Maharashtra (31). Madhya Pradesh had the highest IMR of 67 followed by Orissa (65) and Uttar Pradesh (63) in the same year. If the reduction of IMR continues at its current rate, India is not likely to meet the Millennium Development Goal (MGD) target of 28 in 2015.[2]

WHO and UNICEF (2010) also reports that India is off-track in meeting its MDGs relating to health. Since the progress made by India so far is not up to the mark, it is pushed to the 'insufficient progress' category. However, China, Nepal, Bangladesh and some African countries are on-track in meeting the target by 2015.[3] Low share of public expenditure on health could be a reason for poor performance of the health sector in India. There could be other reasons like public spending in-efficiency, regional inequalities in providing health services etc.

[2] MDGs were adopted by United Nations in 2000. 3 of 8 major MDGs are health related: Goal 4-child mortality reduction, Goal 5-improving maternal health and Goal 6-combating HIV/AIDS, malaria, and other diseases. These goals aim to reduce the mortality figures by two-thirds between 1990 and 2015 and to combat diseases like HIV/AIDS etc by halting the incidence and reversing of the diseases.

[3] India also compares poorly in terms of many health outcomes. The life expectancy at birth (LEB) was 65 years in India in 2009 while it was 82 years in Singapore, 74 years in China and 73 years in Malaysia. Its Infant Mortality Rate (IMR) was 50 while it was just 2 in Singapore, 6 in Malaysia and 13 in Sri Lanka. The under-5 mortality rate (U-5MR) in India (66) was relatively high as compared to Singapore (3), Malaysia (6) and Sri Lanka (16) in 2009. Countries like Nepal and Bangladesh also have better health outcomes than India (WHO, 2011).

Table 2: Per Capita Expenditure on Health by State Governments, Health Facilities, and Health Outcome Indicators

States	2008-09				2009	
	Per capita Public Exp. on Health (1999-00 prices) Rs.	Primary Health Centres	Sub-Centres	Doctors	Infant Mortality Rate	Perfor-mance Index %
Andhra Pradesh	235	1570	12522	2694	49	52
Bihar	100	1776	8858	1669	52	48
Chattisgarh	146	715	4776	1245	54	46
Gujarat	186	1084	7274	1095	48	53
Haryana	192	437	2465	506	51	49
Jharkhand	251	321	3947	2019	44	58
Karnataka	239	2193	8143	3837	41	62
Kerala	330	697	4575	1857	12	98
Madhya Pradesh	138	1155	8869	786	67	30
Maharashtra	213	1816	10579	2503	31	74
Orissa	146	1279	6688	1237	65	32
Punjab	191	394	2950	603	38	65
Rajasthan	226	1503	10951	2121	59	40
Tamil Nadu	252	1277	8706	2295	28	78
Uttar Pradesh	174	3690	20521	2619	63	35
Uttaranchal	351	239	1765	165	41	62
West Bengal	166	922	10356	1107	33	72
All States*	**188**	**23391**	**145894**	**29771**	**50**	

Note: Doctors refer to the medical officers and specialists in the PHCs and the specialists in CHCs.

'*' All States include the 17 major states as well as the special category states and the Union territories.

Source: Bulletin on Rural Health Statistics in India (2009); RBI's State Finances: A Study of Budgets and; Central Statistical Organisation (various years); Sample Registration System Bulletin (various years).

As health is a state subject and states contribute more than 70 percent of total public expenditure on health, in this study, we assess the performance of states in raising health outcomes. For this purpose, we use the latest data available for the years 2000-01 to 2008-09 and the stochastic frontier methodology for panel data. Studies by Jain (1985), Beenstock and Sturdy (1990), Kaur and Misra (2003) and Bhalotra (2007) have already emerged in the Indian context to analyze the impact of

public expenditures in raising health outcomes (but not measuring efficiency). However, a few studies provide the estimates of efficiency of raising health outcomes in India. Kathuria and Sankar (2005) (healthy outcome measured by rural IMR) and Chakrabarti and Rao (2007) have measured the efficiency of raising health outcomes in various Indian states using the stochastic frontier model for panel data. Shetty and Pakkala (2010) used the DEA approach to estimate the efficiency of the health care system in the Indian states considering IMR and LEB as health outcomes in 2001. Purohit (2008) carried out a sub-state level (district level) analysis of health system efficiency for West Bengal considering life expectancy as the health output.

This study contributes to the literature in many ways. Firstly, it uses the latest data available and provides the year-wise efficiency scores for the Indian states in raising health outcome, measured in terms of IMR. Past studies on the topic used the data up to 2001. Secondly, after 2000, three major Indian states – Uttar Pradesh, Madhya Pradesh and Bihar were bifurcated. The present study covers the recent years and provides the efficiency scores for all major states including the bifurcated states. Thirdly, it ranks the states based on their total health outcome performance while studies such as Kathuria and Sankar (2005) rank them based on the rural health outcomes.

This study proceeds as follows. In the following sections, we describe the methodology, the model, the variables and the data used in the study. Then, we present and discuss about the empirical results. In the final section, we provide concluding remarks and policy implications.

METHODOLOGY

The efficiency side of a policy design is concerned with making best use of the economic resources in any economic activity. Farrell (1957) kick started the modern efficiency measurement concepts for any

Decision Making Units (DMUs) like firms, farms, hospitals and state Governments. According to him, the economic efficiency of any DMU is the product of technical efficiency (TE) and allocative efficiency (AE). The AE reflects the ability of a DMU to use inputs in optimal propositions, given their respective prices/costs, while the TE reflects the ability of a DMU to obtain maximum output from a given set of inputs and technology. The major concern in technical efficiency analysis is whether the actual outcome generated could be achieved with less inputs or whether the same inputs could produce better outcomes. Broadly, there are two approaches to estimate the efficiency: (i) mathematical approach or data envelopment analysis (DEA) and; (ii) econometric or stochastic frontier approach (SFA).

In this study, we employ the stochastic frontier approach for panel data to measure the (technical) efficiency of raising health outcomes in the major Indian states. The frontier function can be defined as maximum or potential outcome that a DMU (state Government here) can produce with given level of inputs such as per capita income, per capita state Government expenditure on health and medical infrastructure facilities, and technology.

The actual health outcome (Q_{it}) of a state i at time t can be written as:

$$Q_{it} = f(X_{it}; \beta) \exp(-u_{it}) \quad 0 \leq u_{it} \leq \infty; \; i = 1, \ldots, n; \; t = 1, \ldots, t \qquad (1)$$

where Q_{it} represents the actual health outcome, which is measured in terms of the performance index (PI) relating to IMR (construction of this index is discussed below); X_{it} is a vector of determinants of health outcome such as per capita income and per capita health expenditure; β is a vector of parameters that describe the transformation process; $f(\ )$ is the potential performance function; u_{it} is one-sided non-negative residual term. If a state is inefficient (efficient) the actual outcome is less than (equal to) the potential outcome. Therefore, the ratio of actual and

potential performance is a measure of TE. The residual term u_{it} is 0 when the state generates the potential outcome and is greater than 0 when the actual performance is below the frontier level. In general, the residual term and the state's efficiency are inversely related. The residual term is also referred to as the efficiency effect of the state. To capture the effects of omitted variables and measurement errors, a random noise v_{it} ($v_{it} \sim$ iid N (0, σ_v^2) can also be included in equation (1) as:

$$Q_{it} = f(X_{it}; \beta) \exp(v_{it} - u_{it}) \quad (2)$$

Following Battese and Coelli (1995), the efficiency terms u_{it} are assumed to be independently distributed with a truncated (at zero) normal distribution and time-varying mean (that is, $u_{it} \sim$ N (m_{it}, σ_u^2)). The state and time-varying mean, m_{it}, can be specified as:

$$m_{it} = Z_{it}\delta \quad (3)$$

where Z_{it} is a vector of endogenous variables associated with efficiency namely, literacy rate and proportion of rural population. Thus, the efficiency terms are given by:

$$u_{it} = m_{it} + w_{it} \quad (4)$$

where w_{it} are unobserved id random variables ($w_{it} \sim$ N (0, σ_w^2) and $w_{it} \geq - m_{it}$). The truncation $w_{it} \geq - m_{it}$ guarantees that the efficiency terms are non-negative. The state-specific efficiency can be obtained using Jondrow et al (1982)'s procedure, which has been subsequently generalized by Battese and Coelli (1992) for panel data models. See Greene (1993) and Kalirajan and Shand (1994) for a comprehensive review of frontier methodologies.

The maximum likelihood estimation (MLE) technique can be used to estimate simultaneously the frontier function and the inefficiency effect model. The likelihood function is parameterized in terms of variances in the model and the variance ratio $\gamma = \sigma_u^2 / \sigma^2$ where, $\sigma^2 = \sigma_v^2$

+ σ_u^2. The γ shows the relative magnitude of the inefficiency variance to the total variance in the model and lies between 0 and 1. If it is 0, 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. One can also test the null hypothesis that $\gamma = \delta_0 = - - - = \delta_m = 0$ using the generalized likelihood ratio test statistic (a mixed χ^2 statistic).

While there are many health outcome indicators like Life Expectancy at Birth (LEB), the Crude Birth Rate (CBR), the Crude Death Rate (CDR) and Infant Mortality Rate (IMR) and UNDP uses the LEB for computing the Human Development Index, the IMR is popularly used as the health indicator. Many authors cite IMR as a good indicator of the degree of lack of availability of sanitation and safe water facilities, because of the susceptibility of infants to water borne diseases. It has also been characterized as an outcome variable summarizing multiple health and nutritional afflictions of very young children (Chelliah and Shanmugam, 2001). Chakrabarti and Rao's study on the topic in the Indian context also uses IMR as the health outcome indicator. Therefore, this study uses the performance index (PI) relating to IMR as health outcome variable. Since IMR is a negative indicator and inversely related to per capita income (Goldstein, 1985), PI is used as the health outcome indicator in our analysis.

The PI is computed using the formula: $PI = (IMR_{max} - IMR_{it})/(IMR_{max} - IMR_{min})$, where IMR_{it} is the actual value of IMR for state *i* in time *t*, IMR_{max} is the highest IMR and IMR_{min} the lowest IMR over the years. The value of this index lies between 0 and 1. Higher the value higher is the performance. That is, lower is the IMR. In Table 2, we provide both IMR and PI for major Indian States in 2009. Kerala had the highest PI value of 98 while Madhya Pradesh had the lowest value of 30 in 2009.

EMPIRICAL MODEL AND DATA

We specify the following Cobb-Douglas form of the stochastic frontier production function for any given state *i* in period *t* as:

$$Ln\ (PI)_{it} = \beta_0 + \Sigma\beta_j\ LnX_{jit} + \Phi TIME + (v_{it} - u_{it}) \quad (5)$$

and inefficiency equation is specified as:

$$u_{it} = \delta_0 + \delta_1\ Ln\ (RPOP)_{it} + \delta_2\ Ln\ (LIT)_{it} + \delta_3\ (TIME) + w_{it} \quad (6)$$

where *RPOP* is the proportion of rural population, *LIT* is the literacy rate and *TIME* is trend variable. The X_{jit} in (5) includes: (i) two economic variables, namely, per capita state Government expenditure on health in 1999-00 prices (*PCHEXP*), per capita state income in 1999-00 prices (*PCGSDP*); (ii) three health infrastructure variables – number of primary health centres (PHC), sub-centres (SC) and the doctors and specialists (DOC).

The data source for IMR is the Sample Registration System (SRS) Bulletin published by the Vital Statistics Division, Government of India. The IMR is used to calculate the performance indicator. The "State Finances: A Study of Budgets" published by the Reserve Bank of India (RBI) is the source for state-wise public health expenditure. Central Statistical Organisation (CSO) is the source for the per capita GSDP data. The health infrastructure data are obtained from various issues of the Rural Health Statistics Bulletin published by the Ministry of Health. The proportion of rural population and literacy rates are interpolated using the Census of India data for the years 2001 and 2011 due to non-availability of them during the study period. The final dataset used in this study is a balanced panel of 17 states for nine years (2000-01 to 2008-09). Thus, the total observations used in the empirical analysis are 153. The descriptive statistics of the study variables are shown in Table 3.

Table 3: Descriptive Statistics of the Study Variables

Variables	Mean (S.D)	Variables	Mean (S.D)
Performance Indicator of Health (PI)	46.61 (1.70)	Number of Sub-centres (SC)	7708.00 (348.05)
Per capita income (PCGSDP) in 1999-00 prices	22059.11 (709.17)	Number of Doctors and Specialists (DOC)	1621.00 (73.53)
Per capita heath expenditure (PCHEXP) in 1999-00 prices	166.01 (4.42)	Per cent of Rural population (RPOP)	71.23 (0.78)
Number of Primary Health Centres (PHC)	1235.00 (63.07)	Literacy rate (LIT) in percentage	69.51 (0.72)
Number of observations: 153			

Source: Computed by Authors

EMPIRICAL RESULTS

Table 4 provides the empirical results. Column 1 of Table 4 provides the OLS estimation results of equation 5 for comparative purpose. As expected, the per capita income and per capita state Government expenditure on health have positive and significant impacts on the health performance at 1 per cent level. Infrastructure variables – the sub-centres and doctors also have positive impacts on the health performance. However, these variables are statistically significant only at 10 per cent level. The other infrastructure variable, the primary health centre is having a negative coefficient and its effect is significant at 5 per cent level. This is contrary to the expectation. However, this is justified by the fact that in many states, the number of PHCs exceeded the required level of 3.33 approximately per one lakh rural population suggested by the Ministry of Health. For example, the number of PHCs per one lakh of rural population in states like Karnataka, Tamil Nadu, Chattisgarh, Orissa and Uttaranchal were 5.98, 4.10, 3.92, 3.83 and 3.45 respectively in 2008-09. These are well above the prescribed norms. The time effect is insignificant.

Table 4: OLS and ML Estimates of Stochastic Frontier Health Performance and Technical Inefficiency Functions, Major Indian States (2000-01 to 2008-09)

(Dependent Variable: Log of Performance index for IMR)

Variables	OLS	MLE (Unrestricted)	MLE (Restricted)
	(1)	(2)	(3)
Frontier Health Performance Model			
Constant	-4.991 (-3.546)***	-1.1440 (-1.452)	-1.1802 (-1.956)**
Ln PCGSDP	0.4773 (3.581)***	0.2401 (2.734)***	0.1824 (2.196)**
Ln PCHEXP	0.5265 (2.956)***	0.4751 (4.321)***	0.5610 (5.605)***
Ln PHC	-0.4462 (-2.414)**	-0.1677 (-1.514)	
Ln SC	0.3804 (1.899)*	0.0723 (0.613)	
Ln DOC	0.1285 (1.900)*	0.1577 (3.109)***	0.1097 (2.828)***
TIME	0.0235 (1.392)	-0.0371 (-2.869)***	-0.0312 (-2.463)**
Adjusted R^2	0.409		
Inefficiency Model			
Constant		-4.8053 (-1.765)*	-5.6409 (-1.982)**
Ln RPOP		4.7718 (3.517)***	5.6458 (4.156)***
Ln LIT		-3.6045 (-4.099)***	-4.3643 (-4.915)***
TIME		-0.6981 (-3.224)***	-0.7405 (-3.248)***
Sigma-Squared (σ^2)		1.1029 (3.919)***	1.4079 (4.078)***
Gamma (γ)		0.9644 (75.503)***	0.9793 (119.031)***
Log-likelihood Function		-50.355	-52.137
LR test of the one-sided error (χ^2)		100.539	103.770
Number of iterations		23	22
Number of observations (N)	153	153	153
Mean Efficiency		74.6	72.7

Note: '***' indicates significance at 1 per cent level; '**' at 5 per cent level and; '*' at 10 per cent level

Column 2 of Table 4 presents the Maximum Likelihood (ML) estimation results. The results are more or less similar to what the OLS results indicate in Column 1 except a few changes in the significance level of parameters. Effects of primary health centres and sub-centres turn out to be insignificant, while the time effect and the effect of doctors are significant at 5 per cent level.

Column 3 reports the ML estimates of restricted model after removing insignificant variables namely, PHCs and SCs, which are not statistically significant in the unrestricted model shown in Column 2. Both per capita income and per capita public expenditure on health have positive and significant impact on health performance at 5 per cent level. The expenditure elasticity is 0.56, while the income elasticity is 0.18. Doctor variable is associated with a positive coefficient and significant at 1 per cent level. The trend is negative and significant at 5 per cent level, implying that the average health performance has declined during the study period after controlling input variables. The higher intercept value over the intercept value in OLS indicates that there is a Hicksian neutral technical shift in the performance function.

Results of the inefficiency model in Column 3 indicate that the literacy rate is negatively associated with inefficiency, while the proportion of rural population is positively associated with inefficiency. Both effects are statistically significant at 1 per cent level. These results are as per the expectations. The time effect is negative and significant at 1 per cent level, indicating that the mean inefficiency has declined during the study period.

Both σ^2 and γ terms are positive and significant at 1 per cent level. The γ value of 0.98 indicates that about 98 per cent of the total variation in the performance is due to inefficiency. The average efficiency is estimated as 72.7 per cent indicating that, on an average, only about 73 per cent of the health outcome potentials are realized by states. In

other words, on an average, the states can improve the performance more by 27 per cent, without additional resources. This result needs policy attention.

The state-wise and year-wise efficiency scores are shown in Table 5. Kerala has the highest mean efficiency score of 92.8 per cent followed by Bihar (89.0 per cent) and West Bengal (87.2 per cent). Orissa has obtained the lowest mean efficiency score (40 per cent). The other two poorer states in terms of efficiency levels are Madhya Pradesh and Rajasthan. In 7 out of 17 states, the average efficiency scores are less than the overall mean efficiency of 72.7 per cent. These states require special attention to improve the efficiency levels.

It is observed from Table 5 that over the study years, some states improved their relative performances. For instances, Chattisgarh obtained 13th rank in 2000-01 with efficiency score of 42.7 per cent and improved to 8th position with an efficiency score of 88.2 per cent in 2008-09. West Bengal moved from 5th position to 1st position. Madhya Pradesh improved its position from 16 to 13 while Punjab from 8th position to 3rd position. Even Bihar improved its rank from 3 to 2 during the study period. Relative Ranking of eight states declined over the years although their efficiency value in absolute term increased. For instances, Uttaranchal' rank declined from 2 in 2000-01 to 7 in 2008-09. Jharkhand's rank declined to 11 from 7 while Kerala's rank from 1 to 4.

Table 5: State and Time-specific Efficiency Values.

States	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Mean 1*	Mean 2*	Mean 3#
Andhra Pradesh	45.1 (12)	55.0 (12)	64.7 (12)	63.0 (14)	69.7 (13)	72.1 (13)	74.4 (13)	72.0 (13)	76.2 (14)	65.8 (13)	69.7 (13)	75.0 (6)
Bihar	82.5 (3)	85.5 (3)	87.6 (2)	90.0 (3)	92.3 (2)	89.4 (4)	89.8 (5)	90.8 (6)	94.0 (2)	89.0 (2)	89.2 (2)	79.3 (5)
Chattisgarh	42.7 (13)	46.9 (13)	57.8 (13)	80.9 (10)	79.6 (11)	83.1 (10)	83.7 (10)	87.4 (7)	88.2 (8)	72.2 (12)	71.4 (11)	33.9 (13)
Gujarat	57.5 (9)	69.1 (8)	73.7 (8)	82.1 (8)	81.9 (9)	83.5 (9)	85.5 (7)	85.8 (8)	86.8 (9)	78.4 (9)	80.1 (8)	69.9 (10)
Haryana	50.6 (11)	60.5 (11)	67.8 (11)	67.6 (12)	71.0 (12)	78.7 (11)	85.0 (8)	85.7 (9)	85.4 (10)	72.5 (11)	71.4 (12)	71.8 (9)
Jharkhand	65.1 (7)	73.0 (7)	83.5 (5)	88.0 (4)	87.8 (7)	72.8 (12)	75.5 (12)	83.3 (10)	85.4 (11)	79.4 (8)	76.8 (10)	79.3 (6)
Karnataka	55.3 (10)	61.3 (10)	72.7 (9)	79.9 (11)	81.7 (10)	83.9 (8)	83.9 (9)	78.9 (11)	83.6 (12)	75.7 (10)	80.0 (9)	73.7 (8)
Kerala	92.5 (1)	92.7 (1)	92.9 (1)	93.2 (1)	93.4 (1)	93.0 (1)	92.8 (2)	92.6 (2)	92.1 (4)	92.8 (1)	92.5 (1)	95.1 (1)
Madhya Pradesh	14.0 (16)	17.1 (16)	26.1 (16)	36.7 (17)	45.7 (16)	52.3 (17)	56.0 (17)	63.6 (14)	76.2 (13)	43.1 (16)	47.6 (16)	33.9 (13)
Maharashtra	73.1 (4)	73.9 (6)	81.9 (7)	87.2 (5)	88.7 (6)	91.5 (3)	92.5 (3)	92.5 (3)	91.4 (6)	85.9 (4)	86.7 (4)	90.2 (2)
Orissa	1.9 (17)	9.4 (17)	19.6 (17)	37.9 (16)	40.1 (17)	58.2 (15)	57.9 (16)	62.8 (15)	72.2 (15)	40.0 (17)	44.3 (17)	23.0 (14)
Punjab	57.9 (8)	65.2 (9)	72.3 (10)	81.2 (9)	85.8 (8)	86.9 (6)	89.6 (6)	92.1 (4)	92.8 (3)	80.4 (7)	80.7 (7)	88.2 (4)
Rajasthan	20.9 (15)	24.5 (15)	35.3 (15)	49.9 (15)	51.2 (15)	53.7 (16)	59.3 (15)	62.2 (16)	65.8 (17)	47.0 (15)	52.9 (15)	64.0 (11)
Tamil Nadu	67.4 (6)	77.7 (4)	82.3 (6)	86.8 (6)	89.6 (4)	87.9 (5)	90.1 (4)	91.8 (5)	91.6 (5)	85.0 (5)	86.0 (5)	74.5 (7)
Uttar Pradesh	29.5 (14)	40.0 (14)	54.5 (14)	66.8 (13)	62.2 (14)	63.3 (14)	62.1 (14)	60.4 (17)	70.1 (16)	56.6 (14)	69.2 (14)	40.3 (12)
Uttaranchal	84.8 (2)	85.9 (2)	86.7 (3)	85.6 (7)	88.8 (5)	84.1 (7)	79.0 (11)	76.2 (12)	88.3 (7)	84.4 (6)	83.4 (6)	40.3 (12)
West Bengal	68.2 (5)	76.5 (5)	84.1 (4)	90.3 (2)	92.2 (3)	92.3 (2)	93.1 (1)	94.1 (1)	94.4 (1)	87.2 (3)	87.1 (3)	89.9 (3)
Mean efficiency	**53.4**	**59.7**	**67.3**	**74.5**	**76.6**	**78.0**	**79.4**	**80.7**	**84.4**	**72.7**	**74.6**	**69.2**

Note: The numbers in parentheses are the ranks of the states in terms of their performance.

* Mean 1 and Mean 2 are from the results in Column 3 and 2 respectively of Table 5.

\# The last column in Table 5 contains the efficiency scores (ranks) obtained by Chakrabarti and Rao (2007). The newly formed states of Chattisgarh, Jharkhand and Uttaranchal are assigned the same scores as that of Madhya Pradesh, Bihar and Uttaranchal respectively.

Table 5 also reports the mean efficiency values of sample states using MLE results in Column 2 of Table 4. The overall mean efficiency is 74.6. The ranking of states is more or less the same. Finally, we can compare the efficiency scores estimated in our study with the scores estimated by Chakrabarti and Rao (2007) study, which uses similar methodology and data during 1986 to 1995. The efficiency scores of Kerala, West Bengal, Maharashtra, Punjab, Andhra Pradesh and Rajasthan in our study are lower than that in Chakrabarti and Rao study. In all other states, the efficiency scores in our study are relatively higher. Accordingly, the ranks also changed. For instance, the rank of Andhra Pradesh declined from 6 in Chakrabarti and Rao study to 13 in our study. Madhya Pradesh's rank declined from 13 to 16. The Spearman's rank correlation between the efficiency scores in our study and that of Chakrabarti and Rao study is 0.794, indicating that although our results are related to the results in that study, the relationship is not perfect.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

In this study, we have assessed the performance of 17 major Indian states in generating health outcome using the stochastic frontier methodology for panel data during 2000-01 to 2008-09. Our findings are: (i) Both state and central Governments in India have been spending increased amounts on health in real terms over the years, (ii) During 2000-01 to 2008-09, the per capita public expenditures on health (1999-2000 prices) increased from Rs. 176 in 2001-02 to Rs. 264 in 2008-09 and per capita public spending by all state Governments increased from Rs. 149 to Rs. 188, (iii) In 9 out of 17 states, the number of primary health centres declined, in 3 states the number of sub-centres declined and in 10 states the number of doctors declined, (iv) Although, the health outcome indicator – IMR declined from 66 to 50, India is not likely to meet the MDG target of 28 in 2015, (v) Wide variations exist among the states in terms of the health outcome indicator. For instance, in Kerala the IMR was 12 while it was 67 in Madhya Pradesh in 2009, (vi) Per

capita income and per capita public expenditure on health influence health performance positively and significantly. Interestingly, the expenditure elasticity is estimated at 0.56. The income elasticity is as 0.18, (vii) Health outcomes are positively related to the availability of medical doctors/specialists.

Our results also indicate that as expected, the health outcome efficiency increases with literacy rate and decreases with proportion of rural masses. The mean efficiency is estimated at 72.7 per cent, implying that there is a greater scope for raising the health outcome performance, without additional resources. In 7 out of 17 states, the mean efficiency is below the average mean efficiency. These states need to follow the best practices adopted by other better performing states like Kerala and West Bengal to improve their performance. The mean efficiency has increased continuously over the study years from 53.4 per cent to 84.4 per cent. However, year-wise individual efficiency levels indicates that performance levels remain constant or decrease in some states. Therefore, policy interventions are required from both centre and states to improve the performance of states in achieving the MDGs relating to health.

The policy implications emerged out of the study are as follows. First of all, states can reduce their existing resources (ie., by cutting waste) to achieve the present level of health performance or use them effectively to improve their performances. The state can improve the health performance by increasing public expenditure on health and provide more medical doctors/specialists. They can also educate people and create health awareness among them to improve the health outcomes. Thus, both quantitative and qualitative efforts are needed to improve the health performance in India.

We hope the findings of the study are useful to policy-makers, researchers and other stakeholders to take appropriate strategies to improve the efficiency of health performance of various states in India and remove the regional imbalances.

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