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Efficiency of Health Care Sector at Sub-State Level in India: A Case of Punjab

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Abstract:
In recent years, WHO and other individual researchers have advocated estimation of health system performance through stochastic frontier models. It provides an idealized yardstick to evaluate economic performance of health system. So far attempts in India have remained focused at state level analysis. This paper attempts a sub-state level analysis for an affluent Indian state, namely Punjab, by using stochastic frontier technique. Our results provide pertinent insight into state health system and facilitate health facility planning at the sub-state level. Carried out in two stages of estimation, our results suggest that life expectancy in the Indian state could be enhanced considerably by correcting the factors that are adversely influencing the sub-state level health system efficiency. A higher budgetary allocation for health manpower is recommended by us to improve efficiency in poorly performing districts. This may be supported by policy initiatives outside the health system by empowering women through better education and work participation.
Key Words: Health, Efficiency, Sub-State Level, India, Punjab, disparity, Gini coefficients, Stochastic frontier model, Health facility planning

Introduction:
In recent years interest has been evinced by international agencies and individual researchers to estimate system performance in social sector like health. Beginning with the World Health Organization Report, 2000 and the seminal works of Murray and Frank (1999), the emphasis is being laid on the overall health system performance and its impact on health outcomes.(1,2) It is suggested that system endowments and the efficient utilization of resources within the system produce health outcomes that could be appropriately measured by stochastic production frontier models.(3-9)

An extensive literature has emerged in recent years, which addresses the empirical measurement of efficiency in health care institutions across the globe. Majority of these studies have focused on hospitals, nursing homes, HMOs and district health authorities.(10) In this regard, frontier efficiency measurement techniques have found favour within the health economics literature. These techniques use a production possibility frontier, which provides 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.(11-13) It is possible to determine production frontier that could represent total economic efficiency with the available best suited production techniques. An idealized yardstick based on this method can be used to evaluate economic performance of health system.

In this paper we focus on sub-state level (i.e., district level) study of Punjab. One of the high income states in the country, this state signifies itself as: one of the highest per capita income in India next only to Delhi, Pondichery and Maharashtra. It has an income poverty ratio of just six percent. It is the largest grain producer in the country. Economic development in Punjab is agriculture led. And it owes a great deal in making green revolution a success. However, the prosperity of Punjab has not prevented in intra-state disparity. As noted in Human Development Report of Punjab, "Amidst prosperity pockets of disparity remain. In southern, south – western Punjab, poverty rates are high. In Hoshiarpur district, the literacy level crossed 80 percent in 2001, but in Mansa district, literacy rates are only slightly higher than of Bihar. While in India, between 1991 and 2001, the gender ratio rose from 927 to 933, in Punjab it fell from an abysmal 882 in 1991 to an even lower 874 in 2001" This is indicative of discrimination against women. Economic development in Punjab has been uneven and is marked by disparities between regions and communities- in terms of education, health, standard of living, security and in basic human rights.(14) Such a development pattern negates the very spirit of Alma Ata declaration (1978) which views the health care system as a distribution mechanism. Over a period of time both agriculture and manufacturing are also witnessing declining growth rates.

According to Sample Registration system by Registrar General of India, for the year 2000, IMR of Punjab was 52 and life expectancy in 1996 was 67.4 years. The state ranks much below Kerala with IMR of 14 per 1000 live births (1999) and life expectancy of 73.1 years. Estimates derived from Census tables for life expectancy at district level for 1981, 1991 and 2001 are presented in Table 1 below. It can be observed that life expectancy in the inter-census period rose in most of the districts by three to four years. Generally, southern districts were worse off than the northern and north-eastern districts. A major decline is noticeable for Jalandhar and Nawanshehar, which fell to 16th and 15th place from earlier 4th and 6th rank. Other poor performers are Hoshiarpur and Kapurthala, which did not improve their comparative position in 1991. Between 1991 and 2001, the situation in regard to the top and bottom districts in terms of life expectancy has remained unchanged

Table 1: Ranking of Districts by Life Expectancy in Punjab, 1981, 1991 and 2001								
Districts	**Life Expectancy in 1981**	**Rank in 1981**	**Life Expectancy in 1991**	**Rank in 1991**	**Increase in the decade**	**Life Expectancy in 2001**	**Rank in 2001**	**Increase in the decade**
Amritsar	62.4	3	67.2	3	4.8	72.00	3	4.8
Bathinda	61.1	13	64.7	11	3.6	68.30	12	3.6
Faridkot	61.6	8	65.8	8	4.2	70.10	8	4.3
Fateh Garh Sahib	61.7	7	65.6	9	3.9	69.60	9	4.0
Firozpur	62.1	5	66.6	5	4.5	71.00	4	4.4
Gurdaspur	61.4	11	67.8	2	6.4	74.20	2	6.4
Hoshiarpur	60.9	15	64.5	13	3.6	68.10	14	3.6
Jalandhar	62.3	4	64.2	16	1.9	66.10	17	1.9
Kapurthala	60.4	16	64.5	13	4.1	68.70	11	4.2
Ludhiana	64.2	1	70.5	1	6.3	76.80	1	6.3
Mansa	61.1	13	64.7	11	3.6	68.30	12	3.6
Moga	61.6	8	65.9	6	4.3	70.20	6	4.3
Muktsar	61.6	8	65.9	6	4.3	70.20	6	4.3
Nawanshehar	61.8	6	64.3	15	2.5	66.70	16	2.4
Patiala	61.4	11	65.4	10	4	69.50	10	4.1
Rup Nagar	62.9	2	66.8	4	3.9	70.70	5	3.9
Sangrur	60.4	16	62.8	17	2.4	65.20	18	2.4
Punjab	61.7		65.6		3.9	67.4*		1.8
Highest	64.2		70.5		76.8			
Lowest	60.4		62.8		65.2			
Source: GoP, 2004; * for 1996								

It is noteworthy that despite high per capita income of the state, public investment on health care sector in Punjab is very low. It is estimated to be Rs. 204 per capita and constitutes only 0.998 percent of NSDP.(14) It is also pointed out that more and more people in the state tend to depend on expensive and unregulated private service providers due to poor level of investment in primary health care. Even this meager public expenditure is biased towards tertiary and specialized care and overall allocation is inadequate for primary and secondary health care, under-privileged areas and groups. Other notable features of the health system in Punjab include privatization and globalization of the health care system. As a reform measure, in October 1995, under a World Bank sponsored State Health system Development Project II, an autonomous corporation was created, which is known as Punjab Health System Corporation (PHSC). It became an overarching organization looking after 150 health care institutions which were earlier under the State Directorate of Health. With this, emphasis was laid on mobilizing resources through user fees and majority of patients except below poverty line (BPL) had to pay for services provided by the public hospitals. Even the exemptions for user fees meant for the poor did not benefit much and some case studies indicate that among the poor less than 0.5 percent availed of such exemptions.(15) Besides the formation of PHSC, the state encouraged the private corporate sector in health. Land and facilities at subsidized rates were extended to such hospitals with a clause that these institutions will treat BPL (identified as yellow card holders) up to 10 percent and 5 percent respectively of their outpatients and inpatients. This further deepened the dependence of people on private health sector.

Materials and Methods:

We start with a general stochastic frontier model that is presented as:

$\ln q_j = f(\ln x) + v_j - u_j$ ……(1)

Where $\ln q_j$ is the health output (life expectancy) produced by a health system "j"

X is a vector of factor inputs represented by per capita health facilities (including per capita availability of hospital beds, per capita primary health centers (or sub centers), per capita doctors, per capita paramedical staff, per capita skilled attention for birth .

v_j is the stochastic (white noise) error term

u_j is one sided error term representing the technical inefficiency of health system "j"

Both v_j and u_j are assumed to be independently and identically distributed (iid) with variance s_v^2 and s_u^2 respectively

From the estimated relationship $\ln \hat{q}_j = f(\ln x) - u_j$

The efficient level of health outcome (with zero technical inefficiency) is defined as:

$\ln q^* = f(\ln x)$

This implies $\ln TE_j = \ln \hat{q}_j - \ln q^* = - u_j$

Hence $TE_j = e^{-u_j}$, $0 <= e^{-u_j} <= 1$

If $u_j = 0$ it implies $e^{-u_j} = 1$

Health system is technically efficient.

This implies that technical efficiency of j^{th} health system is a relative measure of its output as a proportion of the corresponding frontier output.

A health system is technically efficient if its output level is on the frontier which in turn means that q/q^* equals one in value.

At the district level only cross sectional data are available and a strict assumption about the distribution of the inefficiency term is required. Resulting estimates of technical efficiency will confirm to the imposed distribution. It is preferable to use the standard distribution (i.e., half or truncated normal).

We presume that differences in technical efficiency pertaining to health system could be discerned at district level health facility planning by non-health related parameters. Thus, we explain the dispersion in technical efficiency by a set of variables which includes per capita income (PCI), male

and female income respectively, literacy, rural and urban literacy respectively, education deprivation, urbanization, water supply and sanitation facilities, gender development index (GDI) and persons below poverty line (BPL). Our model in the second stage is thus:

Dispersion in Technical efficiency = f (PCI, male and female income respectively, literacy, rural and urban literacy separately, urbanization, water supply and sanitation facilities, infrastructure variable such as road per square km., BPL, GDI) + error term…..(2)

This study is based on secondary data. Information is collected from Human Development Report of Punjab[14], websites of the state and other published sources. Main variables used in the study are life expectancy (LEXP), infant mortality rates (IMR), per capita income (PCI) and parameters related to human development indicators (HDI), gender development indicator (GDI) and health facilities. The information relates to district level for the state.

It is presumed that estimated efficiency parameters should help the health policy makers to improve district level and thus state level health system performance. We hypothesize that districts differ in their technical efficiency pertaining to health system due to factors which require emphasis in district level health facility planning. It is also hypothesized that these factors may differ from state to state according to their level of development.

Results:

In regard to selection of variables representing outputs and inputs, we have followed conventionally agreed indicators. As noted in W.H.O report on health system performance of 191 countries[1], we have used life expectancy at birth (LEXP) as an output indicator. It denotes that health system at sub-state level (i.e., district level) should aim at improving the health of population to achieve higher life expectancy.

The MLE results of stochastic frontier model (SFM) for our cross section data for Punjab are presented in Table 2. Actual and estimated LEXP for the districts of the state are presented in Table 3. SFM results depict expected positive and significant signs for population covered per medical institution (POPPERMI), population covered per doctor (POPDOC), nurse per lakh of population (NURSEPERLAKH) (Table 2). A comparison of actual and estimated LEXP for the districts of Punjab (Table 3) depicts Ludhiana as the best performer with its potential achieved in its actual LEXP of 76.8 years. It has achieved its potential at this level given its inputs. Although the actual equals potential for two other districts, namely, Amritsar (72.00 years) and Gurdaspur (74.2 years), yet these districts rank second and third respectively in relation to most efficient district (MED), namely Ludhiana.

Table2: Stochastic Frontier Normal/Half-Normal Model

Number of Observations = 17		
Log Likelihood = 38.201572		
Prob > chi2 = 0.0000		
LEXP	**Coef.**	**Std. Err.**
POPPERMI	0.126*	9.98E-06
POPDOC	0.021*	2.92E-06
NURSEPERLAKH	0.030*	2.18E-06
_cons	2.841*	0.0001
/lnsig2v	-37.829	333.2008
/lnsig2u	-5.946*	0.343
sigma_v	6.10E-09	1.02E-06
sigma_u	0.051	0.009
sigma2	0.003	0.001
Lambda	8380331	0.009
Likelihood-ratio test of sigma_u=0		
chibar2(01) = 6.69		
Prob>=chibar2 = 0.005		
Note: * indicates 1% level of significance; Source: Estimated		

Table 3: Actual and Expected Life Expectancy for the Districts of Punjab

District	Actual LEXP	Estimated LEXP	Deviation From Maximum Efficient District	Ranks
Amritsar	72.00	72.00	-4.80	3
Bathinda	68.30	68.57	-8.50	12
Faridkot	70.10	74.54	-6.70	8
Fatehgarh Sahib	69.60	72.86	-7.20	9
Firozpur	71.00	75.04	-5.80	4
Gurdaspur	74.20	74.20	-2.60	2
Hoshiarpur	68.10	70.83	-8.70	14
Jalandhar	66.10	72.54	-10.70	16
Kapurthala	68.70	69.68	-8.10	11
Ludhiana	76.80	76.80	0.00	1
Mansa	68.30	72.29	-8.50	12
Moga (R)	70.20	75.63	-6.60	6
Muktsar	70.20	70.20	-6.60	6
Nawanshehar	66.70	72.48	-10.10	15
Patiala	69.50	71.89	-7.30	10
Rup Nagar	70.70	71.06	-6.10	5
Sangrur	65.20	71.43	-11.60	17
Source: Estimated				

Discussion:

The difference among the three districts could be seen by looking at the relative utilization of these parameters. These are presented for all the districts in Table 4.

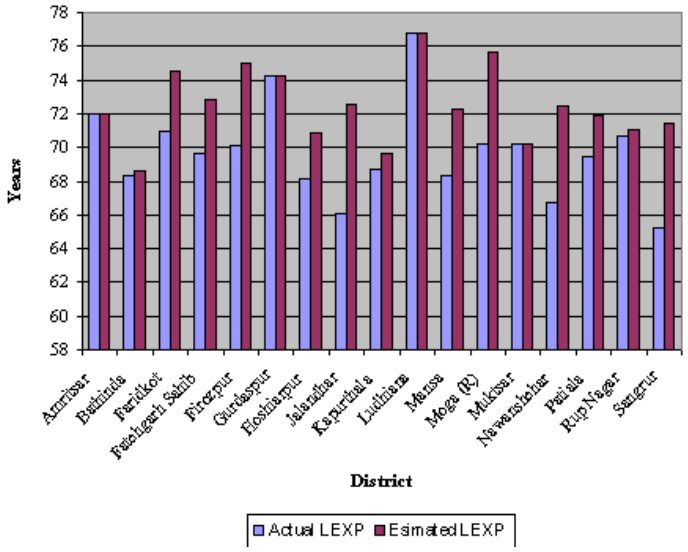
It is obvious that better health outcomes for Ludhiana is due to more availability of nurses and better utilization of MI relative to two other districts. It should be noted that relative efficiency is a measure of actual to the potential and it is with respect to MED. In this regard, maximum distance or deviation (11.6%) is for Sangrur (with the lowest LEXP at 65.2 years) and minimum (after Amritsar and Gurdaspur) for Firozpur (LEXP 71 years). These districts could have achieved a LEXP of 71.43 years and 75.04 years if their health systems were as efficient as MED. Thus both factors count; namely, lack of adequate utilization or lack of adequate resources, which is the case for some of the inputs in poorly performing districts. Table 4 also provides a relative view of respective Gini coefficients. Notably, a third factor is the inequitable distribution of manpower resources across these districts, which is apparent by a high value of Gini coefficients pertaining to doctors, nurses and midwife variables (Table 4).

Table 4

District	Population Served Per					Life Expectancy at birth
	Medical Institution	Bed in Medical Institutions	Doctor	Midwife	Nurse	
Amritsar	10494	617	873	840	1454	72
Bathinda	10006	1172	1421	1253	8351	68.3
Faridkot	13228	709	1219	817	1529	70.1
Fatehgarh Sahib	10404	1343	26530	6471	10011	69.6
Firozpur	11899	1068	3511	1324	1640	71
Gurdaspur	10235	1273	2382	579	973	74.2
Hoshiarpur	8842	998	1845	669	2057	68.1
Jalandhar	11172	878	946	1084	1559	66.1
Kapurthala	9044	971	1867	1463	3910	68.7
Ludhiana	14827	934	1174	674	892	76.8
Mansa	10895	1393	27691	7467	16209	68.3
Moga (R)	10712	1331	21687	2137	2887	70.2
Muktsar	10541	1257	26534	17488	36062	70.2
Nawanshehar	8133	1266	38635	4683	5569	66.7
Patiala	11102	743	724	1532	1696	69.5
Rup Nagar	9455	1141	2468	1198	2983	70.7
Sangrur	10822	1275	2518	1794	4469	65.2
Punjab	10786	947	1485	1015	1696	67.4
Gini Coefficient	0.0756	0.0999	0.582.	0.548.	0.553.	0.021

Source: GOP (2004)

Chart 1: Actual and Estimated Life Expectancy for the Districts of Punjab (2002)



Source: Estimated

It could be noted that per capita availability of medical institutions is relatively not low for poorly performing districts. For instance, as against 14827 population served per medical institution in MED, i.e., in Ludhiana, it is only 10822 and 11172 for Sangrur and Jallandhar. However, adequate utilization of these medical institutions is affected in poorly performing districts due to lack of availability of other inputs. As depicted in Table 4, the availability of beds in Sangrur is catering to 27% more persons than that of Ludhiana. In fact the availability of all the three inputs in Sangrur, namely, doctors, midwife and nurses is catering to 50% more persons than Ludhiana, the MED. Moreover, the availability of nurses in Sangrur is providing service to 80% more patients than that in Ludhiana. Similar is the case of availability pertaining to midwife and nurses for another poorly performing district of Jallandhar. It is, therefore, pertinent that the requirement for more medical and para-medical personnel and more number of beds should be the factors that may be included in the future health facility planning and more health expenditure could be made for this purpose in the state's health budget. This may help to enhance LEXP in poorly performing districts at a faster rate to maintain pace with better off districts.

However, there are other factors that affect adequate performance of health systems at district level. This is estimated by our second stage exercise. It deciphers the non-health system factors that could be possible determinants of dispersion in efficiency. We have tried a set of variables including total per capita income, per capita male and female income separately, literacy, rural and urban literacy separately, urbanization, water supply and sanitation facilities, infrastructure variable such as road per square km., persons below poverty line(BPL) and gender development index (GDI). The best fit comprises of three explanatory variables, namely, per capita female income (PCIF), GDI index and literacy female (Table 5). Pertinently, unlike state level studies[8], PCIF, GDI and literacy female, all of them are significant.(9) It indicates that the level of gender development in the state has helped to reduce disparities in health outcomes.

Table 5: Regression Results for Dispersion

Dependent Variable	Explanatory Variables	Coefficients	"t" values	Statistics		
DEVIATION	(Constant)	71.541	5.092*	Adjusted R Square	F	N
	LITFM	2.023	4.885*	0.679	12.273*	17
	PCIF	3.339	5.779*			
	GDI	-2.766	-5.158*			

Source: Estimated *indicates statistical significance at 1% level

As presented in Table 6, it could be noticed that GDI is relatively high in the districts of Punjab. It indeed should mean that men and women would share in socio-economic development in an equitable manner. However, factually it is not so. This is owing to the fact that at present as calculated in the human development report of the state, GDI does not adequately represent the fact of equality in opportunity in all the spheres. As noted in HDR of Punjab, due to its methodology of calculation: a) it is not affected by gender ratio and b) it is insensitive to low female work participation rates prevalent in Punjab which prevent women from becoming economically empowered. It is owing to these reasons, we have other factors such as female literacy and female income which have emerged statistically significant in our specification. Thus, it is lower level of female income and female literacy, which act as an important deterrent for better health system performance.

Table 6: Gender-related Development Index (GDI) in Punjab-2001

District	GDI	Rank
Amritsar	0.544	17
Bathinda	0.625	7
F. G. Sahib	0.556	16
Faridkot	0.643	4
Firozpur	0.643	4
Gurdaspur	0.565	15
Hoshiarpur	0.645	3
Jalandhar	0.632	6
Kapurthala	0.652	2
Ludhiana	0.619	9
Mansa	0.586	13
Moga	0.607	10
Muktsar	0.606	11
Nawanshehar	0.623	8
Patiala	0.6	12
Rup Nagar	0.669	1
Sangrur	0.575	14
Punjab	0.614	

Source: GoP, 2004

Conclusions:

These results from our district level analysis indicate that health sector efficiency in Punjab could be improved by overcoming disparities in performance at district level. This would require policy initiatives to help the poorer performing districts through adequate support. Pertinently, such districts could fare better through higher per capita public expenditure. This may help better utilization of medical institutions through the presence of essential manpower inputs. Keeping in view relatively a lower level of per capita income in these districts, oft-prescribed privatization and user fees may not be the appropriate sole remedy. It would be better to increase overall public health expenditure in these districts to deploy and make available more medical and para-medical personnel in these districts. This fact should be incorporated in health facility planning at the sub-state level. Further enhancement to life expectancy may be possible at a faster pace in Punjab if such efforts are coupled with steps to promote female literacy and female incomes. This could empower women, particularly in poor performing districts, through better opportunities leading to an increase in their participation in workforce. Further studies at the sub-state level may also be initiated and facilitated if official information base is extended to provide public and private expenditure incurred at the district level on health and other social sectors.

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