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COST EFFICIENCY OF PUBLIC AND PRIVATE HOSPITALS: EVIDENCE FROM KARNATAKA STATE IN INDIA

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Abstract

The main objective of this paper is to analyze the cost efficiency of the public and private hospitals in Karnataka State in India. This is estimated through the parametric and nonparametric methods by using the Hospitals Facility Survey (2004) in Karnataka State. The findings indicate that the choice of econometric approach did not make any significant difference in the results and they are robust. The analysis infers that (a) hospitals (both public and private together in the analysis) are cost inefficient in the State, which is due to technical and allocative system of resources of the hospitals; (b) the private hospitals appear relatively less inefficient than the public hospitals; and (c) the main determinants of the technical and allocative inefficiencies of the public hospitals are due to inappropriate interventions of inpatient days care, share of medical personnel, beds capacity, quality indices, and choice of the locations; while in the case of private hospitals, it relates only to beds capacity and quality indices. It means that the government hospitals will be out of voluntary health insurance schemes, (which are emerging with many options in the State), as a service provider as it lacks the cost efficiency in general and technical and allocative efficiency in particular. It calls for a standardization of public hospitals and improve the quality of healthcare services as an immediate attention in the State. Need based financing through "capitation fee" and an effective alternative payment mechanisms such as user fee with a protected social justice criteria for poor in the public hospitals are the worth considering options in the State. It is also suggested that the private hospitals need to maintain the quality of healthcare services under the emerging competitive environment; otherwise, it would be subject to financial vulnerability since it highly depends on the user fee payment of the patients in the State.

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Introduction

'Hospital' is an economic institution with a social role in the community. The hospitals in the health care system have not been fundamentally altered over the years, and it has received attention due to the central role played in the health care system. It has not only continued to concentrate on human, technical and physical capital but has also consumed a major portion of healthcare budgets in many countries. For example, spending on hospital services to the total health expenditure of 13 OECD countries ranged from the highest of 67.60 per cent of Norway to the lowest of 29.8 per cent of Poland in 2001 (OECD, 2004).

Cost of providing health care services is very important under the scarce resources of health sector in developing countries like India. The national average expenditure on hospital and dispensaries of revenue account in India was around 43.99 per cent in 1950-51, which had been reduced to 25.75 per cent in 1994-95 and 15.76 per cent in 2003-04 respectively[2]. This same trend has been reflected at the State levels with significant variations. The highest proportion had been reported in Tamil Nadu State, which accounted to nearly 65.17 per cent in 1950-51 and had reduced to 43.52 per cent in 1994-95. It is imperative to note that Karnataka State, which is the focus of this paper, reported the second highest proportion spent on hospital and dispensaries. It accounted nearly to 63.04 per cent in 1950-51 and it had been drastically reduced to 22.91 per cent in 1994-95. It may be due to shift in the government policies towards healthcare delivery system in India. A low share of total hospital resources suggests that the government has emphasized on primary healthcare and their concern in reaching the rural population. It confirms from the recent estimation that for almost seven years between 1997-98 and 2003-04, spending on primary healthcare level by the Karnataka State remained fairly stable, which accounted to nearly 55 per cent (Mathiyazhagan, 2004a, 2004b). Though the share of tertiary level healthcare has increased from 27 per cent in 1997-98 to 34 per cent in 2003-04, there was a sharp decline in the share of spending on secondary level healthcare from 23 per cent to 13 per cent in the same period.

Although the share of government health resources going to hospitals is a rough indicator of the structure and emphasis within the health sector, there is a need for the analysis whether the share of the health sector resources used by the hospitals are economically efficient at State levels in India. Knowing the cost function or at least the rough magnitudes of some of the cost parameters is especially important for policy makers as it promotes the setting of polices that are consistent with economic reality. In recent times, there has also been a growing importance towards the private healthcare providers in India (Bhat, 1993; Mathiyazhagan, 2003a). This trend has brought into the forefront investigations of difference in operating performance of costs of different types of hospitals ownership at State levels in India. It is also due to the fact that exploring huge data sets and analysis of hospitals in India is a daunting task. Therefore, this paper sets to analysis the relative efficiency of the hospitals only in Karnataka State in India. It is the first State to introduce a universal health insurance scheme for the farmers with private-public partnership initiatives. An increasing scope of private voluntary health insurance schemes at State levels in India is expected to boost the hospital sector and therefore, cost efficiency of the hospitals is a mandatory option. On this sense, this work sets policy relevance in India.

[2] Compiled and estimated from the combined finance and revenue accounts for the respective years of Reserve Bank of India, Government of India.

Hospitals cost function literature

Analyses of Hospital cost have been well documented in the health economics literature. Several excellent reviews are available on estimating cost functions, e.g., Cowing, Holtmann, and Power (1983), Wagstaff and Barnum (1992), and Barnum and Kutzin (1993). Most of the earlier studies have used microeconomic data to analyze and estimate hospital cost function. It forms two approaches: behavioral cost functions and cost minimization functions (Li and Rosenman (2001); Barnum and Kutzin (1933); Breyer, 1987). Behavioural cost functions have been used to explain the variations in cost per unit of output among hospitals. This type of study has used all the determinants with causal relationship to hospital costs. On the other hand, the literature on cost minimization is based on the assumption that hospitals achieve a least-cost production as they strive to maximize a combination of quantity and quality of output in a given institutional characteristics.

Most of the earlier studies attempted to estimate hospitals costs functions mostly in industrialized countries with specification of regression equation that used composite measures of hospital output, say average or unit costs of inpatient-day or admission as the dependant variable with interrelated covariates such as occupancy rates, patient flow, length of stay and bed capacity as explanatory variables [Feldstein (1967), Lave and Lave (1970), Lave et al (1972), Rafferty (1972), and Bays (1979)]. The use of average hospital cost formulation was to avoid the potential problem of constant variance of the error in the model.

Studies from the developed countries have mostly used a functional form with variable that are consistent with a theoretical production structure. Notably Cowing and Holtmann (1983) developed and estimated a multi-product, short-run hospital translog cost function. It combined both output measures of hospital cost along with input prices such as labor supplies and capital, which many of the earlier studies tend to ignore. Following the theoretical framework by Cowing and Holtmann (1983), Conrad and Strauss (1983) and Grannemann et al (1986) have also employed the translog cost specification. It has been a departure from the previous analyses of hospital costs built upon the work, which specifies the dependent variable in terms of the average cost or unit cost of a hospital in-patient day and employs a set of independent variables thought to determine or correlate with average cost.

The hospital cost function has also focused on the differentiation between the short- and long-run cost analyses of hospitals. These analyses focused on economies of scale and scope of hospitals. The investigation of scale economies may provide useful insights to policy makers in three ways viz., hospital budgeting; the assessment of hospital efficiency; and the assessment of the efficiency by different health interventions (Adams et al., 2003). A large number of empirical studies of economies of scale and scope in hospital services production reported by Aletras et al. (1997) indicate that there were few economies of scale in hospitals beyond 200-300 beds. These findings are irrespective of different methodological frameworks viz., flexible cost productions or flexible production functions. Aletras et al. survey also reports some economies of scope between emergency care and elective activity prior to mergers but not afterwards (Sinay and Campbell 1995). Recent analysis by Prior and Solà (2000) also found strong economies of scope or economies of diversification in Catalan hospitals using the data from 1987 to 1992. Exploring scope economies by cost frontier along three different dimensions, Kittelsen and Magnussen (2003) found strong economies for surgical and medical services, intermediate for inpatient and outpatient production, while elective and emergency care cases have only weak economies of scope, which may not be

statistically significant. Results for the output mix of individual observations reveal both economies and diseconomies in the last of these three dimensions. Contrary to these results, average efficiencies are found to be lower for differentiated than specialized hospitals, in all of the dimensions mentioned, although the differences are not very large in the Norwegian Hospitals.

Chen and Shea (2004) have used a modified hybrid short-term operating cost function and examined the scale economies of nursing homecare. The results show that scale economies exists for Medicare post acute care, with an elasticity of -0.15 and an optimal scale of around 4, 000 patient days annually. However, more than 65 per cent of nursing homes in the analytic sample produced Medicare days at a level below the optical scale.

In recent years, the issue of efficiency in relation the hospital costs has been analyzed by the improved methodological frameworks such as data envelopment analysis (DEA) [Burgess and Wilson (1996), Magnussen (1996) Linna (1998), Seiford (1994), and Wagstaff (1989)] and stochastic frontier models (SFM) [Wagstaff (1989), Zuckerman et al (1994), Wagstaff and Lopez (1996) and Rosko (2001). There were evidences of significantly decreased productivity among hospitals and also large variations in efficiency between different hospitals. The World Health Report 2000 made an assessment of the effectiveness of healthcare delivery by rankings based comparison of the productive efficiency of the health care systems of 191 countries (WHO, 2000). The rankings were based on the measurement of "fixed effects" of the stochastic frontier methodology proposed by Schmidt and Sickles (1984), Cornwell et al., (1990), and Evans et al. (2000a, b). The effectiveness, quality and validity of this measurement has been criticized by Gravelle et al. (2002a, b), Williams (2001), Hollingsworth and Wildman (2002) and Greene (2003). Main criticism of the fixed effects methodology used (and several other related approaches) is that the model fails to distinguish between cross country heterogeneity unrelated to inefficiency and the inefficiency itself (Greene 2005).

Most studies of hospital efficiency have been criticized for not having measured output or even case-mix appropriately (Linna 1998). In addition to this, most of the stochastic frontier studies have used cross-sectional data. The use of panel data in efficiency analysis makes it possible to specify the efficiency parameter as a parametric function of time or of explanatory variables (Battese and Coelli, 1992; 1995) and it also possible to avoid distributional assumptions (Schmidt and Sickles 1984).

Studies on hospital costs function literature in India are very few irrespective of numerous studies available at the international levels. The exiting studies such as Krishnan et al (2005), Parikh and Karnad (1999), Sharma (1998) and Goldar and Agarwal (1995) were focused only on estimating unit costs of the different health cares of the hospitals by using descriptive statistics. None of these studies give any account of efficiency of hospitals and its determinants in India. Therefore, this paper restricts only to the analysis on the cost efficiency of the hospitals and its determining factors in Karnataka State, India.

Analytical Framework for Hospital Costs Efficiency Function:

Aforesaid literature on hospital cost function supports that hospital cost efficiency function can be estimated by setting parametric and non-parametric models. Most parametric models are similar to the specification by a Stochastic Frontier cost function of Aigner et al., (1977), while non-parametric models are basically drawn from Data Envelopment Analysis (DEA).

These models estimate the general cost efficiency and decomposition of cost efficiency into technical and allocative efficiency. However, there are problems in decomposition of cost efficiency by using stochastic frontier models (Atkinson and Cornwell, 1994; Kumbhakar, 1996). Therefore, this paper uses the stochastic frontier cost function for estimating overall cost efficiency along with DEA. It is useful to check are there any differences in estimation of the parameters between these two models. If there is any significant difference in the estimated parameters, the robust model has been used for the decomposition of the cost efficiency into technical and allocative efficiency of the hospitals.

Cost efficiency of the hospitals was estimated with short-run multi-product cost functions since major capital investments were excluded from the analysis. An appropriate functional form for the analysis was derived after a set of statistical specification tests. It was found that Box-Cox transformed frontier cost function would best describe the costs of public and private hospitals of the sample and its equation as follow:

$$\ln \frac{C_i}{w_i} = \alpha + \sum_{j=1}^{m} \beta_j y_{ij}^{(\lambda)} + \delta \ln w_i + u_i + v_i \qquad \ldots.(1)$$

where C is total costs, w and y are input prices and outputs respectively. The Box-Cox transformation is $y^{(\lambda)}=(y^{\lambda}-1)/\lambda$. Using the cost functions, Shephard's lemma gives the input choices which are efficient and thus provide the benchmark against actual demands. In order to estimate individual efficiency measures, residual has been decomposed by using the technique suggested by Jondrow et al., (1982). Accordingly, the conditional estimates of u_i, $E[u_i|v_i+u_i]$, were used to find estimates for the individual inefficiency terms.

The measurement of the cost efficiency by DEA obtained in two-stage process (a) compute the minimum price-adjusted resource usage given technological constraints and (b) compare this minimum to actual observed costs. Let $x = (x_i \ldots\ldots x_k) \in R_i^k$ denote a vector of inputs and $y = (y_i \ldots\ldots y_m) \in R_i^m$

$$\begin{aligned} &Min_{p.x} \sum_j w_{j0}.x_j \\ &s.t.\ \ p.Y \geq y_0, \qquad \ldots.(2) \\ &\quad p.X \leq x, \\ &\quad p_i \geq 0 \\ &\quad \sum_{i=1}^{n} p_i = 1 \end{aligned}$$

where Y is an n x m matrix of observed outputs for n hospitals and X is an n x k matrix of inputs for each hospital. P is a vector 1 x n vector of intensity variables and $w = (w_i \ldots\ldots w_k) \in R_i^k$ denotes input prices. The constraints of the equation (2) define the input requirement set given by

$$L(y) = \left\{ x : p.Y \geq y_0, p.X \leq x, p_i \geq 0, \sum_{i=1}^{n} p_i = 1 \right\} \qquad \ldots.(3)$$

The input requirement set specifies a convex technology with variable returns to scale (VRS), which is imposed by the constraint $\sum_{i=1}^{n} p_i = 1$. Leaving the constraint out of the

model, captures the changes in the technology to constant returns to scale (CRS). Therefore, CRS was also estimated from the equation (2) to control any possible identification problems in the estimation.

The computation of cost efficiency (CE) has been obtained by cost minimization process through inputs (x^*). It can be written as $CE = w'.x^*/w'.x$, where x are actual observed inputs. Further, an estimation of the allocative efficiency is pertinent in an analysis of hospital cost function with multi-product outputs. Therefore, allocative efficiency of the hospitals was estimated by the input factor mix, which is sub-optimal with respect to prevailing input prices when different sets of prices are defined exogenously for each decision making units of the hospitals. In doing so, there is a need to establish a global cost efficiency, which was estimated through total costs (TC) and it is equal to w'. x as input variable (TC=w'. x). Assuming identical input prices, cost efficiency has been calculated by following linear program:

$$\begin{aligned} &Min_{p,\lambda CE}\ \lambda_{CE} \\ &s.t.\ \ p.Y \geq y_0 \\ &p.C \leq \lambda_{CE}.C_0, \\ &\ \ p_i \geq 0 \\ &\ \ \sum_{i=1}^{n} p_i = 1 \end{aligned} \qquad \ldots.(4)$$

Where c is a scalar representing a cost level and C is the n x 1 matrix of observed costs. In eliminating the summation constraint, changes the equation (4) to constant returns to CRS.

The decomposition into allocative and technical components can be estimated by solving the following linear program, which gives the input oriented technical efficiency component:

$$\begin{aligned} &Min_{p,\mu}\ \mu \\ &s.t.\ \ p.Y \geq y_0, \\ &p.X \leq \mu.x, \\ &\ \ p_i \geq 0 \\ &\ \ \sum_{i=1}^{n} p_i = 1 \end{aligned} \qquad \ldots.(5)$$

The technical inefficiency component is given by solution $TE = \mu^*$. Therefore, the allocative efficiency (AE) is equals to the ratio of CE and TE (i.e. AE=CE/TE). The summation constraint on intensity variables p in the equation (5) imposes variable returns to scale (VRS). Eliminating the summation constraint, changes the model to constant returns to scale (CRS). The scale efficiency of cost (SCE) measure has been estimated as the ratio of CRS technical efficiency to VRS technical efficiency (i.e., $SCE = TE_{CRS}/TE_{VRS}$).

The determinants of various components of cost efficiency scores were estimated by using two methods viz., ordinary least squares regression for parametric efficiency scores and censored Tobit model for DEA scores. Firstly, the efficiency scores were modified to explain the degree of inefficiency by setting $\Phi = (1/\phi) - 1$. Therefore, the Φ (i.e. inefficiency scores) were regressed on the hospital characteristics. If the estimated coefficients turn to be negative, it ascertains an association with efficiency. It could be estimated by the following form:

$$\Phi^* = \sum_i \beta_i . x_i + \varepsilon \quad \ldots.(6)$$

$\Phi = 0$ (if $\Phi^* \leq 0$);
$\Phi = 0$ (if $\Phi^* \geq 0$)

where $\varepsilon \sim N(0, \sigma^2)$, and β_i are the parameters for explanatory variables x_i.

Variables and Data Source

The total operating costs (TOC) of the hospital has been used as a dependent variable in the model. It is measured as a sum of recurrent cost of hospital in a given year. It includes all production related costs of a hospital, but not capital costs. It implies that the analyses focus the relationship between output and short-term components of the hospital cost function.

Three variables used as a measure of outputs (y_i) in the analysis. It includes (a) total number of outpatient visits, (b) DRG weighted total inpatient days and (c) weighted sum of quality index of the hospitals. The measurement of the outpatient visits is sum of outpatient visits and emergency visits. In the case of inpatient days care services; it used a DRG patient classification system with weighted average costs incurred by each episode classifications. The weighted average cost of the specialization of eight main DRGs of the hospitals was used.

The case mix of the hospitals by the degree of specialization in terms of DRGs has been used one of the determinants of inefficiency of the hospital costs. It has been measured as a number of cases belonging to hospital and DRG category by index method[1]. It is a cost-weighted[2] measurement for DRG-index for inpatient days (DRG-IID) as the DEA measure tends to give high efficiency scores for the units with a specialized output structure (Nunamaker, 1985). These index variables related only for inpatient days of the hospitals and it is very difficult to get data on DRG adjusted proportions for output visits of the hospitals. Other variables included in the determinant analysis of inefficiency of hospitals costs are the relative number of outpatient visits to all patients, the percentage of total medical personal working hours to the total working hours of other non-medical personnel, number of beds, and quality of healthcare of hospitals.

An understanding of differences in quality and case mix across hospitals, the efficiency implications of variation in average costs cannot be properly interpreted (Barnum and Kutzin, 1993). An increase of quality of the healthcare in the hospitals always coincides with increase in costs and vice-versa. It implies a low average cost is due to an inadequate provision of drugs and thus would represent poor quality and inefficiency. Therefore, the quality index of the hospitals has been used and it constructed by taking into consideration of quality characteristics of the hospitals.

Donabedian's framework (1966) of healthcare quality was used in the analysis. It measured quality of the hospitals in terms of structural, process and outcome units. The structural units of the hospital included (1) the availability and adequacy of infrastructure facilities like drugs and sundries, (2) availability of equipments such as thermometer, sterilizer, stethoscope, BP manometer, wound dressing sets, examination beds, vaginal speculums, reflex hammer, and refrigerators, (3) provisions for the waste management in the hospitals, and (4) maintenance of patient medical records. The indicators for the process

units of the hospitals are included in the analysis: (5) factors attracting patients to the hospital in terms of efficient delivery of services and good doctor-patients relationship, provision of services with good technical quality, and (6) operating constraints of each hospitals bureaucracy and hierarchy, difficulty in getting a technically qualified staff and the constant availability of supplies and increasing number of non-paying patients, and (7) participation in public health promotion activities such as immunization drives, family planning, leprosy, TB, blindness and HIV/AIDS control programs in the hospitals. The outcome unit of the hospitals is (8) basically reflection of strengthening the policy measures of the public and private hospitals. The private-public partnership measures such as contracting out of government services to private sector, government support to private hospitals including supply of drugs and training of staff, which have direct bearing on hospital costs. The Likert Scale Method has scaled these indicators numerically through ordinal measurement[3]. The number 4 stands for very good, 3 for good, 2 for bad and 1 for very bad. The mean score of 0 has been allotted to 'no comments'. The average score of each indicator of the sample hospitals has been assumed to have higher quality healthcare if the score value was high and vice-versa (Mathiyazhagan, 2003a).

Three types of input variables (x_i) and related prices (w_i) were used viz., (a) average total working hours of medical personal, (b) average total working hours of non-medical personnel, and (c) total costs of materials and equipment and other costs. The price variables (w_i) such as average hourly wage rate of medical personnel, average hourly wage rate of the non-medical personnel, and average price of materials, equipments and other costs were also used in the analysis.

The paper uses Hospital Facility Survey (2004) data for an empirical analysis of cost efficiency of the hospitals in Karnataka State in India. For the data on hospital cost and its associated determinants, the paper uses two Hospital Facility Surveys (HFS, 2004) in the State. The first HFS survey was the part of International Health Policy Program (IHPP) in 1993-94 and carried out by the author of this paper. The same hospitals had been revisited (in 1996-97, 1999-2000, 2003-04) and it formed four waves of panel data set of the hospitals in the State. However the paper uses the only recent survey in 2003-04. The revisits of the hospital had been supported by the Asian Foundation of Social and Economic Change (AFSEC) in Tamil Nadu (India). The second HFS (2004) had been carried out by the Karnataka Health System Development Project (KHSDP) with a sponsorship of World Bank, where the author was part of the research team of the survey. The total sample hospitals for the IHPP-AFSEC survey was around 86 (i.e., 40 and 46 of public and private hospitals respectively). The total sample hospitals for the KHSDP survey was around 161 (i.e., 80 and 81of public and private hospitals respectively). However, this paper uses only 13 hospitals from the KHSDP survey in order to get more representation of the private hospitals. Thus, it forms nearly 99 sample hospitals (i.e. 40 and 59 of public and private hospitals respectively) for the analysis. It is confined only to the multipurpose hospitals with 100-150 beds, which are located at taluk levels in the State.

Hospitals in Karnataka State, India

Karnataka is a typical south Indian State with diverse culture, languages and faiths and the economic and social disparities within the State is a replica of the country itself. It is the eighth largest State in terms of area in the Indian sub-continent. The administrative unit of the State consists of 27 districts, 176 talukas, 254 towns and 17, 066 inhabited villages with 45

million population. It has been one among the proactive States for health sector reforms in India with introduction of user fee scheme at the secondary level public hospitals in 1994, contracting out of primary health centres to the non-profit private organizations, endorsing the private public partnerships in the delivery of healthcare system, implementation of state subsidized health insurance scheme for farmers in the State and pioneers in decentralized planning in India. A wide network of health care institutions with updated infrastructure was established in the State at all levels- primary, secondary and tertiary. There were around 300 hospitals of public and private sources with bed ratios of 88 beds for every 100, 000 population. It provides various aspects of healthcare like outpatient, in-patient and preventive healthcare services, which provides a marked improvement in terms of health indicators over the past few decades.

Sources of Revenue for Hospitals

The results from the descriptive analysis of hospital facility survey in the Karnataka State, India indicate four main sources of revenue for hospitals. It includes: (a) direct out-of-pocket payments; (b) funded by the government; (c) covered through private insurance; and (d) financed through charitable sources. The ranking of the sources of revenue and its share revealed by the hospital authorities had been estimated. It was found that most of the private hospitals considered that direct out-of-pocket payments from the patients were the main sources of revenue, which accounted for 88 per cent in the State (Table 1). It is also obvious that since most of the sources of revenue of the private hospitals were direct out-of-pocket payments, the average share of revenues from this source recorded the highest ranking of 88 per cent with 7 per cent financial support from the charitable sources and 4 per cent covered from the private insurance schemes. It implies that private hospitals are not having any financial dependence with the government, which would force them to dictate their own product / service prices. However, the private hospital authorities revealed that most of the of these private hospitals have availed initial financial and tax incentives subject to serve in providing some percentage of free outpatient care services and concession for poor people. There is no evidence for a detailed exploration in this regard in the State.

The main source of the government hospitals is the budget outlays of the government, which accounts to nearly 99 per cent of revenue share (Table 1). Though there is user charge operation in the hospitals, its share accounts to only less than a per cent in the State. It implies that alternative financing for the hospitals through health insurance and user charges have not made any real impact on the availability of total resources to the hospitals in the State.

Most Common Out-Patient Care offered and its Average Fees by the Hospitals

The most common out-patient care offered and its average fees by the hospitals have been estimated and reported in Table 2. The highest or lowest frequencies of the common curative or out-patient care treated by the hospitals have been considered as the first or last ranked common out-patient care of the hospitals. Therefore, the common out-patient care and its average fee revealed by the hospital authorities. Most common out-patient cares offered by the government hospitals are general medicine, obstetrics and gynecology, and family planning and its average fee (i.e., put together as a group mean) of these services was about Rs.100 (US$ 2.27). In the case of private hospitals, the most common out-patient care services offered were general medicines, pediatrics, and obstetrics and gynecology and its average fee for these services were Rs.700 (US$ 15.91).

The estimation shows that general medicine was the first most common out-patient care offered by both government and private hospitals in the State. However, the average fee estimation indicates that there was a huge difference. It accounted for only Re.43 (US$ 0.98) for the private hospitals, which was four times higher than the government hospitals (only Rs.10/-). The second most common out-patient health care of the government hospitals was obstetrics and gynecology as against pediatrics of the private hospitals. The average fee of obstetrics and gynecology of the government hospitals was only Rs.16 (US$ 0.37) and for the pediatrics of private hospitals was around Rs.35 (US$ 0.37). The third most common out-patient care served by the government and private hospitals were family planning services and obstetrics and gynecology respectively. Estimations also reveal that the average fee for the family planning in the government hospitals is very minimal and accounted only for Rs.5/-. This is due to the family welfare programs of the government with full financial support from the Centrally Sponsored Schemes of the Federal Government. Most of the common out-patient care services of the health care providers in the State infer that offering general medicines services and conditions relating to maternal and childcare (i.e., obstetrics and gynecology, family planning and pediatrics) were the leading out-patient care services in the State. It implies that the government hospitals have played an important role in the delivery of public health care services with minimal user fee in the State. It is very crucial to understand the cost of these services in relation to the attained efficiency of the government hospitals, which is really missing in the empirical research in India.

Most Common In-Patient Care offered and its Average Fees by the Hospitals

It could be observed from the survey results that most of the common in-patient and out-patient care services offered by both the private and public hospitals are more or less the same and it only differs in terms of the services ranked. The family planning, obstetrics and gynecology and general medicine were ranked as top three common in-patient cares offered by the government hospitals with the group mean of Rs.250 (US$ 5.68) (Table 3). Among these in-patient care services, the average fess of family planning was around Rs.50 (US$ 1.14) followed by Rs.120 (US$ 2.73) for obstetrics and gynecology care services and Rs.90 (US$ 2.15) for general surgery in the government hospitals. It is also imperative to note that the in-patient care services treated in the government hospitals mostly fell under the public health care services and to a smaller extent under the general surgeries.

The three top common in-patient care services offered by the private hospitals were general medicine, obstetrics and gynecology, and pediatrics. The group mean of these services was around Rs.1100 (US$ 25) (Table 3). The survey results show that the average fee of the obstetrics & Gynecology was the highest with an average fee of Rs.650 (14.77) as compared to the top ranked general medicine care service with an average fee of Rs.250 (US$ 5.68) and the third ranked pediatrics care services offered by the private hospitals. The results indicate that the in-patient care services offered by the government hospitals were nominal as the average mean of these services only accounted for Rs.250 (US$ 5.68), which is four times lower than of the private hospitals.

Most Common Diagnostic Tests offered and its Average Fees by the Hospitals

The estimations indicate that maternal blood smear, routine tests such as blood, urine and stool, TB sputum and X-ray tests were the most common diagnostic tests offered by the government hospitals in the State (Table 4). In the case of private hospitals, the most common diagnostic tests offered were routine tests such as blood, urine and stool, X-ray tests,

maternal blood smear and ultrasound scans. The estimations of average fee (i.e., grouped mean) of these most common diagnostic tests significantly varied between both public and private health hospitals. It accounted for Rs.75 (US$ 1.70) and Rs.350 (US$ 7.95) respectively for both public and private hospitals.

The top most common diagnostic test provided in the government hospitals was maternal blood smear, which has been considered as the third most common diagnostic tests service offered by the private hospitals. The average fee of this diagnostic service of the private hospitals was 15 times higher than the government hospitals. The routine tests of blood, urine and stool were the top most common diagnostic tests offered by the private hospital with the average of Rs.200 (US$ 4.55) and followed by the Radiology (X-ray) with average fee of Rs.250 (US$ 5.68) (Table 4). The nominal average fee of these common diagnostic tests indicate that it is only admission or entry charges for using these services in the government hospitals.

Type of Fee Schedule Used by the Hospitals

In general, information asymmetries exist in health sector to a greater extent as compared to other social sectors. The price of health care services is an unobservable phenomenon and it is the duty of health care providers to provide full information to the patients, which is also considered as a quality indicator of the health care providers. It was found that 70 per cent of the government hospitals used a published fee schedule regarding their care services (Table 5). However, nearly 56 per cent of the private hospitals never used any published fee schedule but they revealed that it was widely known information to their clients. It implies that there is a possibility of arbitrariness in fixing the fee for private hospital care services in the State.

Factors Determining the Fixation of Fee Schedule by the Providers

Five main factors have been identified in determining the fee schedule by the providers. It includes (a) costs of running the service, (b) government regulation, (c) medical association recommendation, (d) market condition, and (f) free care. These have been explained in terms of expressed opinions and views of the managers of the hospitals. It is found that the government health care providers stuck to government rules and regulations in determining fee fixation for their care services, which accounted for 85 per cent (Table 6). It is important to note that government hospital care services were, in general, free for the lower income groups and nominal fees were fixed by an expert committee appointed by the government, which, in turn, becomes a government order for fee schedule of the health care services. The government gave the fee exemption for the socially vulnerable groups such as SC/ST and BPL people (people who are under Below Poverty Line). Nearly 90 per cent of the private hospital authorities expressed that cost of running/ providing care services used to be the determinant factor for fixing the fee schedule of the care services (Table 6). The market condition was the second most determinant factor for fixing the fee schedule of the care services of the private hospitals, which accounted for 11.3 per cent.

Competition in Fixing Fees among the Hospitals

It is found that there was no price competition in fixing fee for health care services among the hospitals in order to attract more clients (Table 7). The hospital authorities expressed that they never considered the fee fixed by their colleagues in the market.

Average Cost of Hospitals in the State

The total average cost (TAC) is measured as a sum of recurrent cost and capital expenditure with taxes and duties or without taxes and duties. The components of the total recurrent cost include the cost of: (a) human resources, (b) drugs, sundries, and utilities, (c) procurement of services, and (d) general administration expenditure. The components of the total capital expenditure of health care provider include the cost of (a) purchase of capital equipment, and (b) maintenance of equipment and buildings, which are also taken into consideration for discounting the cost of capital equipment such as building and capital.

The estimates of the total average cost of hospitals in Karnataka show that there is a significant difference between the cost of both public and private hospitals (Table 8). A minimum total average cost of government hospitals in the State was around Rs.80 million as compared to the total average cost of private hospitals, which was around Rs.110 million. The variations of the total average cost between public and private hospitals are better explained by looking into the share of the components or inputs of average total costs. The inputs of total average cost are recurrent cost and capital expenditure. The recurrent average cost is an indicator that explains the efficiency of the hospitals with given outputs. It is important to note that the proportion of the average recurrent cost of private hospitals is much lower than the government hospitals (Table 9). The average recurrent cost proportion of the private hospitals was only about 40 per cent as compared to the proportion of the government hospitals (70 per cent) in the State. In the case of capital expenditure, private hospitals were spending more than the government hospitals. It accounts to nearly 58 per cent for private hospitals as against the 30 per cent in the government hospitals.

The recurrent cost is an indication of the operational cost of various inputs such as human resources, drugs, sundries and utilities, procurement of services and general administration of the hospitals. It is significant to note that the government hospitals incurred more operational cost than the private hospitals. The estimation of average cost of human resources in the government hospitals was around 80 per cent as compared to just 60 per cent in private hospitals in the State (Table 10).

Drugs, sundries and utilities play a pivotal role in the hospital delivery system. Recent estimation shows that Karnataka State is spending nearly 10 per cent of the health sector budget for drugs and medicines (Mathiyazhgan, 2004). Similar pattern is also reflected in the cost structure of the existing government hospitals in terms of drugs, sundries and utilities in the State. The estimates show that 9 per cent of the total recurrent costs incurred by the government hospitals towards the average cost of drugs, sundries and utilities were two times lower than the share of the private hospitals (Table 10). It implies that the constant availability of the subsidized prices of drugs and medicine for the low income people may not be materialized at the government hospitals. It is a serious problem in the referral hospitals in the State (Mathiyazhagan, 2003a, and 2003b).

Procurement of services in terms of paying transport, rents, and external consultants is another input of recurrent cost of the health care providers. The share of procurement of services in the government hospitals was also lower than the private hospitals (Table 10). It implies that resources available to the vehicles and hiring of private consultants is very limited in the government hospitals irrespective of very acute shortage of specialized doctors in these hospitals. Further, the government hospitals were short of resources even for the

general administrative services, which accounted for 3 per cent as against 5 per cent of the private hospitals in the State.

The inputs of the capital expenditure of the hospitals have also been estimated. The capital expenditure of the hospitals includes two inputs: (1) purchase of capital equipment; and (2) maintenance of equipment and buildings. The share of purchase of capital equipment of the private hospitals was higher than the average cost of public health care providers in the State. It is obvious that the private hospitals incur the highest average capital cost of Rs.66 million as against the Rs.24 million of the government hospitals (Table 11).

Results and Discussion

The cost efficiency and its determinants of the hospitals have been estimated by both stochastic frontier and data envelopment analysis. The results have been reported in Tables 12 through 20. The results of total sample for frontier cost function reported in the Table 12, demonstrates that among two primary measured outputs, an increase in outpatient visits resulted in a positive and significant impact on total operational costs of the hospitals. It accounts that every one percent change in the outpatient visits of the hospital leads to 18 to 20 per cent change in the operational costs of the hospitals in the State. This means that the hospitals need to spend effectively on wage of the personnel, which is the important input factor of the hospital's operation cost. It is evident from the result that there is a positive and significant relationship between wages of medical and non-medical personnel and operation costs of the hospital (Table 12). However, the quality index, which is the proxy measure for quality of the care services and institutional characteristics of the hospitals, has registered an insignificant relationship with the operational costs of the hospitals. It indicates that hospitals are not proficient enough in providing a quality oriented care services irrespective of a positive relationship between the outpatient visits and the operational costs. It is also true in the case of inpatient days care services of the hospitals, which turns to hold an insignificant association with the costs in the State. It may be due to be the fact that hospitals at the lower levels have low bed occupancy rates in the State (Mathiyazhagan, 2003b).

The results also demonstrate that average cost efficiency score for the total sample was around 0.53 by the stochastic frontier model and the same was between 0.50 and 0.54 by the DEA models (Table 13). It implies that most of the hospitals were cost inefficient in Karnataka State in India, which is due to inappropriate technical and allocative system of resources in the hospitals. It is also evident from the results that the average level of technical inefficiency of the hospitals was around 0.50 with VRS hypothesis and 0.51 with CRS. The allocative inefficiency of the hospitals was around 0.48 and 0.50 with VRS and CRS hypotheses respectively. It implies that, in an average, 2-3 per cent of allocative inefficient added to the hospital costs. Thus, the cost inefficiency of the hospitals was contributed equally by both technical and allocative inefficiency levels in the State.

The average cost efficiency scores for the public and private hospitals were 0.40 and 0.60 respectively by the SFM and it was ranging between 0.38 and 0.42 for public hospitals and 0.63 and 0.67 for the public hospitals by the DEA models. The estimations of average cost efficiency scores were not significantly different as is evident from the high correlation coefficient between the average cost efficiency scores by these two models (results are not

reported here[3]). It implies that estimations are robust by these two models. Further, the results also show that the private hospitals appear relatively less inefficient than the public hospitals. Nevertheless, the average cost efficiency scores between public and private hospitals demonstrate a vast difference in the State.

As it can be seen from the Table 14, the null hypothesis is rejected at 1 per cent level of statistical significance in each hospital category. It provides evidence that the differences in efficiency are statistically significant at 1 per cent level of significance. It is also imperative to note that low average efficiency score of public hospital is also due to very a few public hospitals satisfy the highest level of technical inefficiency score of 1 in VRS and CRS models. It accounts to only 10 - 15 per cent of all the hospitals in the sample from the CRS and VRS models respectively. It may also be due to the competing interests of the government hospitals under the bureaucratic meddling, which may lead to restrictions or mandates in terms of hospital resources. It also supports the public finance arguments to characterize non-profit firms as contributing to social efficiency by providing levels of public goods that could be inadequately financed and do not always have required technology and equipments.

The average scale efficiency for the total sample was around 0.55, which also varies between public and private hospitals (Table 13). It accounted to 0.42 and 0.66 for public and private hospitals respectively. It is evident from the results that cost inefficiency of the public hospitals was higher than private hospitals and there was no significant difference in the cost inefficiencies attributed by the technical efficiency and allocative efficiency in the State. In the case of private hospitals, allocative inefficiency added an average of 5-6 per cent to hospital costs (Table 13). It implies that allocative inefficiency contributed to a slightly higher scale than the technical inefficiency of the private hospitals in the State.

The results also offer some insights of cost minimizing vector of inputs such as labour and minor capital used in the hospitals (Table 14). The results for the CRS model indicate that all types of hospital under-utilized labour input of medical personnel by an average of 35 per cent and 44 per cent of other inputs of materials and equipments. In the case of inputs of non-medical personnel, all types of hospitals were over utilized by an average of 3 per cent. The use of inputs varied between public and private hospitals. The use of non medical personnel and expenditure on material and equipments were nearly optimal for the private hospitals, while the public hospitals reported over utilization in the use of non-medical personnel by an average of 10 per cent. The results were similar in the case of VRS model. The results demonstrate that there is a need for rationalization of utilization of non-medical personnel of public hospitals in terms of contracting out these services.

The estimated efficiency scores were analyzed by regressing them against a set of observed characteristics of the hospitals. The determinations of parametric and non-parametric efficiency scores were examined by standard OLS regression and censored Tobit model respectively. The results from both the methods are robust and there are no much differences in the coefficient. The outpatient visits, and share of medical personnel are statistically significant determinants of cost efficiency for all types of hospitals in the State (Table 15).

[3] It has been tested by F statistic at 5 per cent level of significance in terms of mean efficiency scores of the different models.

The other determinants such as hospital quality index and location of the hospitals do not have any significant contribution of the cost efficiency of the hospitals. Outpatient index is the only factor that is a statistically significant determinant of the cost efficiency of the public hospitals (Table 16). In the case of private hospitals, both the inpatient days and outpatient visits have turned out to be significant determinants of the cost efficiency in addition to the share of medical personnel and hospital quality index (Table 17).

The results from analysis of the determinants of the technical, allocative and scale efficiencies of the hospitals demonstrate a significant variation across the type of ownership of the hospitals (Table 18 through Table 20). The analysis from all types of hospitals indicates that the inpatient days care index, outpatient visits and location of the hospitals were positively related with technical, allocative and scale efficiencies (Table 18). The results of the determinants of the technical, allocative and scale efficiencies also differ across the types of ownership of the hospitals. The public hospitals happened to be efficient in terms of technical and allocative systems only in delivering the services of outpatient visits (Table 19). This is due to the high demand of subsidized or free health services provided to the poor people by the public hospitals. It justifies the social role of public hospitals in the State.

The private hospitals has not only been technically efficient but also been efficient in allocation of resources in terms of inpatient days care index, outpatient visits, and share of medical personnel (Table 20). The results also shown that in addition to the determinants of technical and allocative efficiencies, the scale efficiency of the private hospitals correlated with the capacity of beds, and locations of the hospitals. Most of the private hospitals has been located in the urban areas affirms a high demand of outpatient visits and inpatient days care services. The hospital quality index indicator did not have any significant relation with technical, allocative and scale efficiencies of the private hospitals. It implies that private hospitals were efficient without any concerns of quality factors of the hospital services in the State as the hospital quality index did not have any significant relationship with cost interventions of technical and allocation of resources.

Implications of the Results and Conclusion

This paper used the parametric and nonparametric methods to analyze hospital cost efficiency. The findings indicate that the choice of econometric approach did not make any significant differences in the results and they are robust. The analysis infers that (a) hospitals (both public and private together in the analysis) are inefficient in the State, which is due to technical and allocative system of resources of the hospitals; (b) the private hospitals appear relatively less inefficient than the public hospitals; and (c) the main determinants of the technical and allocative inefficiencies of the public hospitals are due to inappropriate interventions of inpatient days care, share of medical personnel, beds capacity, quality indices, and choice of the locations; while in the case of private hospitals, it relates only to beds capacity and quality indices. It means that standardization of hospitals and improvement in quality of healthcare services need to be attended immediately in the state.

The results are having serious implications related to emerging vast number of private voluntary and government sponsored health insurance scheme at the State level. The government hospitals will be out of the health insurance schemes as a service provider as it lacks the cost efficiency in general and technical and allocative efficiency in particular. It is also evident from the accreditation of hospitals for “Yeshasvini” health insurance scheme,

where only 6 government hospitals were endorsed as a provider for this scheme as against over 100 private hospitals from all over the State.

The public hospitals are financed out of tax resources of the government, which are enormously affected and its total outlays has been reduced in real terms due to the stabilization of fiscal monetization by the government in the State (Mathiyazhagan, 2004). It calls for a change, in favour of need based financing and payment mechanism of the public hospitals. Though private hospitals are cost efficient, there is a need to main the quality of care services given the rise in competitive environment of private hospitals in the State. Since most of the private hospitals are highly depending on out-of-packet payments of the patients, it would be subject to financial vulnerability if the care services are not quality oriented.

Table 1: Sources of Revenue across the types of Hospitals in the State

Source of revenue	Public Hospitals		Private Hospitals	
	Ranks for Source	Ranks for Share	Ranks for Source	Ranks for Share
	Per cent of Hospitals Responding			
N=99	40		59	
Direct out of pocket payments (user fees)	5.00	0.80	88.00	95.00
Funded by Govt.	90.00	98.55	0.50	0.50
Covered through private Insurance	3.00	0.65	4.00	2.00
Financed through charitable sources	2.00	0.00	7.00	2.00
Not stated	0.00		0.50	0.50
Total	100	100	100	100

Table 2: Most Common Out-Patient Care offered and its Average Fees by the Types of Hospitals

Type of Provider/ Most common Curative Care	Rank I/ Average Fee	Rank II/ Average Fee	Rank III/ Average Fee	Average Fee (Group Mean in Rs)
Most common Curative Care	General Medicine	Obstetrics & Gynecology	Family Planning	-
Public Hospitals (in Rs.)	10.00	16.00	5.00	100.00
Most common curative care	General medicine	Pediatrics	Obstetrics & Gynecology	-
Private Hospitals (in Rs.)	43.00	35.00	250.00	700.00

Notes: 1US$ equals to Indian Rupees (Rs.) 44 in 2004

Table 3: Most Common In-Patient Care offered and its Average Fees by the Hospitals

Type of Provider/ Most common In-Patient Care	Rank I/ Average Fee	Rank II/ Average Fee	Rank III/ Average Fee	Average Fee
Most common In-Patient Care	Family Planning	Obstetrics & Gynecology	General Surgery	-
Public Hospitals	50.00	120.00	90.00	250.00
Most common In-Patient care	General Medicine	Obstetrics & Gynecology	Pediatrics	-
Private Hospitals	250.00	650.00	300.00	1100.00

Notes: 1US$ equals to Indian Rupees (Rs.) 44 in 2004

Table 4: Most Common Diagnostic tests offered and its Average Fees by the Hospitals

Type of Provider/ Most common Diagnostic tests	Rank I/ Average Fee	Rank II/ Average Fee	Rank III/ Average Fee	Average Fee
Most common Diagnostic tests	Maternal Blood Smear	Routine test (blood, urine, & stool)	TB Sputum	-
Public Hospitals (in Rs.)	15.00	25.00	50.00	75.00
Most common Diagnostics tests	Routine test (blood, urine, & stool)	Radiology (X-ray)	Maternal Blood Smear	-
Private Hospitals (in Rs.)	200.00	250.00	227.00	350.00

Notes: 1US$ equals to Indian Rupees (Rs.) 44 in 2004

Table 5: Type of Fee Schedule Used by the Hospitals

Type of fee schedule used	Public Hospitals	Private Hospitals
Percent providers responding		
N=99	40	59
Published schedule	70.00	10.50
Not published but widely known	0.00	55.50
Fixed on case to case basis	0.0	34.00
Others	30.0	0.00

Table 6: Determinants of ing Fixation of Fee Schedule of the Hospitals

Factors:	Public Hospitals	Private Hospitals
Costs of running the service	0.00	90.00
Government regulation	85.00	0.00
Medical association recommendation	0.00	0.00
Market condition	0.00	11.30
Free care	20.00	0.00
Others	0.00	1.30

Table 7: Competition in Fixing Fees among the Hospitals

Considerations of colleagues charges	Public Hospitals	Private Hospitals
Yes always do	0.00	9.00
No	100.00	79.50
Some times	0.00	11.50

Table 8: Average Total Cost of Hospitals

Type of Provider	Average Total Cost with Taxes & Duties (Rs in Million)
Public Hospitals	80.00
Private Hospitals	110.00
Average Total Cost	90.00

Table 9: Share of the Components of Average Total Cost of Hospitals

Type of Cost	Public Hospitals (%)	Private Hospitals (%)
Recurrent Cost	70.00	40.00
Capital Expenditure	30.00	58.00
Taxes and Duties	0.00	2.00
Average Total Cost (Rs in million)	80.00	110.00

Table 10: Share of the Components of Recurrent Cost of Hospitals

Type of Cost	Public Hospitals (%)	Private Hospitals (%)
Human Resources	80.00	60.00
Drugs, Sundries & Utilities	9.00	18.00
Procurement of Services	8.00	13.00
General Administration Expenditure	3.00	5.00
Average Total Recurrent Cost	56.00	44.00

Table 11: Share of the Components of Capital Expenditure of Hospitals

Type of Cost	Public Hospitals (%)	Private Hospitals (%)
Purchase of Capital Equipment	61.00	79.00
Maintenance of equipment and buildings	39.00	21.00
Total Capital Expenditure (Rs in million)	24.00	66.00

Table 12: Parameter estimates for the frontier cost function for total sample

Variables	Box-Cox model	
	OLS model	Stochastic frontier model
Constant	4.38 (2.87)*	3.20 (2.48)*
Inpatient days	0.40 (0.12)	0.31 (0.16)
Outpatient visits	0.20 (2.98)*	0.18 (3.12)*
Quality index	0.023 (0.49)	0.019 (0.53)
Wages (medical & non-medical personnel)	0.17 (2.81)**	0.21 (2.75)**
R^2	0.80	-
Pseudo R^2	-	0.68
Log L	-	49.20
Heteroscedasticity: Breusch-Pagan χ^2 (4)	18.9	-
Chow test: F(40, 59)	1	-
Box-Cox analysis: H_0:$\lambda = 0$ LR, χ^2 (1)	4.76	-
Endogeneity test: Hausman, χ^2 (1)	0.55	-
Multicollinearity (CI-Index)	35.8	-
N	99	99

Note: Figures in the brackets are't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 13: Efficiency scores of the hospitals by Stochastic Frontier Model and DEA models

Efficiency measure	Total sample	Public Hospitals	Private Hospitals
	Mean	Mean	Mean
Stochastic frontier model	0.53	0. 40	0.65
DEA models Cost efficiency:			
DEACE (1)	0.50	0.38	0.67
DEACE (2)	0.51	0.40	0.63
DEA (3)	0.54	0.42	0.66
DEA (4)	0.50	0.41	0.64
Technical efficiency (CRS)	0.51	0.30	0.65
Technical efficiency (VRS)	0.50	0.41	0.61
Allocative efficiency (CRS)	0.48	0.40	0.65
Allocative efficiency (VRS)	0.50	0.39	0.60
Scale efficiency	0.55	0.42	0.66

Table 14: Technical Efficiency of the Hospitals

Hospital ownership	Mean (CRS model)	Mean (VRS model)
Total sample:		
Technically efficient or optimal working hours of medical personnel	0.65	0.69
Technically efficient or optimal working hours of non-medical personnel	1.03	1.05
Technically efficient or optimal expenditure on material and equipments	0.56	0.51
Public Hospitals:		
Technically efficient or optimal working hours of medical personnel	0.80	0.82
Technically efficient or optimal working hours of non-medical personnel	1.10	1.12
Technically efficient or optimal expenditure on material and equipments	0.70	0.75
Private Hospitals:		
Technically efficient or optimal hours of medical personnel	0.90	0.91
Technically efficient or optimal working hours of non-medical personnel	0.98	0.98
Technically efficient or optimal expenditure on material and equipments	0.97	0.98

Table 15: Determinants of Cost efficiency scores for total sample

Variables	Stochastic frontier estimates	DEA estimates			
	Regression co-efficient	Censored Tobit Model co-efficient			
		DEACE (CRS)	DEACE (VRS)	DEA (CRS)	DEA (VRS)
Constant	-0.69 (-0.21)*	1.22 (0.35)*	1.01 (0.42)**	0.98 (0.27)*	0.76 (0.21)**
Inpatient days index	-0.28 (-0.12)**	0.67 (0.86)	0.58 (1.02)	0.65 (1.13)	0.61 (0.90)
Outpatient visits	-0.87 (-0.23)**	1.12 (0.30)*	1.28 (0.54)**	1.31 (0.68)*	1.02 (0.31)*
Share of medical personnel	0.65 (0.24)	0.59 (0.11)	0.43 (0.06)	0.61 (0.20)	0.54 (0.15)
Beds capacity	0.31 (0.15)**	0.24 (0.10)**	0.28 (0.07)**	0.34 (0.12)*	0.22 (0.06)**
Hospital quality index	1.23 (0.10)*	0.44 (0.12)*	0.29 (0.11)**	0.35 (0.14)*	0.39 (0.16)**
Location of the hospitals	0.18 (0.29)	0.20 (0.40)	0.31 (0.37)	0.25 (0.81)	0.24 (0.55)
σ	R^2=0.41	0.19 (0.08)*	0.24 (0.10)**	0.16 (0.05)**	0.20 (0.09)**
Log-likelihood	-	23.01	19.32	30.16	23.40

Note: Figures in the brackets are‘t’ values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 16: Determinants of Cost efficiency scores for Public Hospitals

Variables	Stochastic frontier estimates	DEA estimates			
	Regression co-efficient	Censored Tobit Model co-efficient			
		DEACE (CRS)	DEACE (VRS)	DEA (CRS)	DEA (VRS)
Constant	0.89 (1.20)	1.42 (1.15)	0.91 (0.66)	1.18 (1.32)	0.96 (0.91)
Inpatient days index	0.85 (0.82)	0.76 (0.90)	0.92 (1.20)	0.71 (0.87)	0.59 (0.60)
Outpatient visits	-0.80 (-0.29)*	-1.10 (-0.61)*	-0.97 (-0.43)**	-1.14 (-0.63)*	-0.86 (-0.32)**
Share of medical personnel	0.65 (0.24)	0.59 (0.11)	0.43 (0.06)	0.61 (0.20)	0.54 (0.15)
Beds capacity	0.19 (0.45)	0.27 (0.34)	0.32 (0.55)	0.56 (0.71)	0.37 (0.73)
Hospital quality index	0.11 (0.15)	0.36 (0.30)	0.18 (0.15)	0.29 (0.26)	0.28 (0.25)
Location of the hospitals	0.13 (0.09)	0.10 (0.08)	0.04 (0.05)	0.08 (0.09)	0.50 (0.45)
σ	R^2=0.38	0.23 (0.12)*	0.32 (0.10)**	0.55 (0.24)**	0.29 (0.13)**
Log-likelihood	-	19.12	17.31	24.32	21.30

Note: Figures in the brackets are't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 17: Determinants of Cost efficiency scores for Private Hospitals

Variables	Stochastic frontier estimates	DEA estimates			
	Regression co-efficient	Censored Tobit Model co-efficient			
		DEACE (CRS)	DEACE (VRS)	DEA (CRS)	DEA (VRS)
Constant	-1.18 (-0.43)*	-1.60 (-0.83)**	-1.23 (-0.45)*	-1.35 (-0.34)*	-1.42 (-0.91)**
Inpatient days index	-0.66 (-0.19)	-0.59 (-0.27)**	-0.72 (-0.29)*	-0.68 (-0.25)*	-0.52 (-0.13)*
Outpatient visits	-0.89 (-0.18)*	-1.23 (-0.50)*	-1.12 (-0.55)**	-1.30 (-0.60)*	-1.26 (-0.43)**
Share of medical personnel	-0.79 (-0.21)*	-0.29 (-0.09)**	-0.10 (-0.03)**	-0.15 (-0.06)**	-0.19 (-0.05)**
Beds capacity	-1.10 (-0.43)*	-1.18 (-0.58)**	-1.09 (-0.29)	-1.17 (-0.40)**	-1.08 (-0.51)**
Hospital quality index	-0.10 (-0.03)**	-0.18 (-0.05)**	0.09 (0.06)	-0.17 (-0.05)**	0.08 (0.06)
Location of the hospitals	0.09 (0.19)	0.50 (0.40)	0.06 (0.05)	0.17 (0.15)	0.30 (0.27)
σ	R^2=0.43	0.40 (0.10)*	0.28 (0.09)**	0.36 (0.10)**	0.20 (0.05)*
Log-likelihood	-	21.05	29.12	20.21	14.20

Note: Figures in the brackets are 't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 18: Determinants of Technical, Allocative and Scale Efficiency for the all types of Hospitals

Explanatory variables	Censored Tobit Model co-efficient from DEA estimates				
	Technical efficiency (CRS)	Technical efficiency (VRS)	Allocative efficiency (CRS)	Allocative efficiency (VRS)	Scale efficiency
Constant	0.86 (-4.18)*	-1.57 (-4.60)*	0.60 (3.15)*	0.89 (3.21)*	0.32 (4.09)*
Inpatient days index	0.79 (3.17)**	-0.22 (0.29)	-0.32 (-0.25)	-0.36 (-0.33)	0.40 (0.38)
Outpatient visits	-1.10 (-3.50)*	-1.22 (-4.55)*	-1.30 (-3.60)*	-1.36 (-3.43)*	-0.56 (4.12)*
Share of medical personnel	0.68 (0.39)	0.50 (0.23)	0.25 (0.16)	0.19 (0.15)	0.45 (0.12)
Beds capacity	0.28 (0.22)	0.79 (0.29)	0.87 (0.40)	0.88 (0.51)	0.59 (0.021)
Hospital quality index	0.18 (0.12)	0.55 (0.31)	0.55 (0.12)	0.43 (0.10)	0.28 (0.13)
Location of the hospitals	-0.40 (-2.60)**	-0.29 (-2.57)**	-0.17 (-2.65)**	-0.30 (-3.27)*	-0.31 (-2.90)**
σ	0.30 (9.31)*	0.34 (11.20)*	0.45 (10.13)*	0.34 (8.15)*	0.21 (8.14)*
Log-likelihood	19.12	30.31	34.10	23.00	22.32

Note: Figures in the brackets are 't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 19: Determinants of Technical, Allocative and Scale Efficiency for the Public Hospitals

Explanatory variables	Censored Tobit Model co-efficient from DEA estimates				
	Technical efficiency (CRS)	Technical efficiency (VRS)	Allocative efficiency (CRS)	Allocative efficiency (VRS)	Scale efficiency
Constant	-1.35 (-4.12)*	-1.32 (-3.25)*	-1.19 (-3.14)*	-1.41 (-2.91)**	-1.29 (2.89)**
Inpatient days index	0.60 (0.27)	0.56 (0.21)	0.69 (0.34)	0.79 (0.45)	0.53 (0.40)
Outpatient visits	-0.23 (-2.90)**	-0.12 (-3.32)**	-0.40 (-2.89)**	-0.32 (-2.97)**	-0.40 (-3.01)
Share of medical personnel	0.22 (0.19)	0.18 (0.10)	0.25 (0.16)	0.21 (0.19)	0.20 (0.15)
Beds capacity	0.20 (0.19)	0.29 (0.10)	0.32 (0.21)	0.25 (0.19)	0.28 (0.20)
Hospital quality index	0.28 (0.20)	0.31 (0.16)	0.27 (0.15)	0.18 (0.10)	0.19 (0.23)
Location of the hospitals	0.30 (0.12)	0.16 (0.14)	0.29 (0.17)	0.26 (0.20)	22.0 (0.20)
Σ	1.40 (2.70)**	1.73 (3.09)*	1.81 (3.17)*	1.20 2.95)*	1.51 (2.81)*
Log-likelihood	24.95	19.79	30.12	34.20	39.00

Note: Figures in the brackets are't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Table 20: Determinants of Technical, Allocative and Scale Efficiency for the Private Hospitals

Explanatory variables	Censored Tobit Model co-efficient from DEA estimates				
	Technical efficiency (CRS)	Technical efficiency (VRS)	Allocative efficiency (CRS)	Allocative efficiency (VRS)	Scale efficiency
Constant	-1.65 (-2.93)**	-1.33 (-3.22)*	-1.40 (-3.21)*	-1.32 (-4.12)*	-1.30 (-2.89)**
Inpatient days index	-1.57 (-3.23)*	-1.71 (-2.87)**	-1.79 (-4.25)*	-1.52 (-5.43)*	-1.63 (-5.21)*
Outpatient visits	-2.12 (-5.51)*	-1.98 (-3.27)*	-1.30 (-2.90)**	-1.56 (-2.89)**	-1.76 (-2.93)**
Share of medical personnel	-1.29 (-1.09)	-2.30 (-3.32)**	-1.25 (-1.07)	-2.34 (-2.95)**	-1.87 (-3.71)*
Beds capacity	1.23 (0.65)	1.10 (0.35)	1.31 (0.48)	1.28 (0.63)	1.10 (1.30)
Hospital quality index	0.89 (0.54)	0.59 (0.76)	0.67 (0.94)	0.78 (0.56)	0.67 (0.54)
Location of the hospitals	-2.50 (-3.40)	-1.16 (-3.12)	-2.17 (-4.32)	-2.43 (-3.38)	-2.01 (-3.23)**
Σ	0.80 (2.79)*	0.86 (3.12)**	0.72 (2.89)**	0.90 (2.95)**	0.43 (2.89)**
Log-likelihood	36.29	43.16	30.61	19.29	37.34

Note: Figures in the brackets are't' values.
* refers to 1 per cent of level of significance
** refers to 5 per cent of level of significance

Notes:

[1] DRG-Index for inpatient days = $\sum_j q_{ij} . \ln\left(\frac{q_{ij}}{p_j}\right)$, where DRG-IID is a DRG index for inpatient days, q_{ij} is the proportion of each DRG case to total DRG cases in a hospital, p_j is the proportion of sum of all DRG cases in all hospitals to total cases (i.e. total cases of inpatient and outpatient cases treated in the hospital). If the estimated DRG-IID is equal to zero if no specialization occurs and hospital DRG case proportion increases according to the level of specialization of the hospitals.

[2] It is a weighted log of a hospital's DRG proportions in monetary terms (i.e. DRG-IID*) and calculated as the produced quantity of the hospital and multiplied by the marginal cost estimates β_j from the equation 1. The DRG-IID* = $\sum_j \hat{\beta}_j \; yij . \ln\left(\frac{\hat{\beta}_j \; y_{ij}}{\hat{\beta} \; \bar{y}_j}\right)$.

[3] Any scale obtained by adding together the response scores of its constituent items is referred to as a Likert or summative scale. This method is used in this paper for analyzing a set of items, composed of approximately an equal number of favorable and unfavorable statements concerning the attitude object (that is quality of the hospital), which has been given to a group of subjects (that is, sources of provider). Hospital administers have been asked to respond to each statement in terms of their own degree of agreement or disagreement. They have been instructed to select one of the four responses: very good, good, very bad, and bad. The specific responses to the items have been combined so that hospitals with the most favorable attitudes will have the highest scores while hospitals with the least favorable or most unfavorable attitudes will have the lowest scores.

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