Determinants and Measurement of Technical & Allocative Efficiency of District Hospitals of Jammu & Kashmir: A Data Envelopment Analysis (DEA)

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The fundamental goal of global health system reform is to achieve universal health coverage, and countries around the world continue to reform their health care systems with the aim of improving service structures, processes and outcomes. Secondary health care is widely seen as the backbone of a national health care system that provides comprehensive services to the population, but both developed and developing countries have been caught in the dilemma of inefficiency in secondary health services. Efficiency improvements are critical for reducing wasted resources and achieving sustainable health outcomes, especially in developing nations.

The efficiency is a measure of the amount of output in relation to a given level of input, and technical efficiency is often used to represent the efficiency of health care services. Whether greater input improves efficiency is unclear; although some studies have noted that insufficient input can limit efficiency, increased input does not itself necessarily lead to increased efficiency. An estimation of efficiency is therefore beneficial, especially for developing countries, when secondary health care reform reaches the point at which the impact of increased input becomes unclear and governments begin looking for solid evidence to improve their existing reform agenda. Existing research has mostly focused on developed countries at the institutional and system levels, but much less attention has been paid specifically to secondary health care services, and more empirical research is needed to support the estimation of secondary health care service efficiency in developing countries in particular. In this regard, the present study has been taken to understand the measurement and determinants of allocative and technical efficiency of selected District Hospitals of Jammu and Kashmir. The study has also tried to assess the impact of institutional as well as environment factors on hospital efficiency.

The DEA model has been widely used to measure the technical efficiency of selected district hospitals of Jammu and Kashmir and it was found that around 93 percent of district hospitals of Jammu and Kashmir are efficiently functioning which indicate that health sector of Jammu and Kashmir has resilience/potential to face any health shock like COVID-19 situation. Further, Tobit regression model was used to assess the impact of institutional as well as environmental factors on hospital efficiency and it was found that population and regional factors does not have any impact on the hospital efficiency but all others factors such as outpatient/inpatient visits and

average length of stay have impact on the hospital efficiency. Although, the district hospitals of Jammu and Kashmir found to be efficient with regard to productivity/outputs of treated cases but still there is a scope for further improvement in terms of infrastructure and some hard to reach districts such as Kishtwar, Reasi, Ramban and etc., need some special attention in this case. These hard to reach districts have high risk of road accidents and therefore, need some air ambulance services in order to minimize the trauma and maternal death cases.

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INTRODUCTION:

Immense investments made in improving the health system of the country since the dawn of independence, has resulted in improved health outcomes such as contraction in infant and maternal mortality rates and increase in life expectancy at national level. However the trend was not uniform at State-level. Some states have shown impressive results while as some were in awful conditions. Despite, the number of reforms, the health sector of Jammu & Kashmir continued to face enormous challenges particularly during the huge rush of patients in recent pandemic. The major challenge has been speculated as the level of inefficiencies in the healthcare delivery in most of the health facilities of the Union territory of Jammu & Kashmir. As long as the challenges are not identified and then addressed, the desired levels of health facilities/outputs are not possible. In view of this backdrop, the present study will deeply examine the 'technical[1] as well as the allocative efficiency'[2] among the district hospitals[3] of Jammu & Kashmir.

Scope of the Study:

The scope of the study is to deeply examine the technical as well as the allocative efficiency of 14 selected district hospitals of the union territory of Jammu & Kashmir and to find out the areas responsible for existing situation of health facilities in the Union Territory. This will help the Government to focus on the areas identified which will bring improvement in health conditions in the union territory of Jammu & Kashmir.

[1] Technical efficiency reflects the ability of a firm to obtain the maximal output from a given set of inputs and allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices/costs

[2] Hospital inefficiencies exist in different forms including technical, allocative, scale, scope and cost inefficiency. A hospital is technically efficient when it maximizes outputs for a given level of inputs or resources, or conversely, when it minimizes inputs for a given level and choice of outputs. Allocative efficiency is when a hospital allocates and uses the least costly combination of inputs in producing its outputs or when hospital resources are committed to produce outputs that are priorities for society. Scale efficiency exists when the size of hospital operations is optimal so that any modifications of its size will render the hospital less efficient. Scope efficiency occurs when a hospital reduces its average cost through the benefit of producing several outputs. Cost efficiencies measure the average cost used in producing outputs compared to a standard or the cost used by other provider

[3] A district hospital provides support to sub-districts in disease prevention and control, health promotion and public health education; referral outpatient and inpatient care, training and supervision of health centres; maternity services, especially the management of complications and emergencies and surgical contraception.

Main Objectives of the Study:

In order to synthesize the major determinants of hospital inefficiency and to develop a framework to identify causes of inefficiency and to develop the multi-factor interventions to address these inefficiencies, the specific objectives of the study are:

1) To estimate the technical as well as the allocative efficiency of district hospitals of Jammu & Kashmir.
2) To estimate the impact of institutional as well as the environmental factors on the efficiencies/inefficiencies of district hospitals of Jammu & Kashmir by the use of Tobit Regression Model.

Variables of the Study:

In order to measure the district hospital's efficiency we have taken a total of seven (27) variables, including four (04) inputs and around twenty three (23) outputs. Moreover, some of the institutional and environmental factors (explanatory factors) affect the hospital efficiency have also been taken into account.

a) Inputs variables:

The four inputs included: i) number of medical officers and specialists including physicians, general medicine, radiologists, pediatricians, gynecologists, surgeons, dental surgeons; anesthetists, ophthalmologists, Orthopedicans ; ii) number of technical officers including medical assistants, nurses and midwifes; iii) the support or subordinate staff (including lab technicians, paramedical staff, orderlies, ward assistants, cleaners/safaiwalas, drivers, gardeners, watchmen, etc.); and iv) number of hospital beds including all type of specialized beds (Appendix – I). These variables are explained as: X_1 is the number of beds as a proxy of infrastructure; X_2 is the number of doctors including all types of specialists; X_3 is the number of all types of nurses plus midwives and X_4 is the number of all types of technicians including lab technicians, X-ray and etc.

b) Output variables:

The outputs variables for each individual District Hospital are: **i)** the number of maternal and child care (MCH) (i.e., antenatal care, postnatal care, family planning, immunization and growth monitoring); **ii)** number of child deliveries including C-Section; and **iii)** number of patients

discharged excluding deaths, major and minor surgeries, number of OPD and number of IPD Patients (Appendix – II). These variables are explained as: Y_1 is the number of Pregnant Women received 4 or more ANC checkups; Y_2 is the number of complicated pregnancies treated with Blood Transfusion; Y_3 is the number of Institutional Normal Deliveries conducted, Y_4 is the number of C-Section deliveries performed, Y_5 is the number of SNCU discharged babies screened in DEIC, Y6 is the number of anaemic cases treated including school going/out of school, adolescents, pregnant and lactating mothers, Y_7 is the number of women receiving Postpartum checkup between 48 hours and 14 days after Institutional delivery, Y8 is the number of Laparoscopic sterilizations (excluding post-abortion) conducted; Y_9 is the number of Child immunization - Measles & Rubella (MR)/ Measles containing vaccine (MCV)- 2nd Dose (16-24 months); Y_{10} is the number of childhood - Diarrhea treated including ORS and Zinc for 14 days; Y_{11} is the number of Directly Observed Treatment, Short-course (DOTS) cases completed successfully; Y_{12} is the number of Allopathic-Outpatient attendance(OPD); Y_{13} is the number of Ayush - Outpatient attendance (OPD); Y_{14} is the number of Major and Minor Operations conducted excluding C-Section (General and spinal anesthesia); Y_{15} is the number of In-Patient Head Count at midnight (IPD); Y_{16} is the number of Newborns successfully discharged from SNCU; Y_{17} is the number of PW and PNC beneficiaries provided - Free Medicines and Diagnostics under JSSK; Y_{18} is the number of PW and PNC beneficiaries provided - Interfaculty transfers when needed under JSSK; Y_{19} is the number of PW and PNC beneficiaries provided - Free Drop Back home under JSSK; Y_{20} is the number of sick infants provided - Free Medicines and Diagnostics under JSSK; Y_{21} is the number of sick infants provided - Interfaculty transfers when needed under JSSK; Y_{22} is the number of Lab tests done; and Y_{23} is the number of Radiology tests done including x-rays, USGs, CT Scan and ECGs.

Data Base and Methods of Analysis:

The data was collected from the Health Management Information System (HMIS) portal of the Ministry of Health and Family Welfare, Government of India as well as from the Medical Record Departments of each District Hospital (DHs) of the union territory of Jammu & Kashmir and afterwards the data was analyzed with the help of **DEAP software, version 2.1 developed by Professor Tim Coelli**.

Methods of Analysis:

The efficiency scores of district hospitals of Jammu & Kashmir has been estimated by the use of input-oriented **Data Envelopment Analysis** (DEA) Model. The general form of the model is as:

$$\boldsymbol{Eff} = Max \sum_{a_{r,}\, b_i} a_r y_{rj0} + a_0 \ \ Subject\ to \sum b_j x_{ij} - a_0 \leq 0;\ \forall j, \sum b_i x_{ij0}$$
$$= 1\ , a_r b_i \geq 0; \forall_r \forall_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where y_{rj} is the amount of output r produced by DH_j; x_{ij} is the amount of input ***i*** used by DH_j; a_r is the weight for output r; b_i is the weight for input ***i***; n is the total number of DH, and j_0 is considered DH; and ∀= for all.

Moreover, the association of institutional and environmental characteristics with the technical efficiency of the district hospitals has been measured with the help of **Tobit Regression Model**. The general form of the model is given as:

$$\boldsymbol{Ineff_i} = \beta_0 + \beta_1 PoP_i + \beta_2 Poverty_i + \beta_3 Division_i + \beta_4 ALoS_i + \beta_5 BoR_i$$
$$+ \beta_6 RoBTP_i + \beta_7 RoBTN_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Ineff is the technical inefficiency score; PoP is the categorical variable of regional population (1 = if population is less than 1,000,000; 2 = if population is above 1,000,000 to 2,500,000 and 3 = above 2,500,000); Division is a categorical variable for 14 districts hospitals (1 = Bandipora, 2 = Budgam, 3 = Ganderbal, 4 = Gandhinagar, 5 = Sarwal, 6 = Kishtwar, 7 = Kulgam, 8 = Poonch, 9 = Pulwama, 10 = Ramban, 11 = Reasi, 12 = Samba, 13 = Shopian and 14 = JLNM Srinagar. The ALoS, BoR, RoBTP, and RoBTN will be included as continuous variables in the model. Finally, ε_i is the stochastic/random error term.

The explanatory variables for a Tobit regression were selected based on the review of literature on efficiency analysis. Factors that affect the efficiency of district hospitals (DHs) was classified to environmental factors i.e., catchment population, administrative locations, and poverty headcount while as the institutional factors include, average length of stay (ALoS), bed occupancy ratio (BOR), ratio of beds to physicians (RoBTP), and ratio of beds to nurse (RoBTN).

The population size is defined as the number of catchment population in the district where the district hospital is located. The poverty headcount is the proportion of people living below the poverty line in the DH's area. The Average length of stay is defined as the average number of days patients spent in the hospital. The Ratio of beds to physicians is the total number of beds per physician and the ratio of beds to nurses is defined the total number of beds per nurse.

RESULTS AND DISCUSSION:

One of the objectives of this study is to estimate the technical as well as the allocative efficiency of district hospitals of Jammu & Kashmir. For which first we need to calculate the descriptive statistics of input and output variables of district hospitals which are as under.

a) Descriptive Statistics:

First, the descriptive statistics of all the inputs and output variables were calculated by using SPSS 22 Software. The mean, standard deviation (SD), minimum and maximum values of all input and output variables are presented in table 1. Subsequently, the technical efficiency (TE) scores were computed using the DEA programme, version 2.1 (DEAP 2.1) developed by **Tim J. Coelli**. To be able to select a maximum number of variables for inclusion in the study; we conducted a correlation analysis among the output variables. The results of this analysis showed that, with Spearman's correlation coefficients greater than 0.3, none of the variables were associated (appendix-IV).

On an average the selected district hospitals of Jammu and Kashmir received around 3430710 outpatient department visits (Y12) of allopathic plus 147480 outpatient department visits of AYUSH and discharged around 161529 in-patients including AYUSH patients. Those outputs were produced using a total of 583 doctors, 645 nurses and midwives, 330 laboratory technicians and around 1005 hospital beds. The number of beds (X1) varied from 42 to 200 with a mean of 129 and a standard deviation 52 while as the average number of doctors (X2) including specialists are 42, around 46 nurses and midwives (X3) and around 23 laboratory technicians (X4) are used in the District Hospitals of the union territory of Jammu and Kashmir (table 1).

On an average with the given inputs, a district hospital of the Union territory is capable to perform around 1005 normal deliveries (Y3) with a minimum of around 196 normal deliveries (DH JLNM Srinagar) and maximum of 3473 normal deliveries (DH Poonch) while as around

1013 C-section deliveries (Y5) with a minimum of around 207 C-section deliveries (DH Reasi) and a maximum of round 3714 C-section deliveries (DH Poonch) are performed by a district hospital in the Union territory of Jammu and Kashmir. The average number of around 1215 women receiving postpartum checkups between 48 hours and 14 days after institutional delivery (Y7) with a minimum of around 95 women (DH Bandipora) and a maximum of around 3714 women (DH Poonch). The average number of complicated pregnancies treated with blood transfusions (Y2) was around 84 deliveries cases with a minimum of around 01 (DH Shopian) delivery and a maximum of around 311 (DH Budgam) deliveries. Further, on an average around 1371 ANC patients (Y1) were being taken by a district hospital with a minimum of around 64 ANC patients (DH Reasi) and a maximum of around 6348 ANC patients (DH Gandhinagar) by a district hospital (table 1).

With regard to the SNCU discharged babies screened in DEICs (Y5), the average number of around 318 babies were screened in DEICs with a minimum of around zero (DH Sarwal) babies and a maximum of around 1550 babies (DH Shopian) were being screened by a district hospital in the union territory of Jammu and Kashmir. In the case of child immunization (Y9), on an average around 317 cases were immunized by a district hospital with a minimum of zero cases (DH Budgam) and a maximum of around 712 cases (DH Kishtwar) while as around 1424 number of childhood diarrhea cases (Y10) treated with a minimum of zero cases (DH Sarwal) and a maximum of 5570 cases (DH DH Samba). The number of anaemic cases (Y6) treated by a district hospital on an average of around 312 cases with a minimum of zero (DH Kulgam and DH Poonch) and a maximum of 3192 (DH Ramban).

With regard to the number of surgeries including minor as well as major (Y14), on an average, a district hospital in Jammu and Kashmir has the strength to perform around 4343 surgery cases (DH Sarwal) with a minimum of 1339 surgery cases and a maximum of 13769 surgery cases (DH JLNM Srinagar) in Jammu and Kashmir while as around 1215 Laparoscopic Sterilizations (Y8) conducted by a district hospital in Jammu and Kashmir with a minimum of around zero cases (DH JLNM, DH Reasi, DH Kulgam, DH Ganderbal and DH Bandipora) and a maximum of around of 258 sterilization cases (DH Kishtwar).

A district hospital in Jammu and Kashmir has done around 46174 Lab tests (Y22) on an average with a minimum of 51722 tests (DH Reasi) and a maximum of 783395 tests (DH JLNM

Srinagar) while as around 46174 radiology diagnostics including x-ray, USG and CT scan tests were done on an average with a minimum of around 22833 tests (DH Ramban) and a maximum of 86139 tests (DH Pulwama).

Table 1: Descriptive Statistics of INPUT and OUPUT variables of District Hospitals

INPUTS	Sum	Mean	Std. Dev.	Median	Mode	Min	Max
X1	1805	128.92	51.71	101	100	42	200
X2	583	41.64	17.75	37	61	22	76
X3	645	46.07	24.98	46.5	16	8	86
X4	330	23.57	6.76	24	24	10	35
OUTPUTS							
Y1	19196	1371.14	1899.21	727	NA	64	6348
Y2	1172	83.71	88.64	46.5	NA	1	311
Y3	14076	1005.42	876.3	678.5	NA	196	3473
Y4	14187	1013.35	896.91	870.5	NA	207	3714
Y5	4458	318.42	400.71	186	0	0	1550
Y6-	4370	312.14	848.58	10	0	0	3192
Y7	17012	1215.14	953.51	1000	NA	95	3714
Y8	595	42.5	71.65	13.5	0	0	258
Y9	4448	317.71	179.07	312	NA	0	712
Y10	19934	1423.85	1643.21	905	NA	0	5570
Y11	884	63.14	120.74	13	0	0	421
Y12	3430710	245050	138526	223433.5	NA	99363	621552
Y13	147480	10534.28	7076.54	9879.5	NA	1123	25312
Y14	60806	4343.28	3712.53	2804	NA	1339	60806
Y15	161529	11537.78	10888.58	8006	NA	569	39554
Y16	3594	256.71	267.11	174.5	NA	0	1087
Y17	131202	9371.57	8640.68	4992	NA	749	28292
Y18	3297	235.5	204.39	235	NA	2	706
Y19	5698	407	550.75	138.5	0	0	1528
Y20	15215	1086	1877.98	412	NA	0	6974
Y21	1045	74.64	88.24	46.5	0	0	272
Y22	2676318	191165.6	190701.8	127037.5	NA	51722	783395
Y23	646436	46174	19693.79	44940	NA	22833	86139

Source: The author has calculated the descriptive statistics from the data collected from HMIS 2023-24.

Whereas in the case of JSSK entitlements, on an average the District Hospitals of Jammu and Kashmir are able provide free medicines as well as diagnostics services (Y17) to around 9371.57 pregnant women including PNC patients with a minimum of 749 patients (DH Sarwal) and a maximum of around 28292 patients (DH Shopian) while as on an average around 407 PW

including PNC patients received free drop back home transport facility whenever needed with a minimum of zero patients (DH Gandhinagar and DH Sarwal) and a maximum of 1528 patients (DH Poonch). Further, on an average around 74.64 sick infants received free medicine as well as diagnostics services with a minimum of zero sick babies (DH Sarwal and DH Reasi) and a maximum of 272 sick babies (DH Shopian).

b) Technical and Allocative Efficiency:

The efficiency of a decision making unit (DMU) refers to its performance in the utilization of resources at its disposal and is a relative concept. It measures either with respect to the normative desired performance of a DMU or with that of any other DMU. Thus, the efficiency measures are basically the methods of comparing the observed performance of a DMU with some specified performance.

The overall efficiency of any DMU has two major components, that is, technical efficiency and allocative efficiency. A DMU is considered to be technically efficient if it is able to produce maximum output from a given set of inputs. *A DMU is allocatively efficient, if it is able to use the inputs in optimal proportions, given their respective costs. As the relevant data on costs of inputs were not available in this study, the allocative efficiency measures were not employed.* We performed DEA with 'input orientation' considering the limited control of district hospitals over their outputs. Our study addresses the question: by how much can input quantities be proportionally saved without changing the output quantities produced?

The technical efficiency (TE) comprises pure technical (PT) and scale efficiency (SE) components. The scale efficiency (SE) puts a direct impact on the overall efficiency of the decision making units (DMU). The increased scale of operations of a DMU results in economies or diseconomies of scale. In this context, the choice of assumption of variable returns to scale (VRS) or constant returns to scale (CRS) in estimating a data envelopment analysis (DEA) model becomes of critical importance. The constant returns to scale (CRS) assumption focuses on productivity regardless of the scale of operations. Whereas, in the variable returns to scale (VRS) assumption, interest is on the extent to which the scale of operation affects productivity. The VRS assumption is also preferred in the cases where all DMUs under analysis were not considered to be operating at an optimum scale. We carried out our analysis with the variable returns to scale (VRS) assumption.

The returns to scale tell us how outputs respond in the long run to changes in the scale/size (inputs) of the hospital. The inappropriate size of a DMU might result in scale inefficiency, which can be further divided into two forms: decreasing returns to scale (DRS) and increasing returns to scale (IRS). The decreasing returns to scale (DRS) denotes that the size of the DMU is very large for the volume of its operations (output increases by a smaller proportion than each of the inputs). However, a decision making unit (DMU) exhibiting internal return to scale (IRS) is very small for its volume of activities and operations (output may increase by a larger proportion than each of the inputs). A scale-efficient DMU operates under constant returns to scale (CRS).

The table 2 shows the scores for constant returns to scale technical efficiency, variable returns to scale technical efficiency, scale efficiency, and returns to scale and the efficiency reference set. It was found that around 93 percent of district hospitals have constant returns to scale and only 1 (7 percent) hospital is relatively inefficient i.e., DH Reasi. Of the total district hospitals included in the study, 13 (93 percent) hospitals were found technically efficient with the technical efficiency score 1.00 constituting the best practice frontier. Further, there is not leftover input and output slacks in the case of efficient hospitals and therefore, these hospitals do not need to reduce its input to maximize their output because they are already at the Pareto optimal with the given level of inputs. The other 1 (7 percent) district hospital was technically inefficient with the technical efficiency score of 0.988. This technically inefficient district hospital could, on an average produce 2 percent more outputs by utilizing the current levels of inputs.

Keeping in view the efficiency scores of the selected district hospitals, it was found that Jammu and Kashmir's health sector is doing well and can have a resilience to face any health challenge like COVID-19 situation or any other pandemic.

Table 2: Input Oriented DEA Technical and Scale Efficiency Scores of District Hospitals

Name of Hospitals	Technical and Scale Efficiency Scores			Type of scale inefficiency	Reference set (lamda weights
DH Bandipora	crste	vrste	Scale	crs	
DH Budgam	1.000	1.000	1.000	crs	
DH Ganderbal	1.000	1.000	1.000	crs	
DH Gandhinagar	1.000	1.000	1.000	crs	
Sarwal Hospital	1.000	1.000	1.000	crs	
DH Kishtwar	1.000	1.000	1.000	crs	

DH Kulgam	1.000	1.000	1.000	crs	
DH Poonch	1.000	1.000	1.000	crs	
DH Pulwama	1.000	1.000	1.000	crs	
DH Ramban	1.000	1.000	1.000	crs	
DH Reasi	0.988	1.000	0.988	irs	Peer lamda weight 2.00
DH Samba	1.000	1.000	1.000	crs	
DH Shopian	1.000	1.000	1.000	crs	
DH JLNM Hospital	1.000	1.000	1.000	crs	
Min.	0.98	1	0.98		
Max.	1.000	1	1		
Mean	0.999	1.000	0.999		
SD.	0.01	0	0.01		

Note: crste = technical efficiency from CRS DEA, vrste = technical efficiency from VRS DEA and scale = scale efficiency = crste/vrste.

Scale efficiency:

Thirteen district hospitals have a scale efficiency of 100 percent, meaning they were at the optimal size for their particular input – output mix. The remaining 1 district hospital had a scale efficiency of less than 100 percent and was thus deemed scale inefficient. The average scale efficiency score was around 98 percent and standard deviation 2 percent, meaning that on average, the scale inefficient hospital could increase its size by 2 percent without affecting its current output levels. The district hospital Reasi is scale inefficient with increasing return to scale while as the remaining all 13 other district hospitals of Jammu and Kashmir are scale efficient with constant return to scale.

c) Tobit Regression Results:

One of the objectives in the study as to how the explanatory variables (institutional as well as the environmental factors) effect the efficiency of a hospital and for that we used the Tobit regression model to assess the effect of explanatory variables on the technical efficiency of a hospital. To measure the association between the inefficiency scores and number of explanatory variables we used a Tobit regression model. Since, by definition, the DEA scores range between zero and one, and some of the data tend to concentrate on these boundary values (i.e., censored for the DMUs with a value at one), ordinary least squares cannot estimate the regression. For the convenience of the calculation, we assumed a censoring point at zero in this model. As a result, the efficient DHs will have score zero and the inefficient DHs will have score greater than zero.

Following, this was performed by transforming CRS and VRS technical efficiency scores into CRS and VRS inefficiency scores and left censoring at zero as follows. Inefficiency score = (1/technical efficiency score) – 1. Both CRS and VRS technical inefficiency score were regressed separately to estimate the association between technical efficiency scores and selected institutional and environmental characteristics.

Based on the two-stage hospital efficiency studies, we would expect a positive relationship between hospital inefficiency (Ineff) and ALOS, POP and REGION. Thus, regression coefficients β2, β3 and β4 are expected to assume a positive sign.

We would expect a negative relationship between the Ineff and OPDIPD, and thus, β1 should a priori assume a negative sign. Tobit coefficients indicate how a one unit change in an independent variable x_i alters the latent dependent variable y*. By estimating the general equation of Tobit, we wish to test two hypotheses. First, in order to test the overall significance of the equation, we state the joint null hypothesis as H_0: β1 = β2 = β3 = β4 = 0 and the alternative hypothesis H_A: β1 = β2 = β3 = β4 ≠ 0. The joint null hypothesis is tested using the likelihood ratio test (LL). Second, β_n is not significantly different from zero in either direction. Thus, the null (H_0) and alternative hypotheses (H_A) are: H_0: $\beta_n = 0$; and H_A: $\beta_n \neq 0$. The individual null hypotheses are tested using the t-distribution test.

The table 3 presents the Tobit regression model results. The joint null hypothesis that H0: β1 = β2 = β3 = β4 = 0 is rejected at the 0.05 percent level of significance because the computed Chi-square of 13.57 is greater than the critical Chi-square value of 9.49 for the four degrees of freedom. Therefore, we can conclude that the H_A: β1 = β2 = β3 = β4 ≠ 0, i.e., the regression coefficients for the explanatory variables (OPDIPD, ALOS, POP, REGION) are not equal to zero.

Table 3: The results of Tobit Regression Model

Variables	**Coefficient**	**t-ratios**
OPDIPD	-2.19	-3.14
ALOS	1.89	2.18
POPULATION	0.32	0.93
REGION	0.011	0.79
Constant	-0.942	

Sigma	0.419 13 left centored observations at Ineff ≥ 0 1 uncensored observation	
X^2	13.57	
Prob. > X^2	0.0089	
Pseudo R_2	0.387	

Note: The critical t-value for 15 degrees of freedom and a 0.05% two-tailed level of significance is 2.131 is less than computed t-ratios for OPDIPD and ALOS, so we can reject the null hypothesis of no effect in these cases and conclude that these two values are statistically significant variables in explaining expected hospital inefficiency.

The coefficient for outpatients/inpatient visits (OPDIPD) has a negative sign and is statistically significant at the 0.05 percent level of significance which means a unit increase in the ratio of outpatient department visits to inpatient days would lead to a decrease in hospital expected inefficiency score by 2.19 units, holding all other variables constant in the Tobit regression model. Thus the higher of a hospital's OPDIPD visits, the lower the predicted inefficiency score.

The coefficient for average length of stay(ALOS) assumed a positive sign as expected, and was statistically significant at the 0.05 percent level of significance which indicate that if the average length of stay (ALOS) increases by one day, hospitals' expected inefficiency score would increase by 1.89 units while holding all other explanatory variables constant. Thus, the higher a hospital's average length of stay (ALOS), the higher the predicted inefficiency score which indicate that more stay creates more cost of per patient.

The coefficients for POPULATION and REGION had a positive sign but were statistically insignificant. Therefore, population size of the region where a hospital is situated and the geographical landscape (highland or lowland) do not have a significant effect on the efficiency (inefficiency) level of a hospital. Further, it was also found that more the bed occupancy ratio (BoR), more the ratio of beds to physicians (RoBTP), and ratio of beds to nurse (RoBTN), there will be more efficiency of hospital.

Limitations of the study:

Due to the lack of data, this study did not include the expenditures on pharmaceuticals and non pharmaceutical supplies among the inputs. Nor does the study take into consideration the differences that may exist between the categories of nurses and doctors in the various hospitals. In addition, even within the same health workforce category, the quality of labour input may vary depending on individual health worker's skills, professional experience and health status.

The study was based on secondary data; we have no way of knowing whether there might have been some variations in the severity of cases treated in each district hospital. Significant differences in the severity of cases treated could affect the number of cases hospitals dealt with relative to their staff numbers and bed numbers, and could therefore have an impact on the results of the analysis. The hospitals treating a large number of severe cases, for example, may handle fewer cases, and will thus appear to be relatively inefficient.

Thirdly, a decision making unit (DMU) is allocatively efficient, if it is able to use the inputs in optimal proportions, given their respective costs. As the relevant data on costs of inputs were not available in this study, the allocative efficiency measures were not employed. Hence this is the biggest limitation of this study.

Some of the negative output variables such as number of maternal deaths, number of child deaths, number of surgical deaths, number of trauma deaths, number of inpatient deaths were not used in this study which may have some impact on their efficiency parameters.

Summary and Conclusion:

Health managers or policymakers need information about how well the district hospitals (DHs) in Jammu and Kashmir are utilizing the available resources to improve their performance. Using routinely available data, this study shed light on the efficiency of the district hospitals applying DEA to understand the comparable score across the facilities. The findings of this study provided empirical evidence on the efficiency level of 14 selected public district hospitals in Jammu and Kashmir and associated institutional and environmental factors.

The study found that around 93 percent of district hospitals (13 of 14 in CRS technical efficiency) are statistically efficient while as only one district hospital (1 of 14 in VRS technical efficiency) found to be statistically inefficient. The inefficient district hospital (DH) would need to improve its performance. The higher technical efficiency of district hospitals (DHs) are likely to facilitate better utilization of resources, control the cost of medical services, and consequently to provide more affordable healthcare.

Although, the district hospitals found to be statistically efficient but at times some of the negative indicators like maternal deaths, child deaths, and surgical site infections occur due to medical negligence. Although the study found that population and regional factors have no impact on the

hospital efficiency but it was found that on an average length of stay and outpatient/inpatient visits have impact on the hospital efficiency. Nonetheless, some hard to reach districts of Jammu and Kashmir found to be location sensitive because most of the population resides at far-flung areas due to which the hospital efficiency gets disturbed at times.

Suggestions:

Though the Department of Public Health and Family Welfare of Jammu & Kashmir has significantly improved its Health Management Information System (HMIS) in recent years, the study showed a considerable scope for further improvement in the HMIS portal as relevant data for 6 (30 percent) GMCs were missing due to which it was not possible to compare the technical efficiency of district hospitals with the technical efficiency scores of benchmark of any district hospital.

The policymakers can use the efficiency estimates of this study to promote benchmarking among the district hospitals where inefficient DH/GMC can learn from efficient district hospitals. The MoHFW can set input mix for district hospitals considering different important resource allocation factors (e.g., population density, poverty) to avoid inefficiency. The DHs at having a maximum and minimum level of efficiency should be investigated further to understand how and why the services provision systems are operating differently at these DHs.

There is a need for a Malmquist Total Factor Productivity Index analysis to measure the trends in efficiency and productivity of hospitals over the period of time. This would entail in collecting inputs and outputs data for a number of years, i.e., from 2010 to 2023. Such an analysis would permit comparison of the current status of hospital efficiency with the situation prevailing in 2019 and 2020.

Most of the areas of district Kishtwar such as Marwah, Warwan, Dachhan, Nagseni, and some hard reach areas of Kishtwar block i.e., Padder and Bonjwah remains cut-off during the harsh weather and the internet connectivity of these areas also remains suspended due to which the headquarter is unable to keep information regarding health status. In this regard, these hard to reach areas need air ambulance services' so that the needy could be managed properly.

Reasi, Ramban, Kishtwar and Doda districts are one among those districts where there is acute shortage of doctors. Due to the terrain topography, remoteness, adverse climatic conditions,

accessibility and transportation issues, doctors generally are not willing to serve in these districts. Although, under public pressure, orders for posting of doctors in the health institutions in these districts are issued by the government and some doctors do join their duties but they also either manage to get themselves transferred from the district or prefer to get leave and consequently most of the health institutions including the district hospitals remain without doctors for most part of the year.

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APPENDICES:

Appendix – I: Selected input variables

Name of District Hospitals	No of beds (X1)	No of Doctors(specialists +Medical Offices) (X2)	No of staff Nurses (X3)	No of technicians (X4)
DH Bandipora	100	35	16	16
DH Budgam	70	61	16	20
DH Ganderbal	170	43	52	14
DH Gandhinagar	160	76	86	35
Sarwal Hospital	102	32	8	23
DH Kishtwar	100	29	30	29
DH Kulgam	200	26	71	27
DH Poonch	161	39	73	10
DH Pulwama	200	61	58	31
Ramban	42	25	41	24
DH Reasi	100	22	68	25
DH Samba	100	24	21	24
DH Shopian	100	43	41	24
DH JLNM Hospital	200	67	64	28

Appendix – II: Selected explanatory variables

Population size	Number of catchment population in the district where the hospital is located
Poverty headcount	Proportion of people living below the poverty line in the DHs area
Average length of stay	Average number of days patients spent in a hospital
Ratio of beds to physicians	Total number of beds per physician in a hospital
Ratio of beds to nurses	Total number of beds per nurse in a hospital
OPDIPD	Number of outpatients/inpatients department visits

Appendix – III: Selected Output variables

Name of District Hospitals	No of Pregnant Women received 4 or more ANC check ups	No of Complicated pregnancies treated with Blood Transfusion	No of Institutional Normal Deliveries conducted	Total No of C-Section deliveries performed	No of SNCU discharged babies screened in DEIC	No of anaemic cases treated including school going/out of school, adolescents, pregnant and lactating mothers	No of women receiving Postpartum checkup between 48 hours and 14 days after Institutional delivery	No of Laparoscopic sterilizations (excluding post-abortion) conducted	No of Child immunization - Measles & Rubella (MR)/ Measles containing vaccine (MCV)- 2nd Dose (16-24 months)	No of childhood - Diarrhea treated including ORS and Zinc for 14 days	No of Directly Observed Treatment, Short-course (DOTS) cases completed successfully	No of Allopathic-Outpatient attendance(OPD)	No of Ayush - Outpatient attendance (OPD)	No of Major and Minor Operations conducted excluding C-Section (General and spinal anesthesia)	No of In-Patient Head Count at midnight (IPD)	No of Newborns successfully discharged from SNCU	No of PW and PNC beneficiaries provided - Free Medicines and Diagnostics under JSSK	No of PW and PNC beneficiaries provided - Interfaculty transfers when needed under JSSK	No of PW and PNC beneficiaries provided - Free Drop Back home under JSSK	No of sick infants provided - Free Medicines and Diagnostics under JSSK	No of sick infants provided - Interfaculty transfers when needed under JSSK	No of Lab tests done	No of Radiology tests done including x-rays, USGs, CT Scan and ECGs
	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23
Bandipora	519	3	712	467	148	580	95	0	362	647	77	145435	14119	1512	3593	146	3954	499	1087	173	103	103306	42251
Budgam	1784	311	593	1362	183	0	1955	107	0	189	0	316052	15939	2097	8714	279	3910	216	1441	618	59	132414	42324
Ganderbal	1079	90	553	478	172	35	568	0	361	903	14	246656	10719	2269	3557	94	14693	63	530	311	64	116263	54550
Gandhinagar	6348	134	1019	847	339	75	860	95	578	1775	421	240784	10961	1755	18721	299	11062	254	0	502	34	408541	47556
Sarwal Hospital	4781	41	275	406	0	0	625	59	314	0	0	125398	21378	4337	569	83	749	11	0	0	0	160930	23602
Kishtwar	89	143	2152	918	380	20	2337	258	712	47	0	167802	3098	9835	13785	373	6179	2	2	895	11	132178	25871
Kulgam	78	35	1091	1644	556	0	97	0	167	979	26	373274	25312	1339	9366	402	5858	706	518	1158	126	218170	52930
Poonch	106	144	3473	3714	189	0	3714	21	393	1751	0	206083	7282	5311	39554	1087	21973	273	1528	6974	242	67270	62838
Pulwama	1664	22	319	1458	571	30	1028	20	279	3079	0	621552	13911	3064	22462	201	20601	13	0	193	2	121897	86139
Ramban	151	173	1399	336	0	3192	1594	25	327	3687	238	118942	6146	2717	5955	148	3973	352	22	322	104	150301	22833
Reasi	64	14	1049	207	0	438	875	0	83	65	40	99363	1123	2891	2206	0	4126	353	279	147	0	51722	30691
Samba	935	52	645	436	83	0	1082	7	304	5570	2	158448	5934	8038	3367	73	3401	101	180	160	22	113298	25889
Shopian	315	1	600	894	1550	0	972	3	258	907	12	341192	9040	1872	7298	126	28292	328	14	543	272	116633	53730
JLNM	1283	9	196	1020	287	0	1210	0	310	335	54	269729	2518	13769	22382	283	2431	126	97	3219	6	783395	75232

Appendix – IV: Correlation matrix of output variables

Variables	*Y1*	*Y2*	*Y3*	*Y4*	*Y5*	*Y6*	*Y7*	*Y8*	*Y9*	*Y10*	*Y11*	*Y12*	*Y13*	*Y14*	*Y15*	*Y16*	*Y17*	*Y18*	*Y19*	*Y20*	*Y21*	*Y22*	*Y23*
Y1	1																						
Y2	0.11330	1																					
Y3	-0.3233	0.34802	1																				
Y4	-0.1740	0.25151	0.68048	1																			
Y5	-0.1405	-0.2878	-0.1150	0.14600	1																		
Y6	-0.2202	0.21574	0.11303	-0.2882	0.28267	1																	
Y7	0.22265	0.57085	0.78368	0.68453	-0.0969	0.03595	1																
Y8	0.18648	0.52876	0.31123	0.00638	-0.0509	-0.1177	0.40144	1															
Y9	0.23729	-0.0071	0.38483	0.02502	0.00679	-0.0099	0.22662	0.55750	1														
Y10	0.06269	0.00225	0.02671	-0.0118	-0.0986	0.34249	0.06719	-0.2704	0.06251	1													
Y11	0.54708	0.19509	0.01826	-0.2123	-0.1212	0.43393	-0.1341	0.07490	0.36052	0.19257	1												
Y12	0.01627	-0.0969	0.27207	0.33660	0.54814	-0.3367	-0.1006	-0.1283	-0.2064	0.09949	-0.1823	1											
Y13	0.31878	0.00809	-0.2762	0.11221	0.09227	-0.2057	-0.4304	-0.1224	-0.2811	-0.1546	-0.0934	0.35911	1										
Y14	-0.1256	0.11142	0.07822	0.05618	0.15585	-0.1871	0.34530	0.26103	0.33731	0.02211	-0.2356	-0.1654	-0.5405	1									
Y15	0.00022	0.15815	0.58465	0.85565	0.11303	-0.2154	0.68112	0.08973	0.29311	0.05858	0.06205	0.36006	-0.1944	0.31208	1								
Y16	-0.1441	0.32063	0.82193	0.94858	0.00992	-0.1783	0.75164	0.15303	0.24220	-0.0455	-0.0617	0.09224	-0.0022	0.15599	0.85335	1							
Y17	-0.1290	0.12474	0.25324	0.48939	0.71433	-0.2317	0.26866	-0.1723	0.10783	0.09563	-0.1015	0.53518	-0.0554	-0.2751	0.46707	0.35033	1						
Y18	-0.3175	-0.1274	0.14668	0.12101	0.15564	0.24842	-0.2859	-0.3951	-0.3463	-0.0894	0.20337	-0.0596	0.31579	-0.4950	-0.1113	0.12664	-0.0495	1					
Y19	-0.2636	0.43881	0.40415	0.58130	-0.2288	-0.1542	0.38558	-0.1043	-0.3262	-0.1979	-0.2695	-0.0541	0.19942	-0.2399	0.27640	0.55599	0.05535	0.3206	1				
Y20	0.22448	0.13255	0.70166	0.86603	-0.0298	-0.1681	0.72538	-0.0804	0.12818	-0.0653	-0.1487	-0.0115	-0.2169	0.36374	0.83933	0.90913	0.31183	0.05503	0.498	1			
Y21	0.37629	0.01799	0.45162	0.52645	0.57014	0.07251	0.29337	-0.2839	-0.0715	0.00874	-0.0807	0.07421	0.08650	-0.3369	0.27643	0.49146	0.65817	0.48868	0.397	0.46577	1		
Y22	0.32304	-0.1458	0.30279	-0.0427	0.01476	-0.1103	-0.1233	-0.0473	0.15216	-0.1519	0.33416	0.09778	-0.1516	0.57421	0.29042	0.01957	-0.2484	-0.0857	-0.287	0.20516	-0.274	1	
Y23	0.03258	-0.2478	-0.1011	0.51415	0.39967	0.37915	0.04065	-0.3490	-0.0968	-0.0447	-0.1288	0.79112	0.08351	0.07666	0.64550	0.33939	0.56654	-0.0372	0.127	0.412	0.179	0.385	1

Appendix – V: DEA Results

Appendix – V: DEA Efficiency Results
Results from DEAP Version 2.1
Instruction file = Eg2-ins.txt
Data file = eg2-dta.txt
Input orientated DEA
Scale assumption: VRS
Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-
3	1.000	1.000	1.000	-
4	1.000	1.000	1.000	-
5	1.000	1.000	1.000	-
6	1.000	1.000	1.000	-
7	1.000	1.000	1.000	-
8	1.000	1.000	1.000	-
9	1.000	1.000	1.000	-
10	1.000	1.000	1.000	-
11	0.988	1.000	0.988	irs
12	1.000	1.000	1.000	-
13	1.000	1.000	1.000	-
14	1.000	1.000	1.000	-
mean	0.999	1.000	0.999	

Note: crste = technical efficiency from CRS DEA
vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:									
1-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
2-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
3-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
4-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							

5-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
6-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
7-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
8-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
9-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
10-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
11-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
12-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
13-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
14-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000							
mean:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000									

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3	4
1		0.000	0.000	0.000	0.000
2		0.000	0.000	0.000	0.000
3		0.000	0.000	0.000	0.000
4		0.000	0.000	0.000	0.000
5		0.000	0.000	0.000	0.000
6		0.000	0.000	0.000	0.000
7		0.000	0.000	0.000	0.000
8		0.000	0.000	0.000	0.000
9		0.000	0.000	0.000	0.000
10		0.000	0.000	0.000	0.000
11		0.000	0.000	0.000	0.000
12		0.000	0.000	0.000	0.000
13		0.000	0.000	0.000	0.000

14	0.000	0.000	0.000	0.000
mean:	0.000	0.000	0.000	0.000

SUMMARY OF PEERS:

firm	peers:
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14

SUMMARY OF PEER WEIGHTS: (in same order as above)

firm	peer weights:
1	1.000
2	1.000
3	1.000
4	1.000
5	1.000
6	1.000
7	1.000
8	1.000
9	1.000
10	1.000
11	1.000
12	1.000
13	1.000
14	1.000

PEER COUNT SUMMARY: (i.e., no. times each firm is a peer for another)

firm	peer count:
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0

12 0
13 0
14 0

SUMMARY OF OUTPUT TARGETS:

firm output:

1. 519.000 3.000 712.000 467.000 148.000 580.000 95.000 0.000 362.000 647.000 77.000 145435.000 14119.000 1512.000 3593.000 146.000 3954.000 499.000 1087.000 173.000 103.000 103306.000 42251.000
2. 1784.000 311.000 593.000 1362.000 183.000 0.000 1955.000 107.000 0.000 189.000 0.000 316052.000 15939.000 2097.000 8714.000 279.000 3910.000 216.000 1441.000 618.000 59.000 132414.000 42324.000
3. 1079.000 90.000 553.000 478.000 172.000 35.000 568.000 0.000 361.000 903.000 14.000 246656.000 10719.000 2269.000 3557.000 94.000 14693.000 63.000 530.000 311.000 64.000 116263.000 54550.000
4. 6348.000 134.000 1019.000 847.000 339.000 75.000 860.000 95.000 578.000 1775.000 421.000 240784.000 10961.000 1755.000 18721.000 299.000 11062.000 254.000 0.000 502.000 34.000 408541.000 47556.000
5. 4781.000 41.000 275.000 406.000 0.000 0.000 625.000 59.000 314.000 0.000 0.000 125398.000 21378.000 4337.000 569.000 83.000 749.000 11.000 0.000 0.000 0.000 160930.000 23602.000
6. 89.000 143.000 2152.000 918.000 380.000 20.000 2337.000 258.000 712.000 47.000 0.000 167802.000 3098.000 9835.000 13785.000 373.000 6179.000 2.000 2.000 895.000 11.000 132178.000 25871.000
7. 78.000 35.000 1091.000 1644.000 556.000 0.000 97.000 0.000 167.000 979.000 26.000 373274.000 25312.000 1339.000 9366.000 402.000 5858.000 706.000 518.000 1158.000 126.000 218170.000 52930.000
8. 106.000 144.000 3473.000 3714.000 189.000 0.000 3714.000 21.000 393.000 1751.000 0.000 206083.000 7282.000 5311.000 39554.000 1087.000 21973.000 273.000 1528.000 6974.000 242.000 67270.000 62838.000
9. 1664.000 22.000 319.000 1458.000 571.000 30.000 1028.000 20.000 279.000 3079.000 0.000 621552.000 13911.000 3064.000 22462.000 201.000 20601.000 13.000 0.000 193.000 2.000 121897.000 86139.000
10. 151.000 173.000 1399.000 336.000 0.000 3192.000 1594.000 25.000 327.000 3687.000 238.000 118942.000 6146.000 2717.000 5955.000 148.000 3973.000 352.000 22.000 322.000 104.000 150301.000 22833.000
11. 64.000 14.000 1049.000 207.000 0.000 438.000 875.000 0.000 83.000 65.000 40.000 99363.000 1123.000 2891.000 2206.000 0.000 4126.000 353.000 279.000 147.000 0.000 51722.000 30691.000
12. 935.000 52.000 645.000 436.000 83.000 0.000 1082.000 7.000 304.000 5570.000 2.000 158448.000 5934.000 8038.000 3367.000 73.000 3401.000 101.000 180.000 160.000 22.000 113298.000 25889.000

13. 315.000 1.000 600.000 894.000 1550.000 0.000 972.000 3.000 258.000 907.000 12.000 341192.000 9040.000 1872.000 7298.000 126.000 28292.000 328.000 14.000 543.000 272.000 116633.000 53730.000
14. 1283.000 9.000 196.000 1020.000 287.000 0.000 1210.000 0.000 310.000 335.000 54.000 269729.000 2518.000 13769.000 22382.000 283.000 2431.000 126.000 97.000 3219.000 6.000 783395.000 75232.000

SUMMARY OF INPUT TARGETS:

firm	input: 1	2	3	4
1	100.000	35.000	16.000	16.000
2	70.000	61.000	16.000	20.000
3	170.000	43.000	52.000	14.000
4	160.000	76.000	86.000	35.000
5	102.000	32.000	8.000	23.000
6	100.000	29.000	30.000	29.000
7	200.000	26.000	71.000	27.000
8	161.000	39.000	73.000	10.000
9	200.000	61.000	58.000	31.000
10	42.000	25.000	41.000	24.000
11	100.000	22.000	68.000	25.000
12	100.000	24.000	21.000	24.000
13	100.000	43.000	41.000	24.000
14	200.000	67.000	64.000	28.000

FIRM BY FIRM RESULTS:

Results for firm: 1
Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	519.000	0.000	0.000	519.000
output	2	3.000	0.000	0.000	3.000
output	3	712.000	0.000	0.000	712.000
output	4	467.000	0.000	0.000	467.000
output	5	148.000	0.000	0.000	148.000
output	6	580.000	0.000	0.000	580.000
output	7	95.000	0.000	0.000	95.000
output	8	0.000	0.000	0.000	0.000
output	9	362.000	0.000	0.000	362.000
output	10	647.000	0.000	0.000	647.000
output	11	77.000	0.000	0.000	77.000
output	12	145435.000	0.000	0.000	145435.000
output	13	14119.000	0.000	0.000	14119.000
output	14	1512.000	0.000	0.000	1512.000
output	15	3593.000	0.000	0.000	3593.000
output	16	146.000	0.000	0.000	146.000
output	17	3954.000	0.000	0.000	3954.000
output	18	499.000	0.000	0.000	499.000
output	19	1087.000	0.000	0.000	1087.000

output	20	173.000	0.000	0.000	173.000
output	21	103.000	0.000	0.000	103.000
output	22	103306.000	0.000	0.000	103306.000
output	23	42251.000	0.000	0.000	42251.000
input	1	100.000	0.000	0.000	100.000
input	2	35.000	0.000	0.000	35.000
input	3	16.000	0.000	0.000	16.000
input	4	16.000	0.000	0.000	16.000

LISTING OF PEERS:

peer	lambda weight
1	1.000

Results for firm: 2
Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	1784.000	0.000	0.000	1784.000
output	2	311.000	0.000	0.000	311.000
output	3	593.000	0.000	0.000	593.000
output	4	1362.000	0.000	0.000	1362.000
output	5	183.000	0.000	0.000	183.000
output	6	0.000	0.000	0.000	0.000
output	7	1955.000	0.000	0.000	1955.000
output	8	107.000	0.000	0.000	107.000
output	9	0.000	0.000	0.000	0.000
output	10	189.000	0.000	0.000	189.000
output	11	0.000	0.000	0.000	0.000
output	12	316052.000	0.000	0.000	316052.000
output	13	15939.000	0.000	0.000	15939.000
output	14	2097.000	0.000	0.000	2097.000
output	15	8714.000	0.000	0.000	8714.000
output	16	279.000	0.000	0.000	279.000
output	17	3910.000	0.000	0.000	3910.000
output	18	216.000	0.000	0.000	216.000
output	19	1441.000	0.000	0.000	1441.000
output	20	618.000	0.000	0.000	618.000
output	21	59.000	0.000	0.000	59.000
output	22	132414.000	0.000	0.000	132414.000
output	23	42324.000	0.000	0.000	42324.000
input	1	70.000	0.000	0.000	70.000
input	2	61.000	0.000	0.000	61.000
input	3	16.000	0.000	0.000	16.000
input	4	20.000	0.000	0.000	20.000

LISTING OF PEERS:

peer	lambda weight
2	1.000

Results for firm: 3

Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	1079.000	0.000	0.000	1079.000
output	2	90.000	0.000	0.000	90.000
output	3	553.000	0.000	0.000	553.000
output	4	478.000	0.000	0.000	478.000
output	5	172.000	0.000	0.000	172.000
output	6	35.000	0.000	0.000	35.000
output	7	568.000	0.000	0.000	568.000
output	8	0.000	0.000	0.000	0.000
output	9	361.000	0.000	0.000	361.000
output	10	903.000	0.000	0.000	903.000
output	11	14.000	0.000	0.000	14.000
output	12	246656.000	0.000	0.000	246656.000
output	13	10719.000	0.000	0.000	10719.000
output	14	2269.000	0.000	0.000	2269.000
output	15	3557.000	0.000	0.000	3557.000
output	16	94.000	0.000	0.000	94.000
output	17	14693.000	0.000	0.000	14693.000
output	18	63.000	0.000	0.000	63.000
output	19	530.000	0.000	0.000	530.000
output	20	311.000	0.000	0.000	311.000
output	21	64.000	0.000	0.000	64.000
output	22	116263.000	0.000	0.000	116263.000
output	23	54550.000	0.000	0.000	54550.000
input	1	170.000	0.000	0.000	170.000
input	2	43.000	0.000	0.000	43.000
input	3	52.000	0.000	0.000	52.000
input	4	14.000	0.000	0.000	14.000

LISTING OF PEERS:

peer	lambda weight
3	1.000

Results for firm: 4
Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	6348.000	0.000	0.000	6348.000
output	2	134.000	0.000	0.000	134.000
output	3	1019.000	0.000	0.000	1019.000
output	4	847.000	0.000	0.000	847.000
output	5	339.000	0.000	0.000	339.000
output	6	75.000	0.000	0.000	75.000
output	7	860.000	0.000	0.000	860.000
output	8	95.000	0.000	0.000	95.000
output	9	578.000	0.000	0.000	578.000

output	10	1775.000	0.000	0.000	1775.000
output	11	421.000	0.000	0.000	421.000
output	12	240784.000	0.000	0.000	240784.000
output	13	10961.000	0.000	0.000	10961.000
output	14	1755.000	0.000	0.000	1755.000
output	15	18721.000	0.000	0.000	18721.000
output	16	299.000	0.000	0.000	299.000
output	17	11062.000	0.000	0.000	11062.000
output	18	254.000	0.000	0.000	254.000
output	19	0.000	0.000	0.000	0.000
output	20	502.000	0.000	0.000	502.000
output	21	34.000	0.000	0.000	34.000
output	22	408541.000	0.000	0.000	408541.000
output	23	47556.000	0.000	0.000	47556.000
input	1	160.000	0.000	0.000	160.000
input	2	76.000	0.000	0.000	76.000
input	3	86.000	0.000	0.000	86.000
input	4	35.000	0.000	0.000	35.000

LISTING OF PEERS:

peer	lambda weight
4	1.000

Results for firm: 5

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	4781.000	0.000	0.000	4781.000
output	2	41.000	0.000	0.000	41.000
output	3	275.000	0.000	0.000	275.000
output	4	406.000	0.000	0.000	406.000
output	5	0.000	0.000	0.000	0.000
output	6	0.000	0.000	0.000	0.000
output	7	625.000	0.000	0.000	625.000
output	8	59.000	0.000	0.000	59.000
output	9	314.000	0.000	0.000	314.000
output	10	0.000	0.000	0.000	0.000
output	11	0.000	0.000	0.000	0.000
output	12	125398.000	0.000	0.000	125398.000
output	13	21378.000	0.000	0.000	21378.000
output	14	4337.000	0.000	0.000	4337.000
output	15	569.000	0.000	0.000	569.000
output	16	83.000	0.000	0.000	83.000
output	17	749.000	0.000	0.000	749.000
output	18	11.000	0.000	0.000	11.000
output	19	0.000	0.000	0.000	0.000
output	20	0.000	0.000	0.000	0.000
output	21	0.000	0.000	0.000	0.000
output	22	160930.000	0.000	0.000	160930.000
output	23	23602.000	0.000	0.000	23602.000

input	1	102.000	0.000	0.000	102.000
input	2	32.000	0.000	0.000	32.000
input	3	8.000	0.000	0.000	8.000
input	4	23.000	0.000	0.000	23.000

LISTING OF PEERS:

peer	lambda weight
5	1.000

Results for firm: 6

Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	89.000	0.000	0.000	89.000
output	2	143.000	0.000	0.000	143.000
output	3	2152.000	0.000	0.000	2152.000
output	4	918.000	0.000	0.000	918.000
output	5	380.000	0.000	0.000	380.000
output	6	20.000	0.000	0.000	20.000
output	7	2337.000	0.000	0.000	2337.000
output	8	258.000	0.000	0.000	258.000
output	9	712.000	0.000	0.000	712.000
output	10	47.000	0.000	0.000	47.000
output	11	0.000	0.000	0.000	0.000
output	12	167802.000	0.000	0.000	167802.000
output	13	3098.000	0.000	0.000	3098.000
output	14	9835.000	0.000	0.000	9835.000
output	15	13785.000	0.000	0.000	13785.000
output	16	373.000	0.000	0.000	373.000
output	17	6179.000	0.000	0.000	6179.000
output	18	2.000	0.000	0.000	2.000
output	19	2.000	0.000	0.000	2.000
output	20	895.000	0.000	0.000	895.000
output	21	11.000	0.000	0.000	11.000
output	22	132178.000	0.000	0.000	132178.000
output	23	25871.000	0.000	0.000	25871.000
input	1	100.000	0.000	0.000	100.000
input	2	29.000	0.000	0.000	29.000
input	3	30.000	0.000	0.000	30.000
input	4	29.000	0.000	0.000	29.000

LISTING OF PEERS:

peer	lambda weight
6	1.000

Results for firm: 7

Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value

output	1	78.000	0.000	0.000	78.000
output	2	35.000	0.000	0.000	35.000
output	3	1091.000	0.000	0.000	1091.000
output	4	1644.000	0.000	0.000	1644.000
output	5	556.000	0.000	0.000	556.000
output	6	0.000	0.000	0.000	0.000
output	7	97.000	0.000	0.000	97.000
output	8	0.000	0.000	0.000	0.000
output	9	167.000	0.000	0.000	167.000
output	10	979.000	0.000	0.000	979.000
output	11	26.000	0.000	0.000	26.000
output	12	373274.000	0.000	0.000	373274.000
output	13	25312.000	0.000	0.000	25312.000
output	14	1339.000	0.000	0.000	1339.000
output	15	9366.000	0.000	0.000	9366.000
output	16	402.000	0.000	0.000	402.000
output	17	5858.000	0.000	0.000	5858.000
output	18	706.000	0.000	0.000	706.000
output	19	518.000	0.000	0.000	518.000
output	20	1158.000	0.000	0.000	1158.000
output	21	126.000	0.000	0.000	126.000
output	22	218170.000	0.000	0.000	218170.000
output	23	52930.000	0.000	0.000	52930.000
input	1	200.000	0.000	0.000	200.000
input	2	26.000	0.000	0.000	26.000
input	3	71.000	0.000	0.000	71.000
input	4	27.000	0.000	0.000	27.000

LISTING OF PEERS:

peer	lambda weight
7	1.000

Results for firm: 8

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	106.000	0.000	0.000	106.000
output	2	144.000	0.000	0.000	144.000
output	3	3473.000	0.000	0.000	3473.000
output	4	3714.000	0.000	0.000	3714.000
output	5	189.000	0.000	0.000	189.000
output	6	0.000	0.000	0.000	0.000
output	7	3714.000	0.000	0.000	3714.000
output	8	21.000	0.000	0.000	21.000
output	9	393.000	0.000	0.000	393.000
output	10	1751.000	0.000	0.000	1751.000
output	11	0.000	0.000	0.000	0.000
output	12	206083.000	0.000	0.000	206083.000
output	13	7282.000	0.000	0.000	7282.000
output	14	5311.000	0.000	0.000	5311.000

output	15	39554.000	0.000	0.000	39554.000
output	16	1087.000	0.000	0.000	1087.000
output	17	21973.000	0.000	0.000	21973.000
output	18	273.000	0.000	0.000	273.000
output	19	1528.000	0.000	0.000	1528.000
output	20	6974.000	0.000	0.000	6974.000
output	21	242.000	0.000	0.000	242.000
output	22	67270.000	0.000	0.000	67270.000
output	23	62838.000	0.000	0.000	62838.000
input	1	161.000	0.000	0.000	161.000
input	2	39.000	0.000	0.000	39.000
input	3	73.000	0.000	0.000	73.000
input	4	10.000	0.000	0.000	10.000

LISTING OF PEERS:

peer	lambda weight
8	1.000

Results for firm: 9

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	1664.000	0.000	0.000	1664.000
output	2	22.000	0.000	0.000	22.000
output	3	319.000	0.000	0.000	319.000
output	4	1458.000	0.000	0.000	1458.000
output	5	571.000	0.000	0.000	571.000
output	6	30.000	0.000	0.000	30.000
output	7	1028.000	0.000	0.000	1028.000
output	8	20.000	0.000	0.000	20.000
output	9	279.000	0.000	0.000	279.000
output	10	3079.000	0.000	0.000	3079.000
output	11	0.000	0.000	0.000	0.000
output	12	621552.000	0.000	0.000	621552.000
output	13	13911.000	0.000	0.000	13911.000
output	14	3064.000	0.000	0.000	3064.000
output	15	22462.000	0.000	0.000	22462.000
output	16	201.000	0.000	0.000	201.000
output	17	20601.000	0.000	0.000	20601.000
output	18	13.000	0.000	0.000	13.000
output	19	0.000	0.000	0.000	0.000
output	20	193.000	0.000	0.000	193.000
output	21	2.000	0.000	0.000	2.000
output	22	121897.000	0.000	0.000	121897.000
output	23	86139.000	0.000	0.000	86139.000
input	1	200.000	0.000	0.000	200.000
input	2	61.000	0.000	0.000	61.000
input	3	58.000	0.000	0.000	58.000
input	4	31.000	0.000	0.000	31.000

LISTING OF PEERS:

peer lambda weight
9 1.000

Results for firm: 10

Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	151.000	0.000	0.000	151.000
output	2	173.000	0.000	0.000	173.000
output	3	1399.000	0.000	0.000	1399.000
output	4	336.000	0.000	0.000	336.000
output	5	0.000	0.000	0.000	0.000
output	6	3192.000	0.000	0.000	3192.000
output	7	1594.000	0.000	0.000	1594.000
output	8	25.000	0.000	0.000	25.000
output	9	327.000	0.000	0.000	327.000
output	10	3687.000	0.000	0.000	3687.000
output	11	238.000	0.000	0.000	238.000
output	12	118942.000	0.000	0.000	118942.000
output	13	6146.000	0.000	0.000	6146.000
output	14	2717.000	0.000	0.000	2717.000
output	15	5955.000	0.000	0.000	5955.000
output	16	148.000	0.000	0.000	148.000
output	17	3973.000	0.000	0.000	3973.000
output	18	352.000	0.000	0.000	352.000
output	19	22.000	0.000	0.000	22.000
output	20	322.000	0.000	0.000	322.000
output	21	104.000	0.000	0.000	104.000
output	22	150301.000	0.000	0.000	150301.000
output	23	22833.000	0.000	0.000	22833.000
input	1	42.000	0.000	0.000	42.000
input	2	25.000	0.000	0.000	25.000
input	3	41.000	0.000	0.000	41.000
input	4	24.000	0.000	0.000	24.000

LISTING OF PEERS:
peer lambda weight
10 1.000

Results for firm: 11

Technical efficiency = 1.000
Scale efficiency = 0.988 (irs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	64.000	0.000	0.000	64.000
output	2	14.000	0.000	0.000	14.000
output	3	1049.000	0.000	0.000	1049.000
output	4	207.000	0.000	0.000	207.000
output	5	0.000	0.000	0.000	0.000

output	6	438.000	0.000	0.000	438.000
output	7	875.000	0.000	0.000	875.000
output	8	0.000	0.000	0.000	0.000
output	9	83.000	0.000	0.000	83.000
output	10	65.000	0.000	0.000	65.000
output	11	40.000	0.000	0.000	40.000
output	12	99363.000	0.000	0.000	99363.000
output	13	1123.000	0.000	0.000	1123.000
output	14	2891.000	0.000	0.000	2891.000
output	15	2206.000	0.000	0.000	2206.000
output	16	0.000	0.000	0.000	0.000
output	17	4126.000	0.000	0.000	4126.000
output	18	353.000	0.000	0.000	353.000
output	19	279.000	0.000	0.000	279.000
output	20	147.000	0.000	0.000	147.000
output	21	0.000	0.000	0.000	0.000
output	22	51722.000	0.000	0.000	51722.000
output	23	30691.000	0.000	0.000	30691.000
input	1	100.000	0.000	0.000	100.000
input	2	22.000	0.000	0.000	22.000
input	3	68.000	0.000	0.000	68.000
input	4	25.000	0.000	0.000	25.000

LISTING OF PEERS:

peer	lambda weight
11	1.000

Results for firm: 12

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	935.000	0.000	0.000	935.000
output	2	52.000	0.000	0.000	52.000
output	3	645.000	0.000	0.000	645.000
output	4	436.000	0.000	0.000	436.000
output	5	83.000	0.000	0.000	83.000
output	6	0.000	0.000	0.000	0.000
output	7	1082.000	0.000	0.000	1082.000
output	8	7.000	0.000	0.000	7.000
output	9	304.000	0.000	0.000	304.000
output	10	5570.000	0.000	0.000	5570.000
output	11	2.000	0.000	0.000	2.000
output	12	158448.000	0.000	0.000	158448.000
output	13	5934.000	0.000	0.000	5934.000
output	14	8038.000	0.000	0.000	8038.000
output	15	3367.000	0.000	0.000	3367.000
output	16	73.000	0.000	0.000	73.000
output	17	3401.000	0.000	0.000	3401.000
output	18	101.000	0.000	0.000	101.000
output	19	180.000	0.000	0.000	180.000

output	20	160.000	0.000	0.000	160.000
output	21	22.000	0.000	0.000	22.000
output	22	113298.000	0.000	0.000	113298.000
output	23	25889.000	0.000	0.000	25889.000
input	1	100.000	0.000	0.000	100.000
input	2	24.000	0.000	0.000	24.000
input	3	21.000	0.000	0.000	21.000
input	4	24.000	0.000	0.000	24.000

LISTING OF PEERS:

peer	lambda weight
12	1.000

Results for firm: 13

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	315.000	0.000	0.000	315.000
output	2	1.000	0.000	0.000	1.000
output	3	600.000	0.000	0.000	600.000
output	4	894.000	0.000	0.000	894.000
output	5	1550.000	0.000	0.000	1550.000
output	6	0.000	0.000	0.000	0.000
output	7	972.000	0.000	0.000	972.000
output	8	3.000	0.000	0.000	3.000
output	9	258.000	0.000	0.000	258.000
output	10	907.000	0.000	0.000	907.000
output	11	12.000	0.000	0.000	12.000
output	12	341192.000	0.000	0.000	341192.000
output	13	9040.000	0.000	0.000	9040.000
output	14	1872.000	0.000	0.000	1872.000
output	15	7298.000	0.000	0.000	7298.000
output	16	126.000	0.000	0.000	126.000
output	17	28292.000	0.000	0.000	28292.000
output	18	328.000	0.000	0.000	328.000
output	19	14.000	0.000	0.000	14.000
output	20	543.000	0.000	0.000	543.000
output	21	272.000	0.000	0.000	272.000
output	22	116633.000	0.000	0.000	116633.000
output	23	53730.000	0.000	0.000	53730.000
input	1	100.000	0.000	0.000	100.000
input	2	43.000	0.000	0.000	43.000
input	3	41.000	0.000	0.000	41.000
input	4	24.000	0.000	0.000	24.000

LISTING OF PEERS:

peer	lambda weight
13	1.000

Results for firm: 14

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	1283.000	0.000	0.000	1283.000
output	2	9.000	0.000	0.000	9.000
output	3	196.000	0.000	0.000	196.000
output	4	1020.000	0.000	0.000	1020.000
output	5	287.000	0.000	0.000	287.000
output	6	0.000	0.000	0.000	0.000
output	7	1210.000	0.000	0.000	1210.000
output	8	0.000	0.000	0.000	0.000
output	9	310.000	0.000	0.000	310.000
output	10	335.000	0.000	0.000	335.000
output	11	54.000	0.000	0.000	54.000
output	12	269729.000	0.000	0.000	269729.000
output	13	2518.000	0.000	0.000	2518.000
output	14	13769.000	0.000	0.000	13769.000
output	15	22382.000	0.000	0.000	22382.000
output	16	283.000	0.000	0.000	283.000
output	17	2431.000	0.000	0.000	2431.000
output	18	126.000	0.000	0.000	126.000
output	19	97.000	0.000	0.000	97.000
output	20	3219.000	0.000	0.000	3219.000
output	21	6.000	0.000	0.000	6.000
output	22	783395.000	0.000	0.000	783395.000
output	23	75232.000	0.000	0.000	75232.000
input	1	200.000	0.000	0.000	200.000
input	2	67.000	0.000	0.000	67.000
input	3	64.000	0.000	0.000	64.000
input	4	28.000	0.000	0.000	28.000

LISTING OF PEERS:

peer	lambda weight
14	1.000