Chapter-7

Multistage Method of Measuring Human Development

7.1 Introduction:

Traditionally, well being of the nation has been measured by economic attainment through per capita income or per capita gross domestic product or per capita consumption expenditure. In the last two decades it is recognized that those conventional measures of well being do not capture broader aspects of human activity. It is also important to note that high economic growth does not automatically translate into betterment of lives in societies. Attempt to consider a different aspect of the life was made in 1990 with United Nations Development Program (UNDP) (1990), introducing the Human Development Index (HDI) to measure human development. The United Nations (UN) has been publishing HDI annually from the year 1990 in its Human Development Report (HDR) of its member countries. UNDP's human development framework exists on three dimensions of well being. They are related to specific socio-economic indicators that reflect three major dimension of human development. They are: i) Longevity, ability to live long and healthy life. ii) Knowledge, ability to read, write and acquire knowledge. iii) Command over resources, ability to enjoy a decent standard of living and have a socially meaningful life.

Since its establishment, the HDI has met with considerable criticism from many quarters for various aspects it takes in computing HDI. From the literature, mainly two types of criticism can be identified. The first addresses the choice of indicators that HDI contains. Dasgupta (2001) views that countries stock of physical, human and national capitals were omitted from the measurement. As a consequence, the results can lead to an improper assessment of HDI. The second branch of literature addresses methodological issues. Several alternative computation approaches have been suggested. Noorbakash (1998) suggested a modified HDI. This modification measures the improvements in human development over a time for a country relative to transformation in the rest of the world. Sagar and Najam (1998) suggested that multi dimensional indices that comprise the HDI must be multiplied instead of being arithmetically averaged. These discussions on HDI lead to the use of data envelopment analysis (DEA) to re-measure the HDI.

Mahlberg and Obersteiner (2001) first proposed the use of DEA approach to compute the HDI and to benchmark this against the best practices of countries. Despotis (2004) reassessed the HDI by introducing the transformation paradigm. This approach takes GDP per capita as the input variable and other variables of HDI as outputs. Results of this approach can not be compared with HDI since increased income in transforming approach lead to increased longevity and education. Despotis (2005) applied this approach to measure the human development of Asia Pacific countries. This measure is obtained in two phase process. All the assumptions underlying the HDI are kept except that of the equal weights scheme for the three major indicators. In the first stage, an ideal value of the composite HDI is estimated for each country. In the second stage, a goal programming model is solved to obtain global estimates of human development based on the optimal common weights of the component indicators. Noorbakash (2002), proposed a method and model for the systematic reduction of regional disparities in Iran. Dejian (2003) studied the state of human development in various provinces applying principal component analysis for China. Recently Lozano and Gutierrez (2008) applied range adjusted measure (RAM) of DEA model to measure HDI for the years 2000 to 2004. The study shows that efficiency scores computed by this approach is always higher than the HDI and is highly correlated with HDI.

The concept and measurement of HDI has been in existence for nearly twenty years. The need for measuring and monitoring HDI for the countries/states is widely recognized all over the world. It is seeding scope for improvement on human development for the future. In India, the first national human development report (NHDR)-2001 (2002) was brought out by planning commission of India. The report brings to light inter state disparities and variations in HDI for major states of India. It also shows that there is a significant overall improvement in human development since 1980 but interstate differences are alarmingly high and probably increasing in some states. It is the major concern of developing countries at large and India in particular. This regional disparity may gradually lead to the polarization of the states. Hence it is a threat to the unity, integrity, stability and development of the nation.

The method proposed in this chapter to measure human development is an alternative procedure and it is a relative measure of socioeconomic development of different states. Study has focused mainly on equality aspect of development of different states with efficiency. Allocation of resources to improve human development alone is not enough. It is equally important to use them efficiently and effectively by all states. Unlike other methods, this analysis shows the way for improvement in human development of the states using available resources optimally through benchmarking procedures. This benchmarking practice starts with identification of peers, which exemplify the best practice in some activity and also set for benchmarking goals for poor human development states. Here, directional distance formulation of DEA model is used and it allows to assessing each state under best possible way relative to other states in the ideal direction. This study will identify best practice states in the country and they are benchmarked on the basis of empirical observations. The proposed method of efficiency measurement takes optimum combination of different indicators in the proportion of original HDI. The weighted combinations of peers and the peers themselves may provide benchmarks for relatively less efficient states and provides achievable goals (more details are given in the section-7.2).

Advantage of directional distance function is that it allows the evaluation of the degree of efficiency in any direction from the observation points. Hence it is possible to measure the efficiency in different direction by changing the value of direction vectors. Here we consider the direction vector as range of possible improvement as defined in Portela *et al.* (2004). The dual problem of this model gives the economic interpretation as virtual profit maximization / cost minimization problem. Here, we estimate the relative efficiency of different states of India to improve human development by utilizing income. Human development is benchmarked on the basis of empirical observations of best practice states. A new estimation of the measure of HDI is made under the same assumptions as that of the original HDI in a multistage process. A set of states appear as efficient in this method of measuring efficiency. Further, the efficient states are discriminated by single average DMU based on the method developed by Shetty and Pakkala (2010a) as discussed in Chapter 5. The method suggested in this chapter will help for systematic reduction of regional disparities among the states. It shows the ways for improvement for poor performing states and to operate as par with the developed states. The proposed approach differs from the previous DEA approaches to assess human development in several ways. The measurement of human development through directional distance formulation of DEA is depending upon the directional vector and production feasibility set. Here, the directional vectors are as defined in $\langle E\ 7.1\rangle$. This depends on the ideal state (imaginary) that one uses minimum input and maximum output among all the DMUs in the set. The measure of efficiency is non-proportional;

hence at the optimal solution it projects inefficient states to Pareto-Koopmans efficient as shown in $\langle E\ 7.2\rangle$.

7.2 Proposed model:

Development programs have been carried out in India through five year plans. This will improve the quality of life and thereby enhancing well being of the society. There is a significant overall improvement in human development over a period of time but there is no indication of reduced regional differences. United Nations method of HDI construction combines three component indicators with equal weights. Often it came across criticism from different quarters. It does not take into account variability in indicator values. Our measure of human development takes into account of variability in optimum combination of the three major socio-economic indicators in the proportion of original HDI. This optimum combination is derived on best possible light relative to remaining states under study.

Application of efficiency measurement through conventional DEA models like CCR, BCC and slack based model (SBM) assumes that both inputs and outputs are nonnegative. The efficiency of decision making units (DMUs) is judged by how much more output can be produced by a given unit of inputs. So, one wishes to maximise the outputs and to minimise the inputs. Here in this study, we have taken life expectancy at birth (LEB), literacy rate (LR) and gross enrollment ratio (GER) as the outputs and per capita gross state domestic product (PCGSDP) as the single input. It is desirable to maximise both input and outputs of human development of different states like in the case of efficiency measurements.

In order to estimate the efficiency of a state, we modify an improved efficiency measure through directional distance formulation of DEA model. Here, the model allows individual outputs to increase or inputs to decrease at different rates. This model assumes variable returns to scale (VRS) technology which allows the scale effects in the efficiency measurement. The model projects each inefficient state on a target vector that has better performance on all component indicators. These projected values lie on the efficient frontier in the direction of ideal DMU.

Unlike using three component indices as outputs and unit input in Mahalberg and Obersteiner (2001) and Despotis (2004,2005), we consider LEB, LR, GER as the outputs of the weight 1/3, 2/9, 1/9 respectively and PCGSDP as the negative input of the weight 1/3 in the measure of efficiency. These weights are taken based on the HDR as in UNDP (2006). The proposed method of efficiency measurements takes optimum combination of the LEB, LR, GER and PCGSDP in the proportion of 1/3, 2/9, 1/9 and 1/3 respectively.

Let 'n' be the number of states $j=1,2,...,n$, and for each j,

LEB_j : Life expectancy at birth for the state j

LR_j: Literacy rate for state j

GER_j: Gross enrollment ratio for the state j

$PCGSDP_j$: Logarithm of the per capita GSDP for *PPS$* for state j

The directional vectors in the model are

$$\left.\begin{aligned} R_{LEB_o} &= \underset{j}{Max}\{LEB\} - LEB_o \\ R_{LR_o} &= \underset{j}{Max}\{LR\} - LR_o \\ R_{GER_o} &= \underset{j}{Max}\{GER\} - GER_o \\ R_{PCGSDP_o} &= PCGSDP_o - \underset{j}{Min}\{PCGSDP_o\} \end{aligned}\right\} \quad \langle E\ 7.1\rangle$$

In order to estimate the human development of state '$State_0$', we modify the improved efficiency measure through directional distance formulation of DEA–minimization model developed in the Chapter-3, model $\langle$M 3.1$\rangle$. The work discussed in this chapter has been accepted for publication (see Shetty and Pakkala (2010c)).

$$\left.\begin{aligned}
&Min\ S(x_o, y_o) = \eta = \frac{1 - 0.3333\beta_{PCGSDP_o}}{1 + (0.3333\beta_{LEB_o} + 0.2222\beta_{LR_o} + 0.1112\beta_{GER_o})} && (7.1a)\\
&subject\ to\ \sum_{j=1}^{n} \lambda_j LEB_j - \beta_{LEB_o} R_{LEB_o} \geq LEB_o && (7.1b)\\
&\sum_{j=1}^{n} \lambda_j LR_j - \beta_{LR_o} R_{LR_o} \geq LR_o && (7.1c)\\
&\sum_{j=1}^{n} \lambda_j GER_j - \beta_{GER_o} R_{GER_o} \geq GER_o && (7.1d)\\
&\sum_{j=1}^{n} \lambda_j PCGSDP_j + \beta_{PCGSDP_o} R_{PCGSDP_o} \leq PCGSDP_o && (7.1e)\\
&\sum_{j=1}^{n} \lambda_j = 1 && (7.1d)\\
&\lambda_j \geq 0,\ j = 1,2,\cdots,n && (7.1e)\\
&\beta_{LEB_o}, \beta_{LR_o}, \beta_{GER_o}, \beta_{PCGSDP_o} \text{ are unrestricted.} && (7.1f)
\end{aligned}\right\} \quad \langle \text{M } 7.1\rangle$$

In the numerator of equation (7.1a) β_{PCGSDP_o} is the relative reduction rate in $PCGSDP$, 0.3333 β_{PCGSDP_o} is the weighted reduction of the input or it is the input inefficiency and $(1-0.3333\beta_{PCGSDP_o})$ is the efficiency of PCGSDP. $\beta_{LEB_o}, \beta_{LR_o}, \beta_{GER_o}$ in denominator evaluates the expansion of outputs LEB, LR and GER respectively and $(0.3333\beta_{LEB_o} + 0.2222\beta_{LR_o} + 0.1112\beta_{GER_o})$ is the possible weighted mean expansion of outputs and the inverse $\frac{1}{\{1+(0.3333\beta_{LEB_o} + 0.2222\beta_{LR_o} + 0.1112\beta_{GER_o})\}}$ measures the output efficiency. So 'η ' is the product of input and output efficiencies. It measures maximum non-radial contraction of input and expansion of the outputs in consistent with technical feasibility in the direction of ideal DMU. Efficiency score of $\langle M_1 \rangle$ lies between zero and one. A state is said to be Pareto-Koopmans efficient if $\eta^* = 1$. This is equivalent to all $\beta_{LEB_o}, \beta_{LR_o}, \beta_{GER_o}, \beta_{PCGSDPo}$ equal to zero. This implies that there is no excess input and output shortfalls in the optimal solution relative to other states.

Applying the Charnes–Cooper transformation to fractional programming of $\langle M\ 7.1 \rangle$, it can be converted into linear programming as in Tone (2001). It measures maximum non-radial contraction of inputs and expansion of the outputs consistent with technical feasibility in the direction of ideal DMU.

$$
\left.
\begin{array}{ll}
 & Min\ \tau = t - 0.3333 B_{PCGSDP_o} \\
subject\ to & t + (0.3333 B_{LEB_o} + 0.2222 B_{LR_o} + 0.1112 B_{GER_o}) = 1 \\
 & \sum_{j=1}^{n} \Lambda_j LEB_j - B_{LEB_o} R_{LEB_o} \geq tLEB_o \\
 & \sum_{j=1}^{n} \Lambda_j LR_j - B_{LR_o} R_{LR_o} \geq tLR_o \\
 & \sum_{j=1}^{n} \Lambda_j GER_j - B_{GER_o} R_{GER_o} \geq tGER_o \\
 & \sum_{j=1}^{n} \Lambda_j PCGSDP_j + B_{PCGSDP_o} R_{PCGSDP_o} \leq tPCGSDP_o \\
 & \sum_{j=1}^{n} \Lambda_j = t \\
 & \Lambda_j \geq 0,\ j = 1,2,\cdots,n \\
 & B_{LEB_o}, B_{LR_o}, B_{GER_o}, B_{PCGSDP_o} \text{ are unrestricted.}
\end{array}
\right\} \quad \langle M\ 7.2 \rangle
$$

Let the optimal solution for $\langle M_2 \rangle$ be $(\tau^*, t^*, \Lambda^*, B^*_{LEB_o}, B^*_{LR_o}, B^*_{GER_o}, B^*_{PCGSDP_o})$, then we have the optimal solution of $\langle M_1 \rangle$ defined as

$$\left(\eta^* = \tau^*, \lambda^* = \Lambda^* / t^*, \beta^*_{LEB_o} = B^*_{LEB_o} / t^*, \beta^*_{LR_o} = B^*_{LR_o} / t^*, \beta^*_{GER_o} = B^*_{GER_o} / t^*, \beta^*_{PCGSDP_o} = B^*_{PCGSDP_o} / t^*\right).$$

Based on the optimal solution, we can determine the efficiency of the DMUs. A DMU_o is Pareto-Koopmans efficient if $\eta^* = 1$ otherwise it is inefficient. Pareto-Koopmans efficient input-output projection for an inefficient DMU_o for $\langle M\ 7.1 \rangle$ is

$$\left.\begin{aligned}
LEB_o^* &= (LEB_o + \beta^*_{LEB_o}\ R_{LEB_o}) = \sum_{j=1}^{n} \lambda_j^* LEB_j \\
LR_o^* &= (LR_o + \beta^*_{LR_o}\ R_{LR_o}) = \sum_{j=1}^{n} \lambda_j^* LR_j \\
GER_o^* &= (GER_o + \beta^*_{GER_o}\ R_{GER_o}) = \sum_{j=1}^{n} \lambda_j^* GER_j \\
PCGSDP_o^* &= (PCGSDP_o - \beta^*_{PCGSDP_o}\ R_{PCGSDP_o}) = \sum_{j=1}^{n} \lambda_j^* PCGSDP_j
\end{aligned}\right\} \quad \langle E\ 7.2 \rangle$$

To rank the DMUs and discriminate among efficient DMUs, Shetty and Pakkala (2010a) developed a procedure for ranking through virtual DMU. Here, we consider nation as the virtual DMU, instead of taking average inputs and outputs of all DMUs. Input and outputs of the nation is the total of corresponding input and outputs of all the states and union territories. The inputs and outputs of the nation are based on all the inputs and outputs of all the DMUs. Hence, in this situation, ranking the efficient DMUs with reference to nation is more meaningful. This model is discriminating the efficient DMUs in such a way that when an efficient DMU is excluded from the reference set, the virtual DMU comes closer to the efficient frontier. The most efficient DMU is the one that influences highest on the displacement of efficient frontier with respect to virtual DMU.

Let $J = \{1, 2 \ldots n\}$ is the set of DMUs, $b \in \{E\}$ where $\{E\}$ is set of efficient DMUs, Suffix *In* corresponds to the inefficient virtual DMU i.e India (input and outputs of India is the total of corresponding input and outputs of all the states and union territories, its performance is certainly low from the developed states). Our approach is to measure the impact of the efficient states on the national efficiency. An efficient $DMU_b \in \{E\}$ is deleted from the efficient frontier in order to find its effects on efficiency on nation.

The improved directional distance formulation of DEA for discriminating efficient DMUs through single virtual DMU based on Shetty and Pakkala (2010a) is given by

$$\left.\begin{array}{ll} & Min\ \tau_{In,b} = t - 0.3333B_{PCGSDP_{In}} \\ Subject\ to & t + (0.3333B_{LEB_{In}} + 0.2222B_{LR_{In}} + 0.1112B_{GER_{In}}) = 1 \\ & \sum_{\substack{j=1 \\ j\neq b}}^{n+1} \Lambda_j LEB_j - B_{LEB_{In}} R_{LEB_{In}} \geq tLEB_{In} \\ & \sum_{\substack{j=1 \\ j\neq b}}^{n+1} \Lambda_j LR_j - B_{LR_{In}} R_{LR_{In}} \geq tLR_{In} \\ & \sum_{\substack{j=1 \\ j\neq b}}^{n+1} \Lambda_j GER_j - B_{GER_{In}} R_{GER_{In}} \geq tGER_{In} \\ & \sum_{\substack{j=1 \\ j\neq b}}^{n+1} \Lambda_j PCGSDP_j + B_{PCGSDP_{In}} R_{PCGSDP_{In}} \leq tPCGSDP_{In} \\ & \sum_{\substack{j=1 \\ j\neq b}}^{n} \Lambda_j = t \\ & \Lambda_j \geq 0,\ j = 1,2,\cdots,n \\ & B_{LEB_{In}},\ B_{LR_{In}}, B_{GER_{In}}, B_{PCGSDP_{In}} \text{ are unrestricted.} \end{array}\right\} \quad \langle M\ 7.3\rangle$$

Rank the efficient DMUs by finding the efficiency score of virtual DMU when that efficient DMU is excluded from the reference set. Efficiency of virtual DMU is computed based on $\langle M\ 7.3\rangle$. Then efficient DMUs are ranked according to ranking of efficiency score of virtual DMU. If there exist a tie between efficiency score of virtual DMU when efficient DMU is deleted from the reference set, these efficient DMUs can be discriminated by considering only tied efficient DMUs in the reference set and evaluating the efficiency of the virtual DMU.

7.2.1 Ranking procedure:

In the first part of our proposed approach, the basic idea is to discriminate the efficient states by evaluating the efficiency of nation by excluding the efficient units one by one through the model $\langle M\ 7.3\rangle$. Intuitively, this means unit 'b' is excluded from the frontier and $\tau_{In,b}$ measures the distance of the nation from the new frontier. The original efficient frontier will change if the DMU_b is deleted and the new efficient frontier gets closer to the inefficient DMU. This score is always less than or equal to one. Hence, based on the effects of efficient states on nation, one can rank all the efficient states.

Step 1: Find the efficiency of each state applying the model $\langle M\ 7.2\rangle$.

Step 2: Break the states into two groups, the state with efficiency score one i.e. efficient states $E=\{1, 2,\ldots,e\}$ and states with efficiency score less than one i.e. inefficient states $I=\{e+1, e+2,\ldots,n\}$

Step 3: Rank all the inefficient states in descending order based on the efficiency score, so that maximum efficiency scored DMU receives the rank e+1 and the last one receives the rank 'n'.

Step 4: Rank the efficient states by finding the efficiency score of nation when that efficient state is excluded from the reference set. Efficiency of nation is computed based on the model $\langle M\ 7.3\rangle$. Then efficient states are ranked according to effect of efficient states on nation. The state with maximum efficiency score receives the rank 1 and the last state receives the rank 'e'. If there exist tie between efficiency score of nation when efficient states deleted from the reference set, these efficient DMUs can be discriminated by considering only tied efficient states in the reference set and evaluating the efficiency of the nation.

A program has been developed to find the efficiency scores for all the DMUs based on the models $\langle M\ 7.2\rangle$ and $\langle M\ 7.3\rangle$ model using the *MATLAB 7.7*.

In multistage reference technology procedure, efficient states are discarded from the subsequent stages. This process lead to decrease the number of units as number of reference stages increases. There are different rules for minimum number of organizations required for efficiency measurement. Nunamaker (1985) argued that number of units in the sample should be at least three times greater than the sum of the number of inputs and outputs included in the study. Therefore, keeping this restriction, multistage reference technology is restricted to the six stages in our study. In each stage, the inefficient states identify its role model based on benchmarking technology and the targets for inefficient state are estimated. Figure-7.1 shows the procedure for multistage reference technology. In general, the group of states shows similarity in their overall human development. The order of the states by this method agrees with other method of measure of HDI.

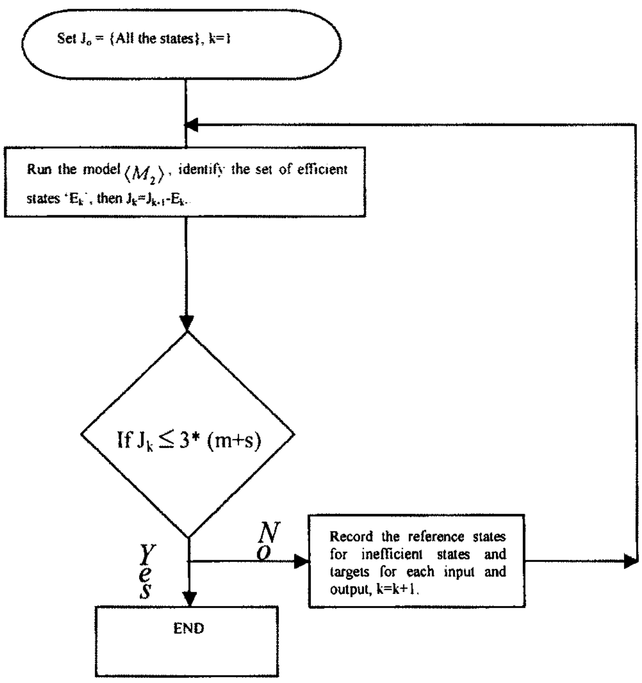

Figure-7.1: Multistage reference technology.

Step-1: Set $k=1$. Take all states as the reference set J_0.

Step-2: Find the efficiency of each state applying the model $\langle M\ 7.2\rangle$ and record the set of efficient states E_k and modify the reference set as $J_k=J_{k-1}-E_k$.

Step-3: Find the efficient targets for inefficient states in J_k for all the input and outputs.

Step- 4: If number of states in $J_k > 3*(m+s)$, then k=k+1 and go to Step-2.

Step 5: Record the reference states for inefficient states and targets for each input and output.

A program has been developed to find the efficiency scores for all the DMUs based on model $\langle M\ 7.2\rangle$ using the *MATLAB 7.7* and is given in the Appendix, Program-7.

7.3 Data:

Sl.No.	State	Life Expectancy at Birth (LEB)	Literacy Rate (LR)	Gross Enrollment Ratio (GER)	Per Capita Gross State Domestic Product	Efficiency Score by Proposed Model	Rank by Proposed Model
1	2	3	4	5	6	7	8
1	Goa	72.5*	82	102	66135	1	1
2	Chandigarh	71.2*	81.9	69	75181	1	2
3	Kerala	73.9	90.9	96	27864	1	3
4	Mizoram	72.9*	88.8	105	22417	1	4
5	Andaman & Nicobar	72.7*	81.3	104	31004	0.8389	5
6	Pondicherry	72.5*	81.2	115	44908	0.7362	6
7	Delhi	70.6*	81.7	85	55215	0.6144	7
8	Manipur	72.3*	70.53	103	18386	0.5974	8
9	Himachal Pradesh	66.5*	76.5	107	31140	0.5278	9
10	Tamilnadu	66	73.5	108	27137	0.5125	10
11	Maharashtra	66.9	76.9	94	32979	0.4926	11
12	Punjab	69.2	69.7	63	32945	0.4874	12
13	Tripura	69.2*	73.2	97	22836	0.4826	13
14	Haryana	65.9	67.9	72	35044	0.4747	14
15	Gujarat	65.9	69.1	96	29468	0.4694	15
16	Nagaland	68.7*	66.6	47	20998	0.4682	16
17	Uttarkhand	66.2*	71.6	93	22093	0.4666	17
18	Sikkim	67*	68.8	80	23731	0.4662	18
19	Arunachal Pradesh	68.8*	54.3	88	22542	0.4616	19
20	Karnataka	65.1	66.6	93	24199	0.4597	20
21	West Bengal	64.6	68.6	84	22522	0.4596	21
22	Andhra Pradesh	64.1	60.5	83	23729	0.4529	22
23	Meghalaya	64.1*	62.6	88	21915	0.4527	23
24	Jammu & Kashmir	66.4*	55.5	71	18630	0.4503	24
25	Chattisgarh	60*	64.6	88	18068	0.4472	25
26	Rajasthan	61.7	60.4	80	16800	0.4446	26
27	Assam	58.7	63.3	73	16825	0.4444	27
28	Orissa	59.2	63.1	84	16306	0.4442	28
29	Madhya Pradesh	57.7	63.7	80	14534	0.4426	29
30	Uttar Pradesh	59.8	56.3	73	11941	0.4376	30
31	Jharkhand	62.3*	53.6	57	17493	0.4423	31
32	Bihar	61.4	47	55	7467	0.4325	32
	India	63.2	64.8	80	22946	0.4542	

Table-7.1: State wise data on three major socio-economic indicators in India, efficiency score and rankings.

* Data has been estimated based on SRS Bulletin-RGI (2006)

The proposed model for measuring HDI has been applied to a latest available data. Table-7.1 shows data for different states and union territories (UTs) (excluding Daman & Diu, Dadar & Nagar Haveli , Lakshadweep) of India. Column-3 of Table-7.1 shows the life expectancy at birth for the year 2000-05 obtained from the Economic Survey 2007-08 (2008) for the major states of India. LEB have been estimated for smaller states and UTs based on regression equation as discussed in KHDR-2005 (2006). The estimation is based on the variables like crude birth rate, crude death rate, natural increase and infant mortality rate obtained from the sample registration system (SRS) report of Registrar-General of India (RGI) (2006). Data on these variables for 15 major states was considered for estimation. Adult literacy rates are not yet available; it was felt that a combination of literacy rate for the age group seven years and more along with intensity of formal education based on school enrollment rates for the age group six to fourteen used to capture the educational attainment in the ratio 2:1. The literacy rates (LR) of census 2001 has been used. GER have been worked out based on enrolment data from the class I-VIII from the Economic Survey (2008) and maximum value restricted to 100. Adjusted GDP per capita (based on purchasing power parity PPP in US Dollars) is used as a measure of a decent standard of living. Real state GDP per capita in PPP$ is calculated for measuring HDI by considering $ 3139 per capita GDP based on UNDP (2006) for India (more detail refer KHDR-2005 (2006)).

7.4 Results and discussions:

This section discusses the two parts on human development efficiency analysis undertaken for different states and UTs of India. The first part evaluates the efficiency scores applying $\langle M\ 7.2\rangle$ and discriminating efficient states and UTs. Further, ranks are assigned based on efficiency score for various states and UTs. In addition, we compare this efficiency score with the HDI for different years. The second part shows the multistage reference technology for inefficient states and their goals to improve their human development indicators in a stepwise approach.

7.4.1 Human Development efficiency and their comparison:

The proposed model has been applied to data set given in Table-7.1. In the first part we measure the efficiency of all the states using $\langle M\ 7.2\rangle$. Efficiency score of each state as shown in column-7 of Table-7.1. Here Goa, Chandigarh, Kerala and Mizoram are the four efficient states and remaining states are inefficient. Efficient states are further discriminated by applying $\langle M\ 7.3\rangle$ and ranked based on their impact on national level. Inefficient states are ranked according to their efficiency score. Besides Kerala, among the major states Punjab, Tamilnadu, Maharashtra and Haryana have done well on the human development efficiency. In general, human development is better in smaller states and UTs. It is also noticed that the economically less developed states are also the states with low human development efficiency. Similarly, economically better off states are also the one's with better performance in human development. Unlike other methods, this analysis shows the way for improvement in human development of the nation using available resources optimally through benchmarking procedures. Here, directional distance formulation of DEA model is used and it allows assessing each state under best possible way relative to other states in an ideal direction. The proposed method of efficiency measurement takes optimum combination of different indicators in the proportion of original HDI. This study will identify best practice states in the country and they are benchmarked on the basis of empirical observations. The benchmarking state may be either a single state or combination of states. These benchmarking states provide achievable goals for relatively less efficient states.

We also compared the proposed method of efficiency score and rankings with HDI-1981 and HDI-1991. Table-7.2 shows the Pearson and Spearman rank correlation coefficients for 32 states and UTs of India. It is found that in all the cases, both types of correlation coefficients are significant at 0.01 levels. Table-7.3 shows that correlation coefficient between the proposed model and HDI-2001 for the major states of India. Again it is found that high correlation in both the cases.

		HDI-1981		HDI-1991		Proposed Method	
		Pearson	Spearman	Pearson	Spearman	Pearson	Spearman
HDI-1981	Pearson	1		0.953		0.755	
	Spearman		1		0.955		0.887
HDI-1991	Pearson	0.953		1		0.814	
	Spearman		0.955		1		0.917
Proposed Method	Pearson	0.755		0.814		1	
	Spearman		0.887		0.917		1

Table-7.2: Pearson and Spearman rank correlation coefficient for 32 states and UTs of India.

		HDI-2001		Proposed Method	
		Pearson	Spearman	Pearson	Spearman
HDI-2001	Pearson	1		0.839	
	Spearman		1		0.979
Proposed Method	Pearson	0.839		1	
	Spearman		0.979		1

Table-7.3: Pearson and Spearman rank correlation coefficient for Major states of India.

Note: All correlations are significant at 0.01 levels.

7.4.2 Multistage reference technology and its relevance to policy makers:

In the second part, a new procedure called multistage reference technology is introduced to improve the performance of backward states in a stepwise approach. This part of the chapter suggests and applies a method for computing targets aiming at reducing regional disparities gradually. It is known that poor performing states or economically backward states can not achieve human development as par with frontier states and UTs. The conventional DEA models like CCR/BCC models indicate the targets in a single stage to operate as par with developed states for poor performing states. Practically it could not be achieved in a short period of time. It is also recognized that economically less developed states can not achieve human development as par with economically developed states and union territories (UTs) through spontaneous growth. Therefore, it is necessary for such poor performing states, goals are to be fixing in a phase wise approach. Multistage reference technology involves more stages of reference targets for relatively poor performing states to improve their performances. Relatively, best performing states are discarded from efficiency measurement of subsequent stages of multistage reference technology and targets are fixed at each stage. The targets of poor performing states are gradually decreases from the lower stages to the higher stages. That is, the first stage gives the efficient but higher target, subsequent stages give less efficient but lower target and are easier to achieve. This information gives the guidelines to policy makers and planners for formulating suitable plan, resource allocation and fixing the goals at different phases. This method will help for systematic reduction of regional disparities among the states. It shows the ways for improvement for poor performing states and to operate as par with the developed states in a stepwise approach.

Stages	Sl.No.	State	Levels	Efficiency Score	Reference States	Target			
						LEB	LR	GER	PCGSDP
1	2	3	4	5	6	7	8	9	10
1	1	Goa	1	1	1				
	2	Chandigarh	1	1	2				
	3	Kerala	1	1	3				
	4	Mizoram	1	1	4				
2	5	Andaman& Nicobar	1	0.8389	2,4	72.7	85.4	100	38505
	6	Pondicherry	1	0.7362	1	72.5	82	100	66135
	7	Delhi	1	0.6144	1	72.5	82	100	66135
3	8	Manipur	1	0.5974	1	72.5	82	100	66135
			2	0.681	6	72.5	81.2	100	44908
	9	Himachal Pradesh	1	0.5278	1	72.5	82	100	66135
			2	0.6416	6	72.5	81.2	100	44908
	10	Maharashtra	1	0.4926	1	72.5	82	100	66135
			2	0.6052	6	72.5	81.2	100	44908
	11	Punjab	1	0.4874	1	72.5	82	100	66135
			2	0.5969	6	72.5	81.2	100	44908
	12	Haryana	1	0.4747	1	72.5	82	100	66135
			2	0.5805	7	70.6	81.7	85	55215
4	13	Tamilnadu	1	0.5125	1	72.5	82	100	66135
			2	0.6085	6	72.5	81.2	100	44908
			3	0.9015	9	66.5	76.5	100	31140
	14	Tripura	1	0.4826	1	72.5	82	100	66135
			2	0.5609	6	72.5	81.2	100	44908
			3	0.8672	8,9	69.7	73.2	100	23271
	15	Gujarat	1	0.4694	1	72.5	82	100	66135
			2	0.5632	6	72.5	81.2	100	44908
			3	0.8081	9	66.5	76.5	100	31140
5	16	Nagaland	1	0.4682	1	72.5	82	100	66135
			2	0.5384	6	72.5	81.2	100	44908
			3	0.7615	8,10	70.6	73.5	97	22921
			4	0.8169	14	69.2	73.2	97	22836
	17	Uttarkhand	1	0.4666	1	72.5	82	100	66135
			2	0.54	6	72.5	81.2	100	44908
			3	0.7679	9	66.5	76.5	100	31140
			4	0.8178	14	69.2	73.2	97	22836
	18	Sikkim	1	0.4662	1	72.5	82	100	66135
			2	0.5432	6	72.5	81.2	100	44908
			3	0.7788	8,10	69.9	73.3	97	23729
			4	0.823	13,14	68.5	73.3	97	23729
	19	Arunachal Pradesh	1	0.4616	1	72.5	82	100	66135
			2	0.5337	6	72.5	81.2	100	44908
			3	0.7637	8,10	69.9	73.3	97	23729
			4	0.8139	14	69.2	73.2	97	22836
	20	Karnataka	1	0.4597	1	72.5	82	100	66135
			2	0.5365	6	72.5	81.2	100	44908
			3	0.7379	9	66.5	76.5	100	31140
			4	0.7966	13,14	66.5	73.3	100	24200
6	21	West Bengal	1	0.4596	1	72.5	82	100	66135

			2	0.5324	6	72.5	81.2	100	44908
			3	0.7237	8,10	69.9	73.3	97	23729
			4	0.7657	14	69.2	73.2	97	22836
			5	0.8843	17,20	66	70.5	93	22522
	22	Andhra Pradesh	1	0.4529	1	72.5	82	100	66135
			2	0.5268	6	72.5	81.2	100	44908
			3	0.703	8,10	69.9	76.9	97	27979
			4	0.7471	13,14	68.5	73.3	97.7	23729
			5	0.8621	17,20	65.4	67.7	93	23729
	23	Meghalaya	1	0.4527	1	72.5	82	100	66135
			2	0.5224	6	72.5	81.2	100	44908
			3	0.6951	8,10	69.9	76.9	97	25979
			4	0.7379	14	69.2	73.2	97	22836
			5	0.8396	17	66.2	71.6	93	22093
	24	Jammu & Kashmir	1	0.4503	1	72.5	82	100	66135
			2	0.5117	6	72.5	81.2	100	44908
			3	0.6837	8,10	69.9	76.9	97	25979
			4	0.7125	14	69.2	73.2	97	22836
			5	0.8157	17,19	66.4	70.3	92.6	22126
	25	Chattisgarh	1	0.4472	1	72.5	82	100	66135
			2	0.5075	6	72.5	81.2	100	44908
			3	0.6382	9	66.5	76.5	100	31140
			4	0.6803	14	69.2	73.2	97	22836
			5	0.7599	17	66.2	71.6	93	22093
	26	Rajasthan	1	0.4446	1	72.5	82	100	66135
			2	0.5016	6	72.5	81.2	100	44908
			3	0.6343	8,10	69.9	73.3	97	23729
			4	0.669	14	69.2	73.2	97	22836
			5	0.7355	17	66.2	71.6	93	22093
			6	0.805	23	64.1	62.6	88	21915
	27	Assam	1	0.4444	1	72.5	82	100	66135
			2	0.5016	6	72.5	81.2	100	44908
			3	0.6179	8,10	69.9	73.3	97	23729
			4	0.6602	14	69.2	73.2	97	22836
			5	0.7151	17	66.2	71.6	93	22093
			6	0.7681	23	64.1	62.6	88	21915
	28	Orissa	1	0.4442	1	72.5	82	100	66135
			2	0.5002	6	72.5	81.2	100	44908
			3	0.6207	9	66.5	76.5	100	31140
			4	0.6592	13	66	73.5	100	27137
			5	0.7243	17	66.2	71.6	93	22093
			6	0.7969	23	64.1	62.6	88	21915
	29	Madhya Pradesh	1	0.4426	1	72.5	82	100	66135
			2	0.4948	6	72.5	81.2	100	44908
			3	0.6053	9	66.5	76.5	100	31140
			4	0.6412	13	66	73.5	100	27137
			5	0.6976	17	66.2	71.6	93	22093
			6	0.7567	23	64.1	62.6	88	21915
	30	Jharkhand	1	0.4423	1	72.5	82	100	66135
			2	0.4987	7	70.6	81.7	85	55215
			3	0.6257	8,10	69.9	73.3	97	23729

			4	0.662	14	69.2	73.2	97	22836
			5	0.7213	17	66.2	71.6	93	22093
			6	0.769	23	64.1	62.6	88	21915
	31	Uttar Pradesh	1	0.4376	1	72.5	82	100	66135
			2	0.4837	6	72.5	81.2	100	44908
			3	0.5885	8,10	69.9	73.3	97	23729
			4	0.6174	14	69.2	73.2	97	22836
			5	0.6671	17	66.2	71.6	93	22093
			6	0.7151	23	64.1	62.6	88	21915
	32	Bihar	1	0.4325	1	72.5	82	100	66135
			2	0.469	6	72.5	81.2	100	44908
			3	0.5634	8,10	69.9	73.3	97	23729
			4	0.5807	14	69.2	73.2	97	22836
			5	0.6264	17	66.2	71.6	93	22093
			6	0.6639	23	64.1	62.6	88	21915

Table-7.4: Step wise targets and reference states for poor performing states.

The interpretation of multistage reference technology follows for different stages, for example Nagaland may take four levels to reach human development as par with first stage peer group states (Goa, Chandigarh, Kerala and Mizoram). The first improvement is the fourth level i.e Nagaland may take its reference as Tripura (Sl. No. 14) and its target derived on data for LEB, LR, GER and PSGSDP are respectively 69.2, 73.2,97 and 22836. Similarly, for the third level reference state is the combination of Manipur and Maharashtra and its targets for LEB, LR, GER and PSGSDP are respectively 70.6, 73.5, 97 and 22921 further it follows up to first level. The higher level of improvement will have hard targets and more efforts are required to emulate first stage efficient states. It is acknowledged that economically less developed states like Bihar, Uttar Pradesh, Jharkhand and Madhya Pradesh can not accomplish human development as par with economically developed states and UTs like Kerala, Goa and Chandigarh through rapid development. Therefore, it is necessary for such poor performing states to fix goals in a phase wise approach. Multistage reference technology procedure gives the guidelines to policy makers and planners to formulate suitable plans, resource allocation and fix the goals. We can see from Table-7.4 that Bihar can steadily increase its human development by accomplishing these targets in a stepwise approach from the sixth level to the first level. Also, this study gives path to allocate the amount of resources to each state in different sectors such as education, healthcare or economy of the state. Hence, this will reduce the disparities among the states in a phase wise approach and leads to gradual decrease in inequality of human development between the regions. Hence, it improves human development of the nation as a whole.

This study will help policy makers to identify and to take corrective measure for underperforming states. The results of multistage reference technology are shown in Table-7.4. In each stage of reference technology, we find the efficiency score for all inefficient states of the previous stage and best among these states comes on the frontier. The study shows that Goa, Chandigarh, Kerala and Mizoram are the four efficient states and remaining states are inefficient in the first stage. Andaman & Nicobar, Pondicherry, Delhi are the second stage efficient states. Andaman & Nicobar is efficient in the second stage and having its first stage efficiency score 0.8389 as given in column-5 of Table-7.4. If it urges to be efficient in the first level itself, it has to improve human development indicators on line with Chandigarh and Mizoram as its role models given in the column 6 of Table-7.4. It has to improve LEB, LR, GER and PSGSDP to 72.7, 85.4, 100 and 38505 respectively and similar interpretation can be drawn using Table-7.4 for Pondichery, Delhi and also for different stages.

7.5 Conclusions:

A new procedure, multistage reference technology is introduced to improve the performance of backward states in a stepwise approach. The chapter suggests and applies a method for computing targets aiming at reducing regional disparities systematically. The new measure of human development is compared with original HDI and found that they are highly correlated. Each poor performing state is compared with the best practice states and its reference states are determined in order to achieve efficiency. This study brings to light interstate disparities and shows ways for improvement. Proposed approach differs from previous DEA approaches to measure human development in several ways. First, the measurement of human development is determined through directional distance function. The directional vector is the ideal state. Second, it considers PCGSDP as the negative input rather than output variable and keeps the condition that more PCGSDP is better for efficiency. Third, the measure of efficiency is non-radial and non-oriented interns it projects inefficient DMUs (states) to Pareto-Koopmans efficiency. Fourth, proposed method of efficiency measurements takes optimum combination of different indicators in the proportion as in original HDI. Moreover, advantage of human development measure by this procedure is that it is benchmarked on the basis of empirical observations of best practice states and target values for poor performing states in a stepwise pattern. The result of the study also focuses on impact of the economic policies on general well being and development.