Measuring the Human Development or Deprivation : A Review of (Different Composite Index) Methods

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February 2007

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Abstract

The present paper reviews the different methods in practice to measure the human development or deprivation, which, in fact, is an emerging part of the development discourse. Specifically it deals with the problems of comparability, aggregation and weighing the dimension/indicators in composite index. The essential part of reporting human development involves a normalization of selected indicators by setting the goal posts of minimum and maximum values of the selected indicator that facilitates the construction of a composite index. The evaluation at the aggregate level (at the national or state level) always conceals the geographical spread across sub-regions, and therefore ignores regional disparities. Another task in constructing a composite index is weighing each individual indicator while summarising them into a composite index.

(Key words: *Human Development, Human Deprivation, Poverty, Composite Index, Measuring the Deprivation, Head Count Ratio*)

[*] This paper is a piece of my ongoing research work on the research theme human development/deprivation and its measurement.

Measuring the Human Development and Deprivation : A Review of (Different Composite Index) Methods

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I. Introduction

The civilized society have been cherishing and exerting the achievement of values such as equality, liberty and fraternity. Equality is in terms of availability of equal opportunity for development and enhancement of quality of one's own life. Development of an individual is intimately linked with social development and vice versa. There have been critical minimum levels of efforts to proceed in this direction and this process needs a more organised way of proper planning supported by time-bound programmes. An essential element of this process lies in the evaluation and assessment of our progress along with its pace to recognize the degree of achievement, based on selected and well-accepted indicators that represent development. Such assessment/evaluation of development were largely based on the criterion that includes economic and material aspects alone during the past. Over the period, the material dimensions of development are complemented with non-material dimensions[1]. In other words, the notion of development being not merely about growth in per capita income has gained wider acceptance, as it includes removal of poverty and under-nutrition and securing access to basic services like health, education water etc. This approach has got to be named as multi-dimensionality of development. The assessment of human development is to whether sufficient efforts are made at making the benefits of development equally distributed among individuals to qualify us as a civilized society.

Sen (1999) says that we have reason to value many things other than income and wealth which ensures real choices and opportunities to lead the kind of life we would value living. The new development paradigm states that development is to facilitate every human being live, as he/she likes (HDR, 1990). It has to expand potential capabilities of every human being[2]. However, the capabilities approach goes far beyond individual attributes to analyze the role of the social environment on human choice and agency (Ranis, 2004). After consistent debates and discussions, this development approach has been converging with the notion of human development[3].

Following the Sen's capability approach, a few essential indicators were chosen to assess the development status of a country/region. United Nations Development Programme (UNDP) came forward to prepare a methodology to select and measure the human development indicators and thereby assess the relative status of the particular country in the set of whole number of countries in the world. The UNDP initiative of showing relative performance of the countries in terms of its ranking on the basis of their human development indices has been accepted world-wide as an effective tool of describing the aspects of human deprivations. At the early stages, three aspects of human well-being are undertaken: per capita income, health and education. These three dimensions are considered representative of human development. Therefore, there was a great deal debate over the efficiency and sufficiency of these indicators while representing human development of a country (Ranis, 2004). This imperfect proxy may have to include the measures of political freedoms and income inequalities (Dasgupta and Weale, 1992). However, the selected three dimensions (per capita income, health and income) as a proxy for human development still remains in practice and widely accepted till date.

a. Human Development index and its Comparability

The essential part of reporting human development status of each country in the world involves normalization of a few selected indicators and then construction of a composite index of those indicators. The process of normalization is approached in two ways; either considering the existing best to take the best normalized value of unity as against the worst normalized value of zero or the best value for each indicator is considered as the best attainable in which case the best normalized value falls short of one. This normalization exercise scales the range of a particular indicator value between 0 and 1 and an average of this normalized values across indicators provide the HDI index value. Through the evolution of revisions in HDI the three dimensions are equally weighed to give rise to the HDI and the gaps between HDI values of two nations are considered indicative of the extent of deprivation a country has compared to the other[4].

The issue of contention here is that the comparability of this index across countries. It is well accepted that comparability of raw value of an indicator to comment on the level of development/achievement is very difficult. Normalization is an efficient tool to get over this particular problem. This process needs a goal post of starting (minimum value) and ending (maximum value) points in the development/achievement continuum. Among the selected proxy indicators of human development, though every indicator has starting point, there is no

ending point for certain indicators. For instance, the increase in level of per capita income is infinite in the long run. Unlike this, longevity of human beings needs to have an upper limit. Of course indicators like literacy has minimum (i.e. zero) and maximum (100 per cent) values. In the former case there is a need to set goal posts of minimum and maximum raw values of the selected indicator. The selection of these goal posts relates to the utilization of the index values. Usually UNDP considers the minimum and maximum values from the observed set of cases (i.e. countries). In other words the value of worst performing country assumes the minimum value and the value of best performing country sets the maximum value. In this case it is obvious that rest of the observed cases (i.e. countries) fall within this range. Hence, there is a possibility of comparability of each country with another in the continuum of development/achievement levels of those countries in the observed set.

As a result, the said comparability remains limited to the domain of countries included in the computation of this index. If there are two (for instance take sets A and B) different sets of observed cases, then the comparability of one set (A) of cases with that of the other (B) is just unreasonable unless and until the later (i.e. set B) set of cases falls in the range of former set (i.e. set A). In other words, the comparability of HDI of Indian states with country level HDI of UNDP depends upon whether the goal posts set for the Indian states are same as that of country level HDI goal posts. If not so, then one cannot compare the HDI value of any Indian states with that of any country. Likewise the same is true regarding the comparability of districts within the states with any other state/country level value of HDI. All that matter is setting of goal posts.

b. The Problem of Aggregation

While assessing the levels of achievement or deprivation, the evaluation at the aggregate level (at the national or state level) always conceals the geographical spread across sub-regions, and therefore ignores regional disparities. The laggard regions always bring down the overall performance at the state/national levels. In the planning process there should be differential emphasis where the laggards have to be focussed more than others. To get an understanding of performance at the regional levels, it requires a disaggregated analysis to facilitate micro level planning given the information availability at this disaggregated level. Such a disaggregated analysis is not only limited to exposing the regional scene of educational progress/development but also helps in identifying specific aspects/features associated with varying degrees of progress across regions.

II. Methods of Composite Indices of Human Development/Deprivation/Poverty

A. Indicators/Variable/Dimension Construction

It is worth mentioning that both the concepts development and deprivations are basically relative once wherein the former reflects the positive side of the outcome/event or an achievement whereas the latter one represents the negative side. The concept of deprivation/poverty is defined, herein, with respect to lack of access to a set of fairly basic requirements (amenities) that might be expected to contribute to the capability for achieving satisfactory human functioning – a 'functioning' being what Amartya Sen (1985) has called 'a state of being or doing'. In other words the 'capability failure' in the different dimension of basic amenities required for standardizing the capability and thereby functioning.

To measure both the concepts, one can, in fact, use either input, process or outcome indicators of the dimension in question. There are varied dimensions of an ultimate outcome – development/deprivation – and with in the dimension different variable/indicators that proximates/represents the dimension. Of which, a selected set of information relating to specific dimensions of the outcome is normally used as proximate. In the process, first of all variables have to be identified and then collect the information related to such indicators and convert the data with a suitable transformation thereby the construction of an indicator.

B. Evaluation of Relative Performance

While evaluating the performance in terms of particular event / outcome / achievement / deprivation, there is no absolute fixed value by which the position of each observation (for example country/state/region) has to be evaluated. Instead, what is in vogue relates to assessment of performance of each observation in relative terms. There are two approaches for this: one is the relative performance of particular observation, for instance a country, in question with respect to either the best or the worst performing one, or both are taken into account. The other is relative performance of the country with respect to an average (of all countries covered). The first one allows us to normalise the selected indicators where the normalised values range between 0 and 1. It (the method) is analogous to one that is adopted in computation of human development index (see UNDP, 2004). The raw indicator/variable is transformed in the following way:

$$NVij = \left\{1 - \left[\frac{BestXi - ObservedXij}{BestXi - WorstXi}\right]\right\} \qquad \ldots\ldots (1)$$

NV_{ij} – normalised index of 'i'th indicator of 'j'th districts; X_i - orginal value of 'i'th indicator; i = 1,2 ….n

The best X_{ij} is decided subject to the concerned indicator's lower or higher value corresponding to the best situation.

The lower value represents lower status in relation to a higher value of the index. A simple computation of the index is made by transforming each of the indicator values as a ratio of the difference between each value and the available best value to the entire range of variation in each of these indicators (see HDR; 2001; Mishra and Dilip, 2004). It indicates the relative position of the districts with respect to each of the selected indicators in a range of value between 0 and 1.

C. Composite Index: Weights

Once the construction of proximate indicators is done another task probably is constructing a composite index of all defined aspects of human development (i.e. dimensions) individually and then the common index of them[5]. There are different methods while constructing these composite indices. The difference is in the system of weighing each individual indicator while summarising them into a composite index. One may choose either a simple-unweighted index which is nothing but average value of the selected indicators where each indicator is equally weighed or weighted index by giving different weights to different indicators depending on their importance. The latter one involves complication in the sense that there could be varied principles behind determining the weight of each individual indicator. On one hand, one can follow ones' own (subjective) value judgement on the importance of particular indicator implying their weight.

a. Principal Component Analysis

On the other hand, weights can be determined by the statistical significance of the indicators following different statistical methods. Principal Component Analysis[6] (PCA) is one of methods commonly adopted for this purpose. The method of PCA, in fact, seeks to reduce large number of variables into few categories known as Principal Components, which explains maximum amount of variance among a set of variable[7]. In other words PCA brings out a few non-correlated linear combinations of the original variables that accounts for the most of the variation in original variables[8].

While running PCA, one can reduce whole set of selected indicators into few factors (seen as dimension) and see the relationship between the factors, on the one hand. And, one may construct dimension index using factor-loading values of the variable as the weight of that particular variable, on the other. However, to mention, one of the shortcomings, of the PCA is that sometimes the factor extraction (i.e. discovering of the underlying dimensions) in the PCA may not conform to the theoretical reasoning or common sense understanding while assigning the individual variables to different factors (i.e. underlying dimensions). One may over come this problem if one has pre-defined dimensions according theoretical reasoning or common sense understanding and carry out PCA for each pre-defined dimension to get dimension index[9]. By the PCA, the dimension index (DI) would be obtained in the following manner:

$$DIx = \frac{\left(\sum_{i=1}^{n} Xi \left(\sum_{j=1}^{n} Lij.Ej \right) \right)}{\left(\sum_{j=1}^{n} Lij.Ej \right)} \qquad \ldots\ldots \quad (2)$$

Where $\mathbf{X_i}$ – 'i'th variable/indicators of Dimension X; $\mathbf{L_{ij}}$ - Factor loading value of 'i'th variable on the 'j'th factor for the dimension X; $\mathbf{E_j}$ – Eigen value of 'j'th factor

In the above equation dimension index is an weighted average of the individual variables of the dimension. The weight of the variable in a dimension is determined by the sum of the products of factor loading of the variable multiplied by the *eigen* value of the factor[10]. There is choice in terms including number of principal components which must either equal to less than the number of indicators, to be considered for the analysis. Otherwise by following technical statistical process number of components may

Another method[11] of constructing composite index using PCA is the composite index is a sum of the products of factor score of the 'i'th variable and the standardised value of the original variable (where first the original value of the variable is transformed to log base 10 and then standardised its value with the ratio of difference of the log transformed original value from its mean to the Standard deviation). For a particular dimension the composite index is estimated as follows:

$$DIx = \sum_{i=1}^{n} Fi \left[\frac{(Xi - Mi)}{SDi} \right] \qquad \ldots\ldots\ldots \quad (3)$$

DI_x – Composite Index Dimension X; **F_i** – Factors score of the 'i'th variable; **X_i** – original value of the 'i'th variable; **M_i** – Mean value of the 'i'th variable; **SD_i** – Standard Deviation of the 'i'th variable.

In this method, the weight of the variable is determined by its factor score only unlike the prior one presented in equation[12] (2). The factor scores of the variables are its loading on the first principal component. It is observed that the first principal component is the linear index of variable with the largest amount of information common to all of the variables (Filmer and Pritchet, 1998:6). The rest of the components are ignored while constructing the composite index.

One of the shortcomings of the PCA is that when the measurement of the variables vary in scale, the comparisons between factors become difficult (Field, 2000). In the variable construction, the scale of measurement is different for different variables; in such a case it does not allow us to make a comparison between the factors within the dimension and between the different dimensions of the (human) development. Only possibility is that we can make a comparison in terms of relative position of the district in each factor or dimension.

b. Alternative Method: Inverse of the Coefficient of Variation

In addition to PCA we propose an alternative method where the weights are determined by the reciprocal of the corresponding coefficient of variation in each of the indicator (see Mishra and Dilip, 2004). One may verify the resulting composite indices of the two methods in making sensible interpretation. In the alternative method, higher weight is assigned to the indicators having lower variation and vice versa. The reason being the output indicator responds relatively with better strength to the indicator that is having the relatively lower variability. The index value according to alternative method is:

$$DIx = \frac{\sum_{i=1}^{n} Di.Wi}{\sum Wi} \qquad \ldots\ldots. \quad (4)$$

DI – Composite index Dimension X; $W_i = 1/CV_i$; CV_i – Coefficient of Variation of the 'i'th variable; W_i – weight of the 'i'th indicator (it is reciprocal value of the coefficient of variation of the 'i'th indicator.

D. Composite Variable Ranking

Another way of interpreting the development across countries/state/regions may be through ranking analysis. There are different methods in assigning rank orders[13]. The popular one among them is the rank order method developed by the French mathematician Jean-Charles de Borda (referred to as Borda ranking). This approach involves simply assigning a rank order score to each unit (here district) being compared in terms of each indicator/component value/index (see Qizilbash, 2004:360). Adding up the rank order scores across number of indicators/variables/dimensions gives the 'Borda score' and ranking the districts according to this score gives the 'Borda ranking', a composite rank of the district.

III. Progression Ratios

We have another method to examine the progression (i.e flow) rate of particular aspect, for instance the child schooling. In other words it measures (in terms of the child schooling) the number of grade a child entered in initial grade (i.e. grade I) would likely to complete given the current enrolment pattern of children across various grades in the elementary cycle. This method, in fact, is borrowed from the demographic literature. It is used for the computation of *parity progression ratio* which is commonly used in fertility analysis[14] (Henry, 1976; Mishra et al, 1999: 8) and also in life table illustration of the progression to higher order births.

The method not only depicts the distribution of enrolment in different grades but also estimates the expected number of years of schooling given the current status of enrolment. The Educational Progression Ratio (EPR) of order 'i' expresses the rate of progression of enrolment in a grade to any grade above it. Though EPR portrays the probability of the children moving from lower grade to any of the higher grade in the near future, it uses the information available at a point of time. The educational progression ratio (EPR) at each stage is calculated using the following formula:

$$EPR_1 = \Sigma^{n}_{i=2} e_i / \Sigma^{n}_{i=1} e_i;\ \ldots.EPR_2 = \Sigma^{n}_{i=3} e_i / \Sigma^{n}_{i=2} e_i;\ldots\ EPR_{n-1} = \Sigma^{n}_{i=n} e_i / \Sigma^{n}_{i=n-1} e_i \ldots \quad (5)$$

$\mathbf{e_i}$ – enrolment in 'i'th grade; i = 1,2,… n grades (we are concerned about grades in elementary cycle i.e. up to VIII grade).

The average expected number of years of schooling (ES) for the children in elementary school is:

$$ES = (EPR_1 + (EPR_1 * EPR_2) + \ldots\ldots\ldots + (EPR_1 * \ldots\ldots.. * EPR_n)) \quad \ldots (6)$$

Following this method one may get the information that once a certain number children entered into class one, how many of them will proceed to next classes and till the completion of primary cycle and elementary one.

IV. Head Count Ratio of Household Amenities Deprivation

In the poverty, one kind of deprivation, literature head count ratio is prominent measurement to know the number poor or the percentage of population below poverty line, in society in question. However, there exist extended poverty measure to account the depth and intensity of the phenomenon of poverty. Whereas in the literature related to deprivation especially that deals with multiple deprivations, the phenomenon of deprivation is measured using the composite index wherein it is the average of the deprivations in number of selected dimensions or indicators (for instance, health, education, housing, sanitation etc.,). This conventional measure ignores to present the statistical fact that number instances the people deprived of the access to or availing the selected public services or basic amenities. Hence an alternatives method is proposed to account the instances of deprivation that is basically a head count ratio of deprivation like that of poverty.

Herein is the method of measurement that accounts the level of deprivation in terms of basic household amenities, which constructs the aggregate head count measure of deprivation (see Jayaraj and Subramanian, 2002). To get the aggregate index of deprivation with respect to capability and functioning in terms basic household amenities, first of all one has to derive the number of individual instances of failure in capability by the following equation.

$$N^0_{i.} = \sum^9_{j=1} N^j_{i.} \quad \ldots (1)$$

Where, i= (1,2,3….n) number of states; j = (1,2,3….9) number of indicators.

$$N_{i.}^{*} = \sum N^j \, . \, N_{i.} \quad \ldots (2)$$

Where, $\sum N^j$ indicates the total number of indicators considered for the index.

$$HD_{i.} = N^0_{i.} / N_{i.}^{*} \quad \ldots (3)$$

Example: The indicators considered for the index are as follows:

$N_{i.}$ = Size of the population of the i^{th} state.

$N^1_{i.}$ = Number of people living in households with one or none dwelling rooms.

$N^2_{i.}$ = Number of people living in households without drinking water facility.

$N^3_{i.}$ = Number of people living in households without electricity connection.

$N^4_{i.}$ = Number of people living in households without lavatory.

$N^5_{i.}$ = Number of people living in households without any specified assets

$N^6_{i.}$ = Number of people living in households using traditional fuel.

$N^7_{i.}$ = Number of people living in households with dilapidated house.

$N^8_{i.}$ = Number of people living in households which do not have banking transactions.

$N^9_{i.}$ = Number of people living in households without bathroom.

If $N^0_{i.} \equiv N_{i.}^{*}$; indicates complete deprivation, in other words all the people living in rural areas are deprived of these basic amenities. The Normalised Index of Deprivation can be derived as follows.

V. Relative disadvantage index

To highlight dispersion of the burden of deprivation across the sub-population groups differing by their household characteristics the *relative disadvantage index* (RDI) is very much useful. This measure takes into account the representation of each group in terms of its share in the population and the particular outcome (development or deprivation). It identifies socio-economic group who bears the burden of deprivation more than their share The positive sign of the index indicates that a particular group is relatively disadvantaged and the negative sign indicates that the group in question is relatively advantaged (see Jayaraj and Subramanian, 2002).

$$RDIj = \frac{Cij - Sij}{(Cij\ Max) - Sij} \qquad (4)$$

Where RDIj - Relative Disadvantage Index of ‘j’th state; Cij is contribution of 'i' th (i.e. rural hhs here) group to the total deprived households in the ‘j’th state; Si - the share of 'i' th group of (i.e. rural) households in the total households of ‘j’th state.

$Ci\ Max = 1$ if $Si > AD$

$Ci\ Max = Si / AD$ if $Si < AD$

Where AD is the average level of deprivation across all the groups.

VI. Decomposition

a. Social Group Decomposability

In the development literature especially that of human development, considerable efforts are made to develop aggregate indices of human development or capability deprivation while assessing human well being. The recognition of widespread prevalence of inequalities in the

distribution of human progress or deprivation across various population groups according to their socio-economic characteristics, has led to developing group-differentiated indices to unravel the depth and varied dimensions of deprivations (see Anand and Sen, 1995; Jayraj and Subramanian, 1999; Majumdar, 1999; Hicks 1997). It is obvious that such burden of deprivation is borne disproportionately by different group. To account for the group-inequality, following the methodology of Anand and Sen used Human Development Report 1997[15] (see HDR, 1997), on can compute the group-inequality-adjusted index of deprivation in the following way.

The ordinary deprivation index is sum of the deprivation levels in each given their share of population as weight.

H= Number of deprived children/ total child population
or
$H = \sum Q_i * H_i$

H- Index value representing 'educational deprivation of children' and it is analogous with head count ratio of poverty; Q_i – Population share of 'i'th group as a weight ; H_i- 'i'th group-specific incidence

H^* - Social-group inequality adjusted index of deprivation

$H^* = \{\sum Q_i * H_i^{\alpha})^{1/\alpha}$

Here it must $\alpha > 1$ so we have taken $\alpha = 2$

Following this method the values of social group disparity-adjusted index slightly different from that of the unadjusted index. It will be more clear when take the ranks of the observation (country/state/region) based on their index values it is sure that ranks of adjusted and adjusted ones they would be different at least for few observation.

b. Decomposing the change in the Trend

In the trend analysis especially time series data or date of the observation over the period for specific intervals, it usual to examine the change over the period; it may be simple percentage change or growth rate. In the literature it is an established fact that the change/growth rate are decomposed into different in-build components of particular aspect. For instance, growth rate of agricultural output wherein Boyce (1987) derived a method to decompose it into three components: growth attributed to increase in land, increase in yield and increase in inputs.

Similarly, while analysing the change over the period in the group inequality adjusted development or deprivation one may decompose the change especially into three components: change due to change in the mean, due to that of group-inequality and the interaction of the both. Such an decomposition can be done in the following manner.

To find the variation (i.e. C^2) in the levels of deprivation across the social groups

$C^2 = [1/H^2 * \{\sum Qi * Hi^{\alpha})^{1/\alpha}$ Then to get the inequality co-efficient (I):

$I = [1+C^2]^{1/\alpha}$

The change during 1990's can be seen as

$\vartheta H^* = H^*_t - H^*_{t+1} = H * I_t - H_{t+1} * I_{t+1}$

ϑ = change; t – the initial year (i.e.1993-94); t+1 – the later year (i.e.1999-2000)

To decompose the change

$1 = - [(H_t * \vartheta I/\vartheta H^*) + (I_t * \vartheta H/\vartheta H^*) + (\vartheta H * \vartheta I//\vartheta H^*)]$

The first term (i.e. $H_t * \vartheta I/\vartheta H^*$) in the equation reflect the change during the period due to the change in the mean, the second term indicates the change due to reduction in group-inequality, and the third one is the interaction term.

VII. Correlation and Sensitivity Analysis

Correlation analysis examines the relationship between any of two variables: whether outcome, process or input variables. In other words it indicates the association between two variables and the degree (i.e. coefficient of correlation) and the direction (positive or negative/inverse relation). One of the shortcomings of the correlation analysis is that the existence of relation doesn't ensure the causation i.e. between two variables 'A' and 'B' whether 'A' causes 'B' or 'B' causes 'A'. Moreover there is possibility that correlation analysis may indicate a statistical relationship technically between unrelated, in common sense understanding, variables 'A' and 'B'. The latter defect may avoided by choosing variables to be included in the analysis, based on theoretical or common sense understanding.

Despite such problems involved, correlation analysis is useful and sometime may be necessary one. It is an important step in carrying out more advanced technical analysis like regression. For instance, in the regression analysis there is a problem of multi-collinearity

which can be detected with correlation analysis. Likewise in the Principal Component Analaysis (PCA) reduction of data set from a large number of indicators to very few will be based on the correlation analysis. In the PCA, highly correlated variables/indicators are formed as a dimension. Having said, one may get into correlation analysis to examine the depth and intensity of association between an individual indicator and the composite index.

VIII. Discussion and Remarks

The present paper reviews the different methods in practice to measure the human development or deprivation, which in fact is an emerging part of the development discourse. Over the period, the material dimensions of development are complemented with non-material dimensions. This approach has got to be named as multi-dimensionality of development.

The essential part of reporting human development involves a normalization of selected indicators and then construction of a composite index. The issue of contention here is that the comparability of this index across countries. Normalization is an efficient tool to get over this particular problem where there is a need to set goal posts of minimum and maximum raw values of the selected indicator. This process facilitates the comparability of each territory with another in the continuum of development/achievement levels of those observed set. However, while assessing the levels of achievement or deprivation, the evaluation at the aggregate level (at the national or state level) always conceals the geographical spread across sub-regions, and therefore ignores regional disparities. Another task in constructing a composite index is weighing each individual indicator while summarising them into a composite index. One may choose to construct either a simple-unweighted index weighted index. The latter one involves complication in the sense that there could be varied principles behind determining the weight of each individual indicator.

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End Notes

[1] This paradigm shift in the discourse of economic development changed the development criterion from mere per capita income growth of a nation to human development. In other words, development apart from income relates to general well-being and economic capabilities of the people.

[2] Sen (1999) say that development is a process of expanding the real freedoms that people enjoy. Therefore, development can be seen in terms of expansion of the real freedoms where the expansion of human capability can be seen as the central feature of the process of development.

[3] Consequently, the role of social variables in the fostering of economic progress received much attention. Human development approach says that human beings are the both ends in themselves and means of production. Human development is the enlargement of the range of choice and it is an end itself (Streeten, 1994).

[4] The essential part of reporting human development status of each country in the world involves normalisation of a few selected indicators and then construction of composite index of those indicators. Following UNDP methodology a country's development/achievement with respect to each of the indicators is calculated using the formula that: $I(i, j) = \{[(\max X(i, j) - X(i, j)]/(\max X(i, j) - \min X(i, j))\}$. An average level of development/achievement (i.e. I(i, j)) for each country is calculated by taking a simple average of the selected development/achievement indicators (that represents the dimension of per capita income, health and education). The formula is: $Ij = \{\Sigma\ I3(i, j) / 3\}$. Then one has to substrat Ij value from unity to get HDI of 'j'th state i.e. HDI = 1 – Ij.

[5] it may be constructed for input and outcome indicators separately for each country.

[6] As a matter of fact, PCA may be used for two different purposes: i). When there are large number of variables/indicators, to simplify the analysis and bringing out the underlying dimension out of those indicators it useful to reduce the large number of indicators in a few without losing their importance (for instance see IAMR, 2001); and ii). In situation of constructing a composite index and when it is necessary to give weight to each indicator, the PCA helps us in weighing each indicator according to their statistical significance (e.g see Filmer and Pritchett, 1998). . When there are too many indicators related to particular phenomenon, one has to reduce them to few for simplifying the analysis.

[7] In situation of large set of information related to a phenomenon like educational development and the existence of clusters of large correlation between subsets of variables informs that these correlated variables may be measuring aspects of the same underlying dimension. These underlying dimension are known as factors (or latent variables). Here the analysis could be simplified when one

can reduce the data set from a group of correlated variables into a smaller set of uncorrelated factors. In the PCA, factors are conceived based on the statistical property (i.e. variability) where the individual indicators are combined with that of similar variability.

[8] PCA decomposes the original data into a set of linear variates (Field, 2000).

[9] In the present exercise we have followed this approach where a set of dimensions (i.e. school related, human resource, physical infrastructure, incentive, grants and enrolment related ones) are predefined and the indicators related to each dimension is brought to PCA to determine underlying sub-dimensions within the particular dimension.

[10] This method is used in a study on educational development across Indian States by Institute of Applied Manpower Resources, New Delhi (see IAMR, 2000).

[11] Recently used in Filmer and Pritchet (2002).

[12] Filmer and Pritchet (1998) used only the first principal component of the PCA.

[13] Ranking can be derived in different ways: a rank may be assigned to a district based on its relatively position in the series of values (may be raw values or normalised ones) in each component/variable of each dimension. To arrive at the composite rank, all these ranks are combined (an average of the ranks of all components in all dimensions may serve the purpose) together.

[14] This concept is similar to that of the 'hypothetical cohort' used in fertility analysis, where in the age specific fertility rates at a point of time are cumulated over ages to indicate the expected fertility per women at the end of the reproductive span assuming that the current fertility regime will continue in the near future.

[15] See Technical Appendix of HDR (1997)