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Measurement of Imbalances in Regional Development in India : Graphical Approach

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INDIA is a democratic country with a federal structure. The country is divided into several States/Union Territories and balanced growth of all States/ Union Territories is necessary for the harmonious development of this federal country which has adopted social justice as one of the major planks of its developmental policy. India with its vast size, however, presents a picture of extreme regional variations in terms of several socio-economic indicators. This observation is well supported by the wide variations in the ranking of States according to several characteristics utilised for this purpose. These wide variations clearly bring out in sharp focus the lopsided development of States in specific characteristics considered in this study.

Regional imbalances are to a large extent built in due to unequal natural endowments and lack of infrastructure facilities which form the basis for rapid economic growth. The deficiencies and inadequacies in the development policies of the Government might have also aggravated the already existing economic disparities over the years.

The need to reduce the imbalances in development has been recognised in principle by the Government of India and has been enunciated in several plan documents and policy announcements. In order to evolve an effective and well structured policy framework for reducing imbalances, it would be necessary to have a properly designed and scientific definition of 'imbalances'. There have been many definitions of the term 'imbalances' depending on the purpose of the study and the perspectives of the situation under consideration. In the circumstances there is no clearly laid down comprehensive definition as to what constitutes the overall and comprehensive 'imbalances'. The most acceptable and single, overall and comprehensive measure for comparison of

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imbalances among Countries/States is the national income or per capita income compiled as per the well laid-down standardised procedures. The traditional comparison of national income or state domestic product, however, fails to reflect fully the inherent process of structural transformation and the socio-economic development that have taken place in most of the developing countries like India. Further, the national income or state domestic product (SDP) fails to reflect the upgradation of the quality of life that has taken place due to economic development.

There are several studies which have been carried out recently; among them, the studies published by Hemlata Rao, R. T. Tiwari and R. H. Dholakia may be mentioned. R. H. Dholakia [G.P. Mishra (1985)] has analysed inter-State variations in growth in terms of per capita income on the assumption that per capita income is a function of three factors: worker rate (workers per population), industrial structure and capital intensity and productivity. The study by R. T. Tiwari [G.P. Mishra (1985)] is addressed to the analysis of inter-State disparities in the levels of development measured in terms of a composite index of development constructed on the basis of 19 indicators of development. Hemlata Rao [G.P. Mishra (1985)] has constructed composite index of development based on 51 variables belonging to 18 sectors and used 'factor analysis' for studying general and social developments. There are many other studies also which mainly concerned themselves with a particular sector of economy, such as those on 'agriculture' by J. P. Singh, P.H. Prasad (1985) or those confined to a particular State, such as the study for Karnataka carried out by Hemlata Rao (1984). But in all the studies, the authors have attempted to develop the 'composite index' and ranked the State accordingly or measured the regional disparities by 'coefficient of variation', mainly.

An attempt has been made in this article to study the regional imbalances prevailing in the major States of Indian Union on the basis of more comprehensive set of indicators (15 indicators) such as, percentage of urban population and percentage of population below poverty line apart from indicators pertaining to agriculture, industry, etc. This is done in a more rigorous manner through three graphical procedures involving the use of advanced statistical techniques for presenting multivariate data. The three graphical approaches are: (i) Dendrogram, (ii) 2-dimensional representation of first two factors of Principal Components and (iii) Biplot based on Cluster Analysis, Principal Component Analysis and Singular Value Decomposition method, respectively.

This study is divided into three sections. Section I deals with a brief description of the nature of data, their sources and limitations thereof. Thereafter, imbalances prevailing among the States are discussed in Section II.

The main findings and conclusions emerging from the study are commented upon in Section III.

I

Description of Data

Selection of indicators is one of the most difficult task. In reality, one has to face the constraint of non-availability of reliable and desirable data on a uniform basis for analytical requirements. The concept of 'disparity' as defined by Boudhayan Chattopadhyaya and Moonis Raza has been taken into consideration for selection of the variables. 'Disparity arises as a result of failure to exploit the hidden development potentials of a region's initial resource endowment, its latent comparative and obsolute resource advantages, relative to another comparable reasons and is, therefore, comprised of factors which are not natural or physiographic but human, institutional and historical socio-political and/or economic technological' [Chattopadhya and Raza (1975), pp. 11-34]. Accordingly, several indicators have been considered in the present study covering aspects pertaining to financial, banking, demographic, agricultural and other infrastructural facilities in the State. All together, 15 important socio-economic indicators have been taken into account for which data are available for all States in the form of time series. The extent and availability of data differs from State to State and as such the latest year for which data are available for all the States is chosen as the cut-off point for our analysis. Efforts were accordingly made to collect the latest available information as well as to render them uniform in respect of time domain. However, many difficulties had to be encountered as some of the data were available pertaining to calendar year while some others were available only on a financial year basis. Therefore, an attempt was made to collect the data for the year 1984-85 or nearest to that year.

The present study does not cover all the States as data for all the selected variables were not uniformly available for all the States and further as several changes have been taken place with many Union Territories becoming full-fledged States. The study is, therefore, confined to 15 major States viz. Andhra Pradesh (AP), Assam (AS), Bihar (BH), Gujarat (GU), Haryana (HY), Karnataka (KA), Kerala (KE), Madhya Pradesh (MP), Maharashtra (MH), Orissa (OR), Punjab (PN), Rajasthan (RJ), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB). In the similar type of study, R.H. Dholakia (1985) has also chosen the same set of States as mentioned above. Data pertaining to 15 major States were collected to make the analysis more relevant and purposeful for policy formulation. The data were collected from various available sources. The study largely depends on the data available in the publications of the Centre for Monitoring Indian Economy (CMIE). Data on per capita average plan outlay, per capita state domestic product, percentage of urban population, number of small scale units registered, number of daily factory workers, net area sown, per capita consumption of electricity and per capita (rural) income from agriculture, were collected from the September, 1987 issue of the CMIE. Information on fertilizer consumption per hectare of gross cropped area and percentage of villages electrified were taken from September, 1986 issue of CMIE. Similarly, information were collected regarding percentage of population below poverty line and number of beds in hospitals per lakh population from February, 1988 and September, 1985 issues of CMIE, respectively. The data pertaining to two banking indicators viz. number of bank branches per lakh population and per capita bank credit were taken from the publication 'Industrial Data Book 1986' of the Centre for Industrial and Economic Research. Data pertaining to number of primary agricultural credit societies were collected from 'Important Items of Data - Credit & Non-Credit Co-operative Societies 1984-85' by the National Bank for Agriculture and Rural Development.

In some cases, scaling of data were done suitably, such as, per lakh population or per 10 lakh population and thus the indicators were related with the population of the States for uniform representation of data. There are also several other socio-economic indicators which reflect the overall development of States, standard of living of the people, etc. This analysis is, however, confined to only 15 important indicators as it is felt that these 15 indicators would substantially reflect the development of States in several spheres apart from other considerations relating to computational tasks and availability of data. The data were processed using computer facilities for different multivariate techniques/analysis packages available in the Indian Statistical Institute, Calcutta.

The indicators are listed below :-

1) Per capita average plan outlay,
2) Real per capita state domestic product in manufacturing sector,
3) Percentage of urban population,
4) Percentage of population below the poverty line,
5) Number of small scale units registered with SIDO per lakh population,
6) Average number of daily factory workers per lakh population,
7) Number of commercial bank branches per 10 lakh population,
8) Per capita bank credit (Rs.),
9) Fertilizer consumption per hectare of gross cropped area (Kg.),
10) Percentage of area sown to total geographical area,
11) Per capita consumption of electricity,
12) Percentage of villages electrified,

13) Number of beds in hospital per lakh population,
14) Per capita (rural) income from agriculture (Rs.),
15) Number of primary agricultural credit societies per thousand population.

II

Empirical Analysis through Multivariate Graphical Approaches

One of the major objectives of the study was to present the multivariate socio-economic indicators graphically in such a manner as to provide an insight into and facilitate a clearer understanding of the level of disparities or imbalances prevailing among the various States. The major problem confronted was the representation of data for several variables on a 2-dimensional plane. For this purpose, the advanced statistical techniques for representation of multivariate data have been made use of. Among these, some approaches take into account the entire set of data, such as, Chernoff Faces, Constellation Graphs, etc. But the more popular and widely used techniques for representing the multivariate data after reducing dimensionality are, Biplot, Dendrogram, etc. In the present study, three graphical approaches have been considered for analysing the imbalances or disparities which involve reducing dimensionality. They are (i) Cluster Analysis alongwith Dendrogram, (ii) Principal Component Analysis with its 2-dimensional representation of first two principal components, and (iii) Singular Value Decomposition method and Biplot technique.

Before analysing the data on the basis of three graphical approaches, a broad data analysis based on Statement I has been carried out. For this purpose Statement II presenting the ranks of different States for each of the variable are also taken into account. The data on ranks are broadly classified into four groups - 'Agriculture', 'Industry', 'Services' and 'Others'. The variables which are related to or influence development of any particular economic characteristic in above mentioned groups are clubbed together for simplicity of analysis. The analysis based on Statement I and Statement II as indicated above, are discussed. This is followed by a coverage of different methodologies and empirical analysis based on three graphical approaches viz. Cluster Analysis, Principal Component Analysis and Biplot technique, in that order.

1. Data Analysis based on 'Ranks' :

Data analysis has been carried out for different groups of items as classified in the Statement II. The data in Statement I and corresponding 'ranks' in Statement II are the main focal points for discussions about the level of imbalances that prevail among different States.

Agriculture

This group consists of three indicators, viz. (i) fertilizer consumption per hectare of gross cropped area, (ii) percentage of area sown to total geographical area and (iii) per capita (rural) income from agriculture. From Statement II, it is seen that Punjab was on the top of the list pertaining to all the three indicators. Haryana followed next securing total ranks 9 as against 3 for Punjab. In case of fertilizer consumption, Haryana lagged behind in comparison with Tamil Nadu, Andhra Pradesh and Uttar Pradesh. Per capita (rural) income from agriculture sector for Punjab (Rs. 2325/-) was almost double of that for Maharashtra (Rs. 1239/-), even though Maharashtra ranked third in case of this group of indicators. Haryana with per capita (rural) income from agriculture at Rs. 1880/- followed Punjab. In terms of total ranks pertaining to Agriculture, West Bengal ranked immediately after Punjab and Haryana. Assam was at the bottom of the scale in respect of 'fertilizer consumption' and 'percentage of area sown', while, Bihar was at the bottom in respect of 'per capita (rural) income from agriculture'.

Industry

Five indicators were considered in this group. Punjab was once again on the top of the list in respect of three indicators pertaining to 'number of small scale industries registered with SIDO', 'per capita consumption of electricity' and 'percentage of villages electrified'. Punjab ranked third in respect of 'per capita state domestic product in manufacturing sector' and was just behind Maharashtra and Gujarat which held first and second ranks, respectively. Though Maharashtra secured first position in respect of 'per capita SDP in manufacturing sector' and second position in respect of 'number of daily factory workers' and 'per capita consumption of electricity', in terms of the total ranks for industry-group, Maharashtra was placed in the fourth position behind Punjab, Gujarat and Haryana. However, 'per capita SDP in manufacturing sector' for Maharashtra was Rs. 304/- which was almost double of those for Punjab (Rs. 166/-) and Haryana (Rs. 157/-). Orissa, Assam and Bihar were placed at the bottom end of the scale with total ranks for this group of 64, 63 and 61, respectively.

Services

Four indicators were considered for this group and among them, two indicators related to banking. Maharashtra was at the top in respect of 'per capita bank credit' and 'number of primary agricultural credit societies'. It also held the second position in respect of 'number of beds in hospitals per lakh population', just behind Kerala. Punjab was on the top of the list in respect of 'number of commercial bank branches per 10 lakh population' followed by Kerala, Karnataka and Gujarat, respecitvely, in order. Bihar was again at the bottom in the total rank-hierarchy closely followed by Assam. But the third rank for this group from the bottom was held by three States - Madhya Pradesh, Orissa and Uttar Pradesh.

'Others'

Three indicators relating to 'per capita average plan outlay', 'percentage of urban population' and 'percentage of population below poverty line' are taken into consideration for this group. Punjab was on the top in respect of 'percentage of population below ,poverty line' followed by Haryana and Assam. Assam which was at the bottom in respect of seven indicators out of fifteen indicators chosen for the study moved up to third position in respect of 'percentage of population below poverty line'. In respect of 'percentage of urban population' Maharashtra topped the list and was followed by Tamil Nadu and Gujarat. Haryana was placed at the top in respect of 'per capita average plan outlay' followed by Punjab, Gujarat and Maharashtra, in order. Bihar which was at the bottom in total ranks for service group was also again at the bottom for this group preceded by Uttar Pradesh and Orissa.

Overall views

The overall comments of the ranking analysis can be made on the basis of total ranks as given in column (21) of Statement II. The picture emerging from the ranking pattern showed that Punjab was much ahead of other States securing total ranks as low as 38. The two States - Haryana and Maharashtra followed through at considerable distance with a rank of 61. This was closely followed by Gujarat (63). Bihar stood at the bottom-most position securing a score as high as 190. Assam and Orissa closely followed Bihar with a score of 182. Maharashtra and Haryana were placed in second position while the eleventh position was held by Assam and Orissa. West Bengal and Kerala were grouped in the sixth position. This analysis presents an overall view of the relative positions of States in the state of development. Six states - Punjab, Haryana, Maharashtra, Gujarat, Karnataka and Tamil Nadu scored less than 100 (total ranks). Among this group, three clusters may be thought of. They are (i) Punjab (Score : 38), (ii) Haryana, Maharashtra and Gujarat (Score : 61-63) and (iii) Tamil Nadu and Karnataka (Score : 90-95). The second group of States with scores between 100 and 160 were Andhra Pradesh, Kerala, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal. Among these six States, two clusters can be identified. Therefore, the fourth cluster may be thought of comprising Andhra Pradesh, Kerala and West Bengal (Score : 105-118) and fifth cluster may be formed by Madhya Pradesh, Rajasthan and Uttar Pradesh (Score : 131-155). The remaining three States - Assam, Bihar and Orissa which have scored between 161 and 200 form the third group and this group of States can be treated as sixth cluster (Score : 182-190). Thus, this analysis has facilitated categorisation into six clusters corresponding to levels of development as measured by total ranks. The *lower rank* represents a *better state of development.*

The analysis made above is similar to other rank analyses (weighted or unweighted) based on either per capita SDP or composite index of development [see, Iyengar, Nanjappa and Sudarsan (1980), N.S. Iyengar and P. Sudarsan (1981), Hemlata Rao (1984)]. This rank analysis, however, suffers from limitations as set out below:

(a) It fails to reveal the pattern of development and hence forming of group/cluster on the basis of this. Say, in reality development pattern of Maharashtra and Gujarat is quite different from that of Punjab and Haryana. But it cannot throw any light on this aspect.

(b) It does not take into consideration the dispersion (i.e. variance) of the variables and gives equal weights to all variables.

(c) Ranking sometimes might present some distortions. Thus, in Industry group, Maharashtra was placed in the twelfth position in respect of 'number of small scale units registered with SIDO' resulting in its overall placement in the third position after Punjab and Haryana. This may not be supported by evidence pertaining to other characteristics.

It is, therefore, necessary to opt for the more sophisticated and advanced multivariate techniques which could take care of all the above mentioned drawbacks of simple ranking device and then forming groups and clusters. Nevertheless, this ranking approach has helped to get preliminary idea about the cluster formation as well as the hierarchy-pattern of development to some exent. The different methodologies of three graphical approaches and the empirical analyses emerging therefrom are discussed in the following paragraphs.

2. Cluster Analysis : Dendrogram

The main objective of cluster analysis is to classify units/individuals into specific Clusters/Groups according to some chosen criteria. 'More formally, cluster analysis aims to allocate a set of individuals to a set of mutually exclusive and exhaustive groups such that individuals within a group are similar to one another while individuals in different groups are dissimilar' [Chatfield and Collins (1980), p.212]. It is, however, to be understood that there is no completely satisfactory way of defining a 'cluster', although we usually have an intuitive idea as to what is meant by the word 'cluster' and, therefore, different methods applied to the same set of data may produce different structures of clusters which are substantially different. In the cluster analysis, one has to divide the individuals into smaller sets or group them into larger sets, so that one eventually ends up with complete hierarchical structure of the given set of individuals called hierarchical tree and can be represented diagramatically. The hierarchical structure is often represented by two dimensional diagram and this diagram is called as 'tree diagram' or 'Dendrogram'. The tree is often presented 'upside down' so that the 'branches' are at the bottom and 'root' of the tree is at the top and it is necessary to arrange the individuals such that the branches of the tree do not cross over. As the individuals within the clusters are close together and the distance between clusters are relatively larger, normally accepted criteria adopted for the purpose of classification is either the Distance Matrix (or Dissimilarity matrix) or Affinity Matrix (or Similarity matrix). The Distance Matrix is formed by taking Euclidean Distance, D = ((d)),
where $d^2 = (x_{11} - x_{21})^2 + (x_{12} - x_{22})^2 + \dots\dots + (x_{1p} - x_{2p})^2$, for the two p-dimentional random vectors X_1 and X_2.

Given a set of observed distances between all individuals, there are many ways in which distances between groups of individuals can be defined. But 'a necessary and sufficient condition for an observed dissimilarity coefficient to be exactly represented by a Dendrogram is that it should satisfy the ultrametric inequality' [Chatfield and Collins (1980), p. 220]. The ultrametric inequality is defined as

$$d^*_{rs} \leq \text{Max} \quad (d^*_{rt}, d^*_{st})$$

for all individuals r,s,t, where d^*_{rs} denotes the threshold distance between individuals r and s.

Now after standardisation of each variable by substracting its mean and dividing it by its standard deviation and then taking 'Euclidean Distance', a Dendrogram is plotted based on 'Single - Link Method' which is perhaps the most important method for finding hierarchical tree or Dendrogram. [See, Hartigan, (1975), Chatfield and Collins (1980)]. The Distance Matrix based on the standardised variables is given in the Statement III and dendrogram drawn in the above manner is shown in Fig. 1.

Empirical Findings

The 'clusters' from Dendrogram are obtained by drawing a line perpendicular to the distance axis. If we consider the distance, d=3.5, then we get five distinct clusters such as (i) {BH, OR, MP, RJ, UP}, (ii) {AP, KT, TN, KE, WB, GU}, (iii) {HY}, (iv) {PN} and (v) {MH}. The least developed States, Bihar, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh and Assam form one cluster. Among the least developed States, Bihar and Orissa are almost similar, where distance is only 1.75. Again, Madhya Pradesh and Rajasthan, and Bihar and Uttar Pradesh are similar in nature, where the respective distances between the pairs are 1.83 and 1.86, respectively.

The second cluster is formed by all four southern States viz., Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, and West Bengal and Gujarat. Within this cluster, Karnataka and Tamil Nadu are nearer in developmental pattern. Actually, Andhra Pradesh, Karnataka and Tamil Nadu form a sub-cluster within the second cluster. West Bengal, Gujarat and Kerala have individual shortest distances with Andhra Pradesh. So, Andhra Pradesh becomes the focal State of this middle developed group of States.

The third and fourth clusters are formed by the highly agriculturally developed States - Haryana and Punjab, respectively. Though the distance between these two states is as high as 4.09, they are more similar in the developmental pattern.

The fifth cluster is formed by Maharashtra alone which is a highly developed State in respect of most of the indicators. In respect of 'per capita bank credit', it is far ahead compared to others. However, if we consider the distance d=4.3, then we get only three distinct clusters. They are (i) {AP, KT, TN, WB, GU, KE, BH, OR, MP, RJ, UP}, (ii) {HY, PN} and (iii) {MH}. It shows that except the three highly developed States - Haryana, Punjab and Maharashtra - all other 12 States fall into one cluster. Haryana and Punjab form the second cluster and Maharashtra forms the third cluster. As this does not lead to a sharp analysis of clusters, the former procedure of considering d=3.5 may have to be adopted.

It can be readily seen that the clusters which were formed earlier on the basis of the usual rank analysis is different from the clusters formed using Cluster Analysis technique. As per the former analysis, Punjab and Haryana which are agriculturally well developed States and similar in many respects actually formed one cluster at distance 4.09. Maharashtra and Gujarat were on the top of the list for the indicators particularly relating to urbanisation, industry, banking and agricultural co-operative societies. In the latter analysis also Punjab and Haryana formed exclusively one cluster but not Maharashtra and Gujarat. It is observed that though Maharashtra and Gujarat are nearer in respect of most of the indicators, the major difference arises in case of 'per capita bank credit'. The 'per capita bank credit'in Maharashtra was Rs. 1530/ - in 1984 which was about three times larger than that for Gujarat. This has perhaps led Maharashtra to be classified into a separate cluster in the Cluster Analysis. In a similar manner, Kerala, West Bengal and Gujarat become separate entities and they separately maintain minimum distances with the cluster of Andhra Pradesh, Karnataka and Tamil Nadu only.

Among the four southern States, Andhra Pradesh, Tamil Nadu and Karnataka are, more or less, similar. In rank analysis Andhra Pradesh could not be classified into the same cluster. Among the least developed States, Bihar and Orissa were similar and Assam maintained minimum distance of 2.76 with Bihar compared to that of Orissa which maintained a distance of 1.75 with Bihar. But in rank analysis Orissa and Assam scored equal ranks. Assam would have been considered the least developed State but its position improved in respect of 'percentage of population below poverty line'. Therefore, the formation of clusters on the basis of Cluster Analysis has led to a more rational basis of cluster formation compared with the cluster formed on the basis of rank analysis. Clusters based on Cluster Analysis come closer to reality and general perceptions of relative development of States.

3. Principal Component Analysis : 2-dimensional plot

In order to arrive at a composite index of development, it is desirable to assign some weights to different indicators. The weights should be based on proper and appropriate scientific criteria. Currently the technique of Factor Analysis is widely used by the regional planners and economists and research workers. In the Factor Analysis (FA), 'factor loading' which is nothing but the coefficient of correlation between the observed variables and the unknown derived factor are calculated. With the help of these factor loadings, the composite index of development is calculated [See, Iyengar, Nanjappa and Sudarsan (1980)]. The Principal Component Analysis which is similar to Factor Analysis is also widely used for developing composite index of development [See, Brian J. Berry (1960), A. Kundu (1980)]. In the recent past, Hemlata Rao (1984) has also used the Principal Component Analysis (PCA) for the construction of the composite index of development. PCA transforms a set of correlated variables to a new set of uncorrelated variables and the objective is to find out first few components which account for most of the variations in the original data. 'The difference between PCA and FA is that

PCA produces an orthogonal transformation of the variables which depends on no underlying model, while FA is based on a proper statistical model and is more concerned with explaining the covariance structure of the variables than with explaining the variances' [Chatfield and Collins (1980), p. 82]. The two methods are similar in one respect, viz. that they have no relevence if all the observed variables are approximately uncorrelated. Admittedly FA has some advantages over PCA, particularly as the maximum - likelihood estimation overcomes the scaling problem and a proper statistical model, with an error structure, is involved, but there are many drawbacks to FA, such as:

a) The assumptions about the model, independence of specific factors and common factors which are not always realistic in practice have to be made in setting up the FA model.

b) The concept of a set of underlying unobservable variables is one which may be reasonable in some situations, but is not appealing in many other practical situations.

c) The FA model assumes knowledge of m, the number of factors. In practice, m is often unknown and it is not easy to select the 'correct' value of m. In contrast, the components derived in PCA are unique (except where there are equal eigen-values).

d) Even for a given value of m, the factors are not unique as different methods of rotation may produce sets of factors which look quite different.

e) It is easy to calculate component scores for an individual in PCA but it is not easy to estimae factor scores from observed data.

f) The common factor and the specific factor each have a multivariate normal distribution.

Due to these drawbacks listed above, Chatfield and Collins (1980) recommended, "In view of the disadvantages listed above, we recommend that FA should not be used in most practical situations, although we recognize that this view will be controversial. "(See, p.89). In the present study, PCA technique only has been considered for evolving the composite index of development and also location of clusters visually. The usual objective of the PCA is to ensure if the first few components account for most of the variations in the original data and if they do so, then the effective dimensionality of the problem is less than p (where p is the number of original variables or dimension in data set). Then the first few components alone could be used in subsequent analysis where one can operate with a smaller number of variables. In other words, the main advantage of PCA lies in reducing the dimensionality of the data in order to simplify later analysis. Plotting the 'scores' of the first two components for each individual is a useful way of trying to locate 'clusters' in the data where one effectively reduces the dimensionality to two. "If the first two components 'explain' a 'large' proportion of the total variance, we can plot the 'scores' on these two components for each individual so that we can again look for clusters visually" [Chatfield and Collins (1980), p. 218]. The utility of this technique mainly depends to the extent of the total variances explained by the first two principal components. Normally, if the first two components fail to explain more than 50 per cent of the total variance, this technique should not be used. With the help of principal component analysis, p-dimensional matrix X_{nxp} can be represented by Z_{px2} (2-dimensional matrix) taking the first two principal component vectors. The desired matrix may be defined as Z_{px2} : (Z_1, Z_2) which explain at least 50 per cent of Σ, where Σ is the variance - covariance matrix of X. After analysing the data in the present study, it was observed that the variances explained by different components were as under :

Table 1 : **Variance explained by Components in Principal Component Analysis**

Components	**Variance explained**	**Cumulative proportion of total variance**
1	8.65	0.58
2	2.55	0.75
3	1.35	0.84
4	0.91	0.90
5	0.46	0.93
6	0.32	0.95
7	0.26	0.97
8	0.22	0.98
9	0.19	0.99
10	0.08	1.00
11	.	.
12	.	.
13	.	.
14	.	.
15	0.00	1.00
Total Variance	15.00	1.00

As the variance explained by the first two components was about 75 per cent of total variances, the first two components can very well be taken for computing the values of Z_1 and Z_2. The values of the Component Loadings (P_i, i = 1,2) and the corresponding Component Scores ($Z_i = P_i X_i$, i = 1, 2) are given below:

Table 2 : Value of Component Loadings and Component Scores in Principal Component Analysis

Component Loadings			Component Scores		
Variable	Component-1	Component-2	State	Component-1	Component-2
1.	2.	3	4.	5.	6.
X_1	0.845	0.355	Andhra Pradesh	2490.13	- 43.56
X_2	0.813	0.488	Assam	1523.01	-287.82
X_3	0.776	0.471	Bihar	1457.19	-41.88
X_4	-0.686	0.403	Gujarat	3899.46	352.09
X_5	0.667	-0.618	Haryana	4191.80	-326.57
X_6	0.861	0.336	Karnataka	3162.37	301.96
X_7	0.762	-0.131	Kerala	2719.27	247.10
X_8	0.619	0.715	Madhya Pradesh	2034.14	-183.73
X_9	0.627	-0.336	Maharashtra	2034.14	1083.43
X_{10}	0.784	-0.406	Orissa	2034.14	-325.20
X_{11}	0.925	0.055	Punjab	2034.14	-843.85
X_{12}	0.838	0.079	Rajasthan	2034.14	-393.52
X_{13}	0.690	0.277	Tamil Nadu	2933.42	646.47
X_{14}	0.739	-0.555	Uttar Pradesh	1751.93	-221.76
X_{15}	0.684	0.331	West Bengal	3253.49	305.40

With the help of these two components, a 2-dimensional graph was plotted (Fig.2) taking first component on X-axis and second component on Y-axis. The average scores are taken at the centre of the axes. The component loadings are the correlation coefficients between the original variables and the derived components. The first principal component also has explained 58 per cent total variance of the original variables. From Table 2, it is observed that the first component is highly correlated with most of the variables, with a positive correlation coefficient with each variable except X_4 (percentage of population below the poverty line). It shows that general development as reflected by the first component is inversely related with the percentage of population below the poverty line. Again it is seen that the first component is highly correlated (more than 80%) with the variables X_1 (per capita average plan outlay), X_2 (real per capita SDP in manufacturing sector), X_6

(average number of daily factory workers), X_2 (per capita consumption of electricity and X_{12} (percentage of villages electrified). The correlation coefficients for other variables are also high and lie between 60 to 80 per cent. The second component has positive component loadings or correlations with X_2 (real per capita SDP in manufacturing sector, 0.49), X_4 (percentage of urban population, 0.47) and X_8 (per capita bank credit, 0.72); and in contrast, negative correlations for such variables as X_5 (number of small scale units registered with SIDO, -0.62) and X_{14} (per capita income from agriculture sector, -0.56). It can be interpreted such as that this factor distinguishes between urban-banking-industry based developed States and SSI-agriculture based developed States clearly. As the first component is uncorrelated with the second component and they are perpendicular to each other, these can be represented graphically in 2-dimensional plane easily. If one variable has a much larger variance than those of other variables, then this variable will dominate the first principal component of the covariance matrix whatever be the correlation structure between the original variables and the first component. PCA method leads us to a better understanding of the correlation structure and may facilitate generating some hypotheses regarding the inter relationship among the variables. PCA also helps us to indentify meaningful variables (say, highly correlated variables like X_1, X_2, X_6, etc.) which emerge as better development indicators. In this study, PCA has been used mainly to reduce the dimensionality of the problem as a prelude to further analysis of the data.

From the 2-dimensional plot of the first two principal components (Fig. 2), it was observed that similar to Cluster Analysis, it also displayed the pattern of similarity or dissimilarity of the States. This exercise confirmed that Bihar, Assam, Orissa, Uttar Pradesh, Madhya Pradesh and Rajasthan can broadly be grouped together to form one cluster located in the third quadrant of the plane. The scores of both the principal components are below average scores for each of the above mentioned States which can be interpreted to point out to the fact that these States are the least developed States. The scores for Andhra Pradesh and Kerala which are nearer to the average score indicates that these two States are at the middle stage of development. All the industrially developed States like Tamil Nadu, Karnataka, West Bengal, Gujarat and Maharashtra fall in the first quadrant having the scores above average score. Among these States, Tamil Nadu, Karnataka and West Bengal may be considered as one cluster. Similar to the earlier Dendrogram analysis, Maharashtra alone can be treated as a separate cluster. Again, Gujarat was situated between Maharashtra and the cluster of Tamil Nadu, Karnataka and West Bengal. The first principal component can be regarded as some sort of weighted average of the variables and can be regarded by itself as a measure of development as it alone takes care of 58 per cent of total variance (λ_1, = V $(Z_1) = 8.56$ out of total variance 15). If the States are ranked according to the first principal component, then the following pattern in the rank-hierarchy emerged : -

Table 3 : **Rank of the States in Developmental Pattern according to First Principal Component**

Rank	State	Rank	State
1	Punjab	9	Andhra Pradesh
2	Maharashtra	10	Rajasthan
3	Haryana	11	Madhya Pradesh
4	Gujarat	12	Uttar Pradesh
5	West Bengal	13	Orissa
6	Karnataka	14	Assam
7	Tamil Nadu	15	Bihar
8	Kerala		

The Table 3 above has brought out clearly that Punjab, Maharashtra and Haryana top the list in order of development. Similarly, from the bottom, Bihar, Assam and Orissa hold the lowest development status in that order. These broadly correspond to the Dendrogram analysis discussed earlier.

If the States are ranked according to 'per capita net State Domestic Product (SDP)' which is generally the accepted criteria for comparison of the economic performance of the States, the following pattern has emerged :

Table 4 : **Per capita Net State Domestic Product at Constant (1970-71) Prices in 1984-85**

Rank	State	Amount (in Rs.)
1.	Punjab	1566
2.	Haryana	1110
3.	Maharashtra	1017
4.	Gujarat	970
5.	West Bengal	833
6.	Karnataka	772
7.	Tamil Nadu	745
8.	Andhra Pradesh	705
9.	Rajasthan	679

Rank	State	Amount (in Rs.)
10.	Kerala	607
11.	Assam	584
12.	Uttar Pradesh	580
13.	Madhya Pradesh	574
14.	Orissa	512
15.	Bihar	476
	All-India	775

Source : CSO, New Delhi, *Estimates of State Domestic Product*, June 1987,

If the States are compared according to this rank-hierarchy with the ranking pattern of first principal component, it is observed that the pattern of the first 7 ranks remain intact in both cases except in case of Haryana and Maharashtra, where second and third ranks have been interchanged between these two States. In the principal component analysis, Maharashtra with the total component score of 4450.34 had come as a closer second behind Punjab for which the component score was 4571.17, whereas, Haryana was placed in the third position with total component score of 4191.80. In the ranking based on per capita SDP criteria, Haryana followed Punjab having per capita net SDP of Rs. 1110/- compared with Rs. 1566/- for Punjab. Maharashtra was placed in the third place having per capita SDP of Rs. 1017/-. The ranks for Gujarat, West Bengal and Karnataka remained same in both the ranking patterns but wider variations were observed in principal component analysis.

Again, Bihar turned out to be the least developed State by both the criteria. The placement of States in ranks 8 to 14 differed substantially in case of ranking based on SDP criterion with those based on first principal component criterion. Assam and Rajasthan which are less developed States closer to Bihar in many respects rank higher and Kerala has gone down in the ranking hierarchy by the per capita SDP criterion. Kerala which is one of the middle stage developed State in many respects, especially in demographic and social respects, holding 8th position by principal component criterion was placed in 10th position by per capita SDP criterion and even Rajasthan was placed above Kerala. Similarly, Assam which is to be considered as the least developed State according to many socio-economic criteria as discussed in the previous chapter (cluster analysis), was placed just below Kerala and above Uttar Pradesh, Madhya Pradesh, Orissa and Bihar in the ranking pattern based on SDP criterion.

This analysis has clearly brought out that per capita SDP criterion above could not always take into account developments in the various spheres and justified our earlier observation that SDP alone cannot be regarded as very satisfactory measure of overall economic development. In contrast, cluster analysis and principal component analysis emerge as more analytical and highly useful tools for analysis of relative variations in development of States based on multi-variate approaches.

4. Singular Value Decomposition : Biplot

Sometimes, it is preferable to represent multivariate data (p-dimensional) in two dimensions only possibly with super imposition of some extra information on the graphs. In this respect, it turns out to be a superior method than the earlier two methods. This procedure addresses itself to the problem of finding a k-dimensional (k = 2 in practice) sub-space (k < p) in which the n data points in p dimensions are represented, such that these sets of points are as close as possible. Suppose a data point $\underset{\sim}{x}_j$ is approximated by a point $\hat{\underset{\sim}{x}}_j$ in a k-dimensional sub-space S, distance (d_j) between $\underset{\sim}{x}_j$ and $\hat{\underset{\sim}{x}}_j$ is defined as

$$d_j^2 = ||\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j||^2 D_p = (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)^T D_p (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)$$

where D_p is a p-dimensional diagonal matrix of positive numbers indicating weights for each variable. Each data point has a weight w_j, j = 1, 2, ..., n attached to it. The elements of D_p could be reciprocals of variances and in many situations w_js may be equal also. Then we may define the closeness of $(\underset{\sim}{x}_1, \underset{\sim}{x}_2, ..., \underset{\sim}{x}_n)$ to a sub-space S to be

$$\Psi (S; \underset{\sim}{x}_1, \underset{\sim}{x}_2, ..., \underset{\sim}{x}_n) = \sum_{j=1}^{n} w_j d_j^2.$$

It can be shown that the search for optimal (corresponding to *minimum* Ψ_s) sub-space S may be restricted to those which contain the centroid $\bar{\underset{\sim}{x}}$ of $(\underset{\sim}{x}_1, \underset{\sim}{x}_2, ..., \underset{\sim}{x}_n)$; thus we can modify Ψ as $\Psi (S; \underset{\sim}{x}_1, \underset{\sim}{x}_2, ..., \underset{\sim}{x}_n)$

$$= \sum_{j=1}^{n} w_j (\underset{\sim}{x}_j - \bar{\underset{\sim}{x}} - \sum_{l=1}^{k} f_{jl} \underset{\sim}{v}_l)^T D_p (\underset{\sim}{x}_j - \bar{\underset{\sim}{x}} - \sum_{l=1}^{k} f_{jl} \underset{\sim}{v}_l)$$

where $\underset{\sim}{v}_1, \underset{\sim}{v}_2, ..., \underset{\sim}{v}_k$ are basis vectors of the sub-space, $\hat{\underset{\sim}{x}}_j$ being equal to $\bar{\underset{\sim}{x}} + \sum_{l=1}^{k} f_{jl} \underset{\sim}{v}_l$. The complete solution to the problem of minimising ψ to find $\underset{\sim}{v}_1, \underset{\sim}{v}_2, ..., \underset{\sim}{v}_k$ is given by Singular Value Decomposition (SVD) procedure and Low Rank Matrix Approximation. The SVD is essentially an expression of a matrix X_{nxp} of rank r in the following form :

$$X_{nxp} = U_{nxr} D_{rxr} V^T_{rxp}$$

$$\text{i.e. } X = \sum_{l=1}^{r} \alpha_l u_l v_l$$

Where $U^T U = I = V^T V$ and D_α is a diagonal matrix with elements $\alpha_1 \geq \alpha_2 \geq .... \geq \alpha_r \geq 0$.

Here $\propto_1, \propto_2$ .... $\propto_r$ are desig r orthonormal n-vectors u_1, u_2 .... u_r of U called left singular vectors are an orthonormal basis of the columns of X and are the eigenvectors of XX^T with associated eigenvalues $\propto_1^2, \propto_2^2$ .... $\propto_r^2$. Similarly, the r orthonormal p-vectors $\underset{\sim}{v}_1, \underset{\sim}{v}_2$ .... $\underset{\sim}{v}_r$ of V called right singular vectors, are an orthonormal basis of the (transposed) rows of X and are the eigenvectors of X^TX with associated eigenvalues $\propto_1^2, \propto_2^2$ .... $\propto_r^2$. It can be shown that if SVD exists and if $\propto_1, \propto_2$ .... $\propto_r$ are distinct, then SVD represents unique reflections in corresponding singular vectors. The matrices $F = UD\propto$ and $G = VD\propto$ contain co-ordinates of the rows and columns of X with respect to basic vectors in V and U, respectively.

Householder - Young Theorem : If X has Singular Value Decomposition (SVD), $X = UD\propto V^T = \sum_{l=1}^{r} \propto_l u_l v_l^T$

and if $\hat{X}$ or $X_{(K)} = \sum_{l=1}^{k} \propto_l u_l v_l^T$

then $X_{(K)}$ is the solution to the problem of minimising

$$||\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j||^2 = \Sigma\Sigma\ (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)^T (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)$$

i.e. $\Psi\ (S; \underset{\sim}{x}_1, \underset{\sim}{x}_2, \ldots\ldots, \underset{\sim}{x}_n) = \sum_{j=1}^{n} d_j^2$

Considering the more general case, we have

$\Psi\ (S; \underset{\sim}{x}_1, \underset{\sim}{x}_2, \ldots\ldots, \underset{\sim}{x}_n) = \Sigma\, w_j\, (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)^T D_p\, (\underset{\sim}{x}_j - \hat{\underset{\sim}{x}}_j)$ Solution to this minimisation problem is obtained by following extension of SVD. We can write

$$X = N\ \ D_\mu\, M^T, \text{ where } N^T\Omega N = I,\ M^T\phi M = I$$

$$D_\mu = \text{Diag}\,[\mu_1, \mu_2, \ldots\ldots, \mu_r],$$

where $\mu_1 \geq \mu_2 \geq \ldots\ldots \geq \mu_r$ and Ω, ϕ, are p.d. matrix.

This forms the basis of BIPLOT technique.

The Biplot : A biplot is a graphical display of a matrix X of n rows and p columns by means of markers $a_1, a_2, \ldots a_n$ for its rows and markers $b_1, b_2, \ldots b_p$ for its columns. These markers are chosen in such a way that the inner product a_i T b_j represents x_{ij}, the (i,j) th element of X. Now, if we assemble all the 'a' markers as columns of a matrix A and all the 'b' markers as columns of a matrix B, then this inner product relationship means that matrix product A^TB represents the matrix X itself. The prefix 'bi' in biplot does not refer to its being two dimensional but indicates that it is a joint display of rows and columns of the matrix X. The matrix X could be biplotted exactly if it is of rank one or two, because the biplot itself is planar. For a matrix of higher rank several steps have to be taken in order to display it by an approximate biplot. Then in the first step X is approximated by using SVD as $\hat{X}$ or $X_{(2)}$ of rank 2 and $\hat{X}$ is biplotted.

i.e. $\hat{X} = U_{(2)}\, D\propto_{(2)}\, V^T_{(2)}$

The second step is to factorise this rank 2 approximation $X_{(2)}$ as a product A^TB of a matrix $A^T_{(nx2)}$ and a matrix $B_{(2xp)}$. The third step is to take each column of matrix A as row marker 'a' and each column of matrix B as a column marker 'b' and plotted as an approximate biplot of the original matrix X. Here the problem is to minimise the function

$$\sum_i \sum_j (x_{ij} - x_{ij}^{(2)})^2$$

subject to elements of a rank 2 matrix

$$X_{(2)} = A^TB$$
$$= (A^TR)(R^{-1}B),$$

where R is a non-singular matrix. This factorisation is not unique. The non-uniqueness of the factorisation has some advantages for the statistician, who may choose a factorisation which has desirable data-analytic or statistical features. One particular attractive factorisation is referred to as the GH^T factorisation. This has orthonormal column for G. Then

$$X_{(2)} = GH^T$$
$$\text{and } X_{(2)}^T X_{(2)} = HG^T GH^T = HH^T,$$

which is specially useful if the rows of X represent individuals and the columns represent variables. Then $X_{(2)}^T X_{(2)}$ is n times the estimated variance-covariance matrix, and so the inner products of rows h of H in a GH^T biplot represent the covariance and the squared lengths of h's represent the variances. The cosines between h-vectors, therefore, represent the correlations between the variables. (See, K. R. Gabriel (1981), p. 31).

Empirical Findings

The NAG package of program which is available in the ISI computer has the required routine for SVD. This package was used to compute the required quantities for Biplot. Now considering the data in the Statement I as a matrix X where the rows are 15 States and the columns are 15 different variables, i.e., development indicators, the values of $G_{(nx2)}$ and $H^T_{(nx2)}$ matrices were obtained as follows :-

$$G = \begin{bmatrix} 18.055 & -3.007 \\ 11.804 & -9.170 \\ 10.550 & -1.212 \\ 27.728 & 8.386 \\ 30.511 & -7.750 \\ 22.640 & 5.631 \\ 18.936 & 4.165 \\ 14.574 & 4.486 \\ 30.636 & 19.001 \\ 12.502 & -10.370 \\ 32.666 & -19.947 \\ 15.317 & -11.967 \\ 19.391 & 15.743 \\ 12.284 & -6.380 \\ 24.170 & 8.018 \end{bmatrix} \qquad H^T = \begin{bmatrix} 9.564 & -2.989 \\ 6.147 & 3.004 \\ 1.086 & 0.253 \\ 1.373 & -0.011 \\ 6.084 & -3.824 \\ 54.168 & 19.474 \\ 3.138 & 0.455 \\ 25.148 & 21.028 \\ 2.520 & -0.669 \\ 2.506 & -0.635 \\ 8.928 & 0.007 \\ 3.534 & -0.037 \\ 3.983 & 0.961 \\ 54.779 & -28.305 \\ 0.618 & 0.024 \end{bmatrix}$$

Where G represents the States according to chronological order as given in Statement I and

H^T represents 15 indicators given serially in the Statement I.

Now, for the matrix X, a GH^T biplot is drawn in Fig. 3. It is biplotted after the mean of each column of G and H^T has been subtracted from the entries in the respective columns.

The points or the row markers represent States; the arrows or the column markers represent the growth indicators. The lengths of the arrows represent the variances of different indicators and the angles represent their correlations between indicators. The centre of this biplot is at the State-mean or centroid of all these indicators.

Looking at the configuration of the fifteen indicators, it is observed that large variances exist for X_6 (average no. of daily factory workers), X_8 (per capita bank credit) and X_{14} (per capita (rural) income from agriculture) which indicate that these three indicators varied substantially from State to State. But the variances are relatively smaller for all other indicators. The correlations are also interesting. On the left hand side of the plot, the angles between X_3, X_4, X_7, X_9, X_{10}, X_{11}, X_{12}, X_{13} are fairly small which indicate the high correlations existing between these indicators. Again X_1 (per capita average plan outlay) is highly correlated with X_5 (the average no. of daily factory workers per lakh population). Similarly, X_2 (real per capita state domestic product from manufacturing sector) is related with X_3 (percentage of urban population). The indicators X_6, X_8, and X_{14} with higher variances fall on the right side of the graph and are not correlated with other indicators. But X_6 (average no. of daily factory workers per lakh population) is somewhat related with X_8 (per capita bank credit).

Looking at the points for States, it is observed that all the undeveloped States fall on the left side of Y-axis. Kerala and Tamil Nadu fall nearer to Y-axis indicating that they are neither developed nor to be considered as undeveloped States. Andhra Pradesh falls nearer to origin which shows the average representation of Indian Union as per development concept.

All the undeveloped States, i.e., Assam, Bihar, M.P., Orissa, Rajasthan and UP fall in the third quadrant. The four industrially developed States Maharashtra, Gujarat, West Bengal and Karnataka fall in the first quadrant and Kerala and Tamil Nadu in the second quadrant. Again, the agriculturally developed States Punjab and Haryana fall in the fourth quadrant. This biplot not only displays the configuration of the variables (i.e. indicators) and the scatterness of the individuals (i.e. States) but also relates the two. It, therefore, reveals the relationships of variables with the individuals as to which States are influenced by the specific development indicators. Thus, Punjab and Haryana are influenced by the indicator X_{14} (i.e. per capita income from agriculture). Similarly, Gujarat, Karnataka, Maharashtra, Tamil Nadu and West Bengal are influenced by indicators X_6 (average no. of daily factory workers per lakh population) and X_8 (per capita bank credit). Among them Maharashtra is highly influenced by 'per capita bank credit ' and Punjab is highly influenced by 'per capita income from agriculture ' to a greater extent.

III
CONCLUSIONS

India is a large country with divergent geographical and natural endowments which have led to distortions in economic development in different parts of the country. The development policies of the country accordingly lay great emphasis on the need to secure social justice through economic development of all regions in the country. Reducing the imbalances among States and among different classes of people of the society through significant and concerted efforts has always been the focus of the country's Five Year Plans. Despite the several measures taken by the Government and the policy thrust towards development of backward regions of the country on a priority basis, still there are considerable disparities prevailing in the different States of the country and even within different parts of developed States. It is, therefore, necessary to monitor the efforts for reduction in imbalances over the period so that resources can be diverted to still backward States and backward pockets in developed States. In this context it was, therefore, felt that it is necessary to evolve objective quantitative monitoring tools which could be used for on an ongoing basis. For this purpose, it is required to identify what could clearly be construed as broad band of indicators of development encompassing several sectors of the economy and forge them into an overall measure of development. The state domestic product can be used as an overall indicator of development, but it has its own limitations as an overall measure which focuses on only income aspects and cannot bring out the structural transformation and improvement in the quality of life which are reflected by other indicators of development in specific sectors. It was, therefore, necessary to consider many other indicators also for a proper study of disparities existing among the different States in several sectors on the basis of selected important socio-economic indicators. Though several studies have been done by many researchers, the studies were statistically confined to the methodology of deriving the composite index of development by Factor Analysis or by Principal Component Analysis. Some of them have also measured the 'disparity' prevail-ing among the States or among the districts in India by 'Percentage of Coefficient of Variation' or by 'Gini-Coefficient' or by 'Theil's Index', mostly based on single variate distribution. In this study, three graphical packages involving sophisticated techniques have been used to reveal the disparities prevailing among the major States of India in or around the year 1984-85. The statistical techniques involving sophisticated multivariate analysis would considerably facilitate a clearer insight into and a more meaningful analysis of the imbalances. Besides, usual rank analysis based on the selected indicators and on 'Composite index' developed by principal component analysis have also been carried out as usually done by the other researchers.

Three graphical techniques have been considered for the present study, each of them having its own advantages and limitations. These are as follows:-

i) Dendorgam using Cluster Analysis

ii) 2-dimensional representation of first two principal components using Principal Component Analysis, and

iii) Biplot presentation involving use of Singular Value Decomposition technique.

In the Dendrogram analysis, the states could be classified under similar clusters which are internally homogenous. It also gives the measurement of closeness in terms of the smallest distance prevailing between any two States/ Clusters of States/Clusters of States through the analysis of 'Euclidean distances' based on 'Single-Link Method.' In the 2-dimensional plot of the first two principal components, it was possible to classify the States according to the nature of development and also to visualise how they were scattered on the two dimensional plane based on the first wo principal components which substantally explain the total variance of the indicators (75 per cent). Further, it was possible to rank the States even according to first principal component alone as it accounted for more than 50 per cent variability of the development indicators. Like the Principal Component Analysis, Biplot representation classifies the States according to the nature of development. The Biplot technique is conceptually superior to earlier techniques of Cluster Analysis and Principal Component analysis. It gives graphical representation of variances and correlations of the indicators. It displays not only the configuration of the variables and the scatterness of States, but also relates the both. Thus, it provides a larger degree of insight into the divergencies prevailing among the States.

All the three analyses broadly bring out the major aspects of imbalances in States. It can be seen from Dendrogram analysis that Punjab and Haryana emerged as States having similar developmental patterns. In 2-dimensional plot, Punjab was far away from the Central point (average point of development) indicating that it was the highest developed State compared to other States. When the States are ranked according to the first prinicpal component analysis, Punjab again was placed on the top of the list of developed States. Biplot graphical analysis also confirmed that Punjab was ahead of other States in overall development.

The development of Punjab and Haryana was mainly influenced by the indicator 'per capita (rural) income generated from agriculture'. This again confirmed the pivotal position of these States in adopting modern agricultural practices and as leaders of the green revolution. The cluster analysis showed that Punjab, Haryana form one cluster and Maharashtra alone would be placed in one cluster which was unique in nature. The same can be visualised from the 2-dimensional plot of principal components and Biplot representation also. According to the rank criteria of first principal component, Maharashtra fall in the second position in the development ranking. Biplot analysis showed that the development of Maharashtra was mainly influenced by the banking activity (per capita bank credit) and industrial development and concentration of financial market in Maharashtra. Gujarat, West Bengal, Tamil Nadu and Karnataka formed a cluster. The Dendrogram analysis had brought out that among these industrialised States, Karnataka and Tamil Nadu were similar in nature of development and according to the ranking of first principal component, Karnataka was better placed in comparison to Tamil Nadu. Biplot on the other hand indicated that Tamil Nadu was far away from the average point of development. The distance of Tamil Nadu in the Biplot was far away from the central point and came only behind Maharashtra and Punjab.

According to the rank criteria, Tamil Nadu held the 7th rank of development. Biplot and the 2-dimensional plot of principal components revealed that Karnataka and West Bengal were nearer in the pattern of development and Gujarat maintained the minimum distance with these two States. According to rank criteria of first principal component, Gujarat and West Bengal were placed in the 4th and 5th position in developmental list. All other less developed States-Bihar, Assam, Orissa, Rajasthan, Uttar Pradesh and Madhya Pradesh-formed one cluster as shown by Dendrogram. The same was confirmed from the 2-dimensional plot and Biplot. Bihar, Assam, Orissa and Rajasthan maintained, mre or less, equal distance from the central point of development and on the left hand side of the Y-axis in the Biplot, whereas most of the developed States (either industrially or agricultirally) were situated on the right hand side of the Y-axis. Biplot showed that Andhra Pradesh along-with Kerala is nearer to the central point of development. All these points seem to have Andhra Pradesh in the middle stage of development and could be construed as presenting the median position of India as a whole.

Again, all the three types of analyses confirmed that Bihar was the least developed State among all the 15 States considered in the study. According to Dendrogram analysis, Orissa was closer to Bihar and can be considered as coming next to Bihar. But according to rank criterion of first principal compnent, Assam was next to Bihar. From Biplot it was seen that Orissa and Assam were nearer to each other and Assam in turn was comparatively nearer to Bihar. Therefore, Assam and Orissa can, by and large, by considered as closely following Bihar in their state of development. Similarly, the next three ranks (4th, 5th, 6th) from the bottom of the list of development referred to the States - Rajasthan, Uttar Pradesh and Madhya Pradesh and actual rank of these States differed depending on the analysis chosen for the study.

The above study has clearly brought out the various implications of development of States through a well structured broad based analysis of selected criteria for development. Though these three types of analyses differ to some extent in their ranking of States, the overall classification of development emerged clearly and there was close consistency in the group classifications of States. The analysis has also brought out the relative strength of States in various indicators which again broadly was in line with similar conclusions emerging from other studies also. Thus, the different types of analyses have provided a sharper insight into the prevalent imbalances in 1984-85 (or nearest to this period) which would not be available in the traditional comparison of State Domestic Product as overall indicator of development. Studies of the above type particularly coinciding with the plan periods could be utilised for monitoring of progress achieved in each of the plan period and to evaluate the extent of reduction of imbalances to enable proper appreciation of the relative success or otherwise of the governmental efforts in this regard.

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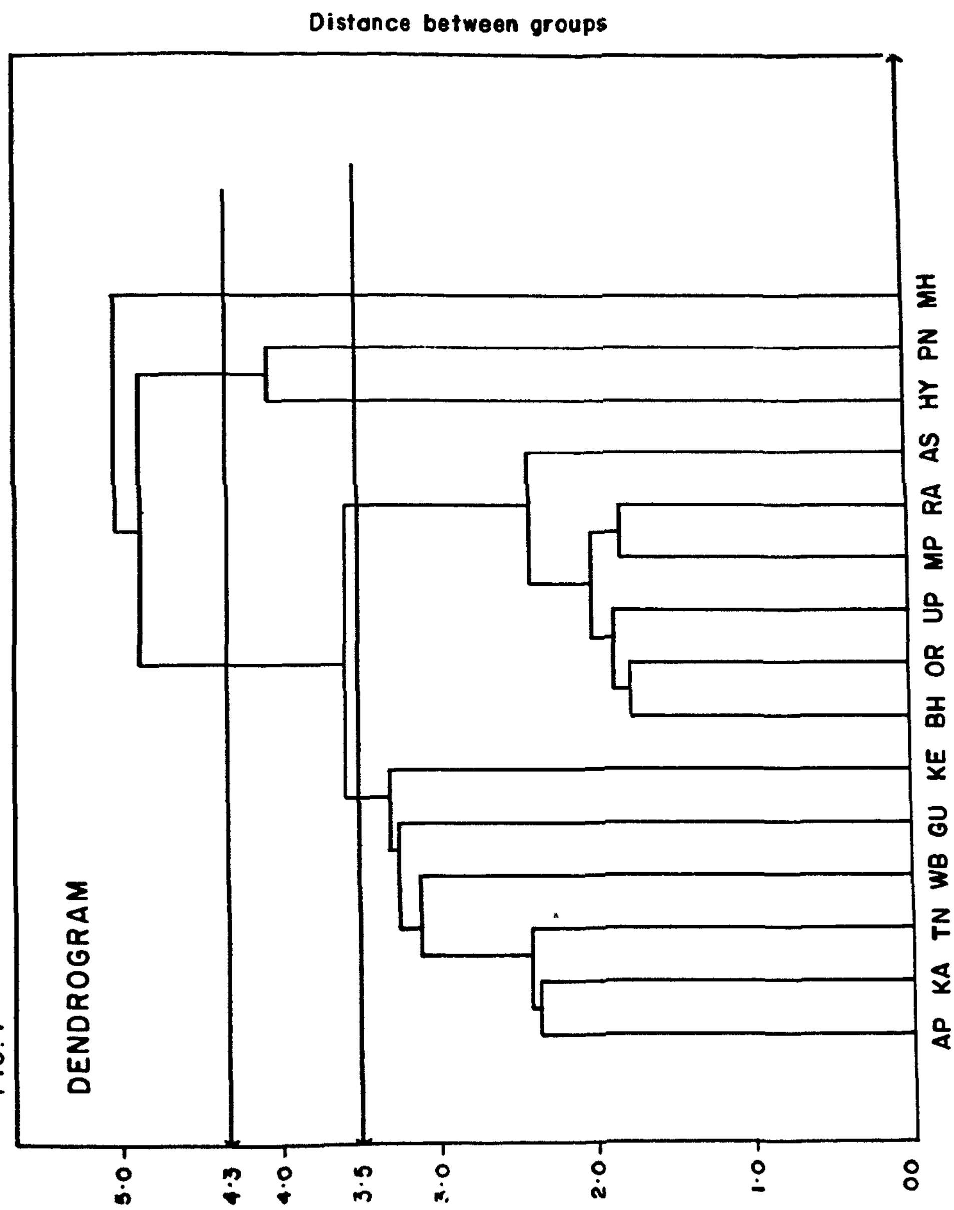

Distance between groups
DENDROGRAM
AP KA TN WB GU KE BH OR UP MP RA AS HY PN MH
5·0
4·3
4·0
3·5
3·0
2·0
1·0
00

FIG. 1

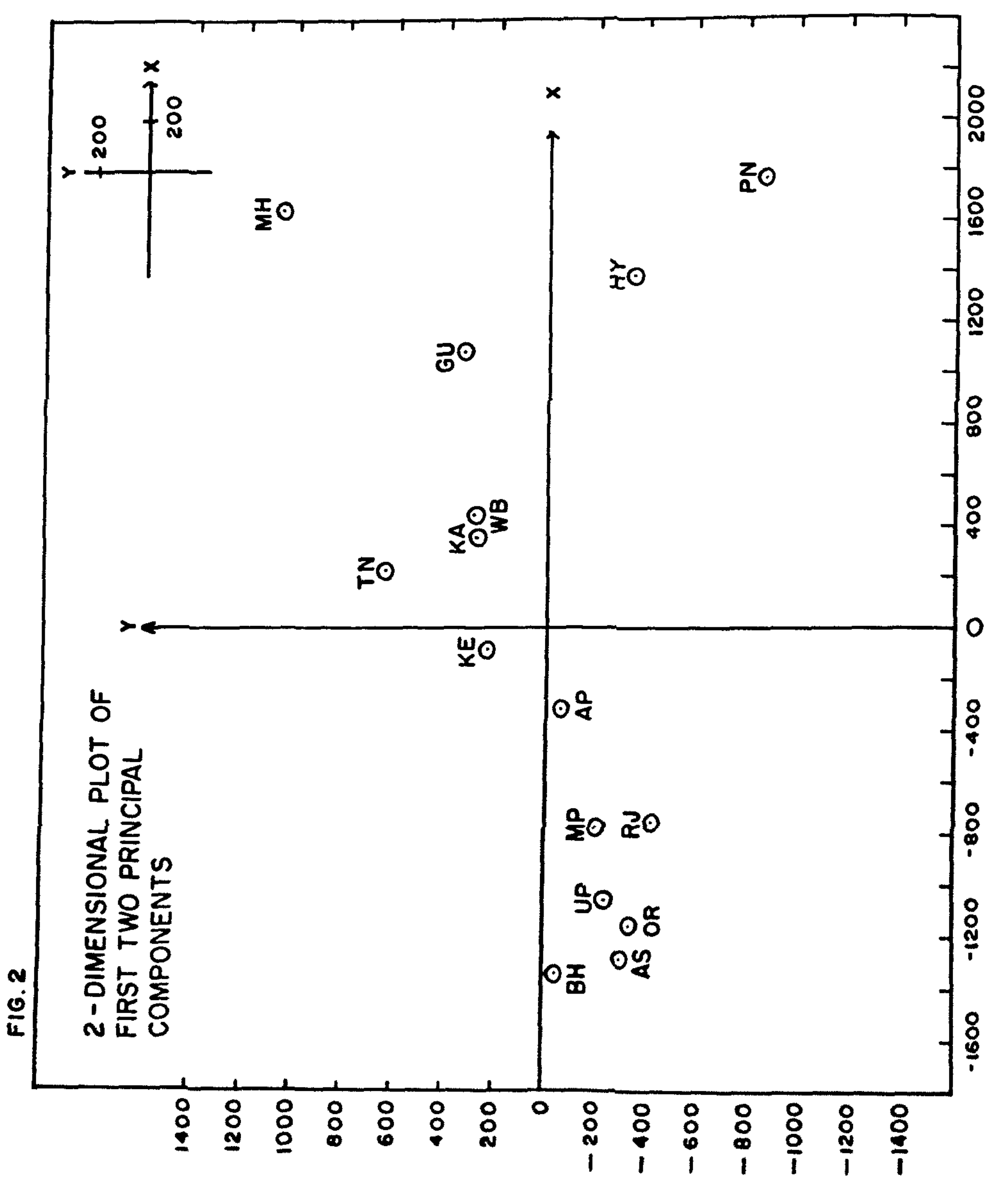
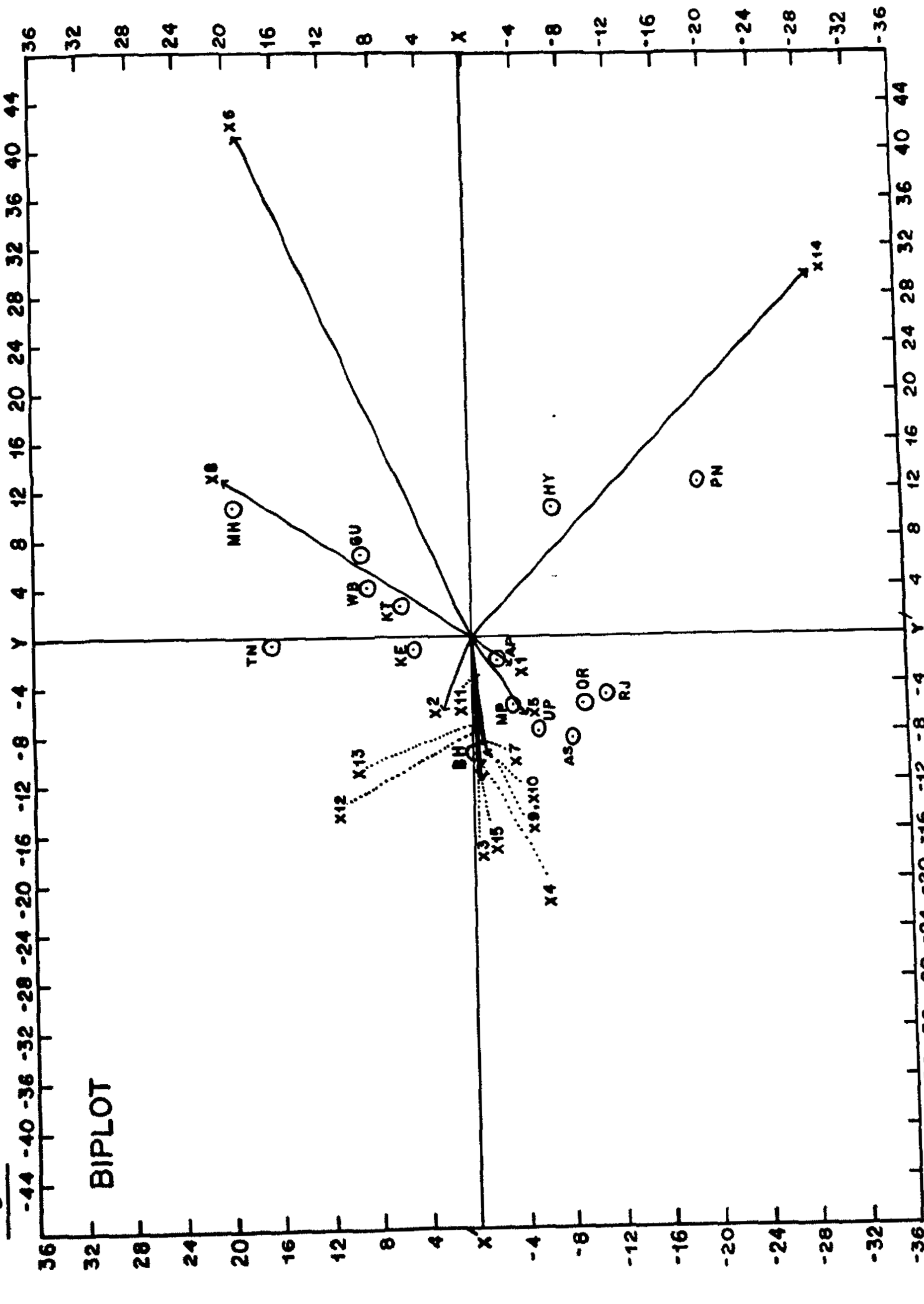


FIG. 2

2-DIMENSIONAL PLOT OF FIRST TWO PRINCIPAL COMPONENTS

Fig:3


BIPLOT
X6
X8
X14
MH
GU
WB
KT
TN
KE
HY
PN
AP
X1
OR
RJ
MP
X5
UP
AS
X2
X11
X13
X12
BH
X7
X9,X10
X3
X15
X4
X
Y

Statement 1 : Comparative Socio - Economic Indicators for Major States in India

State	Per capita average plan outlay (Rs.) [1st to 6th plan]	Real per capita State Domestic Product in Manufacturing Sector (Rs.) 1984-85	Percentage of urban population 1984	Percentage of population below poverty line 1983-84	Number of small scale units registered with SIDO per lakh population 1984@
	X_1	X_2	X_3	X_4	X_5
(1)	(2)	(3)	(4)	(5)	(6)
1. Andhra Pradesh	154	81	23.3	36.41	75
2. Assam	148	69	10.3	23.5	26
3. Bihar	115	63	12.5	49.5	49
4. Gujarat	262	210	31.1	24.3	121
5. Haryana	378	157	21.9	15.6	255
6. Karnataka	172	158	28.9	35.0	87
7. Kerala	160	80	18.8	26.8	82
8. Madhya Pradesh	169	74	20.3	46.2	142
9. Maharashtra	244	304	35.0	34.9	56
10. Orissa	152	21	11.8	42.8	44
11. Punjab	351	166	27.7	13.8	342
12. Rajasthan	157	48	20.9	34.3	113
13. Tamil Nadu	163	152	33.0	39.6	95
14. Uttar Pradesh	144	80	18.0	45.8	88
15. West Bengal	148	117	26.5	39.2	198

Source : 1) Cols. 2, 3, 4 & 6 from CMIE, September 1987
2) Col. 5 from CMIE, February 1988.

@ : Compiled by dividing the data by the estimated population data 1985.

Statement I : Comparative Socio - Economic Indicators for Major States in India

(Contd.)

State	Average number of daily factory workers per lakh population June, 1984@ X_6	Number of commercial bank branches per 10 lakh population 1984@ X_7	Per capita bank credit (Rs.) 1984@ X_8	Fertilizer consumption per hectare of gross cropped area (Kg.) 1984-85 X_9	Percentage of net area sown to total geographical area 1983-84 X_{10}
(1)	(7)	(8)	(9)	(10)	(11)
1. Andhra Pradesh	887	65	438	75.1	41.59
2. Assam	439	35	135	4.1	34.42
3. Bihar	609	45	152	35.9	43.59
4. Gujarat	1862	78	592	46.3	48.87
5. Haryana	1518	72	593	57.8	81.43
6. Karnataka	1378	91	631	52.6	55.32
7. Kerala	1075	96	611	43.9	56.09
8. Madhya Pradesh	734	59	225	17.1	43.34
9. Maharashtra	1763	68	1530	28.5	59.48
10. Orissa	385	55	222	13.0	38.47
11. Punjab	1427	106	327	151.2	83.59
12. Rajasthan	492	61	282	11.1	47.42
13. Tamil Nadu	1417	73	726	99.9	44.98
14. Uttar Pradesh	485	53	245	65.1	58.66
15. West Bengal	1563	48	671	54.8	60.17

Source : 1) Cols. 7 & 11 from CMIE, September 1987.
2) Cols. 8 & 9 from *Industrial Data Book 1986*, Centre for Industrial and Economic Research, New Delhi,
3) Col. 10 from CMIE, September 1986.

@ : Compiled by dividing the data by the estimated population data of 1985.

Statement I : Comparative Socio - Economic Indicators for Major States in India *(Concld.)*

State	Per capita consumption of electricity (Utilities + Non-utilities) (KWH) 1984-85 X_{11}	Percentage of villages electrified 1984-85 X_{12}	Number of beds in hospitals per lakh population 1984 X_{13}	Per capita (rural) income from agriculture (Rs.) 1982-85 X_{14}	Number of primary agricultural credit societies per thousand population June 1985 X_{15}
(1)	(12)	(13)	(14)	(15)	(16)
1. Andhra Pradesh	167	83.9	67	1093	12
2. Assam	47	53.7	49	928	10
3. Bihar	87	49.4	39	590	9
4. Gujarat	282	88.3	118	1210	18
5. Haryana	229	100.0	63	1880	16
6. Karnataka	190	83.1	90	1074	12
7. Kerala	129	100.0	176	933	6
8. Madhya Pradesh	157	57.1	33	905	10
9. Maharashtra	292	92.8	135	1239	27
10. Orissa	126	50.5	44	1017	10
11. Punjab	354	100.0	125	2325	17
12. Rajasthan	131	59.5	58	1222	14
13. Tamil Nadu	229	99.7	85	578	9
14. Uttar Pradesh	109	56.0	47	869	7
15. West Bengal	129	50.4	92	1075	13

Source : 1) Cols. 12 & 15 from CMIE, September 1987.
2) Col. 13 from CMIE, September 1986.
3) Col. 14 from CMIE, September 1985.
4) Col. 16 from Important items of Data Credit & Non-credit Co-operative Societies 1984-85, NABARD.

Statement II : Ranking of States according to development criteria in four Groups - Agriculture, Industry, Service and Others

State	Agriculture			
	Fertilizer consumption per hectare of gross cropped area X_9	Percentage of area sown to total geographical area X_{10}	Per capita (rural) income from agriculture X_{14}	Total Rank R_1
(1)	(2)	(3)	(4)	(5)
1. Andhra Pradesh	3	13	6	22
2. Assam	15	15	11	41
3. Bihar	10	11	14	35
4. Gujarat	8	8	5	21
5. Haryana	5	2	2	9
6. Karnataka	7	7	8	22
7. Kerala	9	6	10	25
8. Madhya Pradesh	12	12	12	36
9. Maharashtra	11	4	3	18
10. Orissa	13	14	9	36
11. Punjab	1	1	1	3
12. Rajasthan	14	9	4	27
13. Tamil Nadu	2	10	15	27
14. Uttar Pradesh	4	5	13	22
15. West Bengal	6	3	7	16

Source : Statement I

Statement II : Ranking of States according to development criteria in four Groups - Agriculture, Industry, Service and Others (*Contd.*)

State	Industry					
	Per capita SDP in manufacturing sector X_2	Number of small scale units registered with SIDO X_5	Number of daily factory workers per lakh population X_6	Per capita consumption of electricity X_{11}	Percentage of villages electrified X_{12}	Total Rank R_2
(1)	(6)	(7)	(8)	(9)	(10)	(11)
1. Andhra Pradesh	8	11	9	6	5	39
2. Assam	11	15	14	13	10	63
3. Bihar	12	13	11	12	13	61
4. Gujarat	2	5	1	3	4	15
5. Haryana	5	2	4	4	1	16
6. Karnataka	4	9	7	5	6	31
7. Kerala	9	10	8	9	1	37
8. Madhya Pradesh	10	4	10	7	8	39
9. Maharashtra	1	12	2	2	3	20
10. Orissa	14	14	15	10	11	64
11. Punjab	3	1	5	1	1	11
12. Rajasthan	13	6	12	8	7	46
13. Tamil Nadu	6	7	6	4	2	25
14. Uttar Pradesh	9	8	13	11	9	50
15. West Bengal	7	3	3	9	12	34

Source : Statement I.

Statement II : Ranking of States according to development criteria in four groups - Agriculture, Industry, Service and Others

(Contd.)

State	Services				
	Number of commercial bank branches per 10 lakh population	Per capita bank credit (Rs.)	Number of beds in hospitals per lakh population	Number of primary agricultural credit societies per thousand population	Total Rank
	X_7	X_8	X_{13}	X_{15}	R_3
(1)	(12)	(13)	(14)	(15)	(16)
1. Andhra Pradesh	8	8	8	7	31
2. Assam	15	14	11	8	48
3. Bihar	14	15	14	9	52
4. Gujarat	4	7	4	2	17
5. Haryana	6	6	9	4	25
6. Karnataka	3	4	6	7	20
7. Kerala	2	5	1	11	19
8. Madhya Pradesh	10	12	15	8	45
9. Maharashtra	7	1	2	1	11
10. Orissa	11	13	13	8	45
11. Punjab	1	9	3	3	16
12. Rajasthan	9	10	10	5	34
13. Tamil Nadu	5	2	7	9	23
14. Uttar Pradesh	12	11	12	10	45
15. West Bengal	13	3	5	6	27

Source : Statement I.

Statement II : Ranking of States according to development criteria in four groups - Agriculture, Industry, Service and Others *(Concld.)*

State	Others				
	Per capita average plan outlay (Rs.) X_1	Percentage of Urban population X_3	Percentage of population below poverty line* X_4	Total Rank R_4	Overall Rank $(R_1 + R_2 + R_3 + R_4) = R_5$
(1)	(17)	(18)	(19)	(20)	(21)
1. Andhra Pradesh	10	7	9	26	118 (7th)
2. Assam	12	15	3	30	182 (11th)
3. Bihar	14	13	15	42	190 (12th)
4. Gujarat	3	3	4	10	63 (3rd)
5. Haryana	1	8	2	11	61 (2nd)
6. Karnataka	5	4	8	17	90 (4th)
7. Kerala	8	11	5	24	105 (6th)
8. Madhya Pradesh	6	10	14	30	150 (9th)
9. Maharashtra	4	1	7	12	61 (2nd)
10. Orissa	11	14	12	37	182 (11th)
11. Punjab	2	5	1	8	38 (1st)
12. Rajasthan	9	9	6	24	131 (8th)
13. Tamil Nadu	7	2	11	20	95 (5th)
14. Uttar Pradesh	13	12	13	38	155 (10th)
15. West Bengal	12	6	10	28	105 (6th)

Source : Statement I.

* : Rank for this indicator is given in the ascending order as higher value of this indicator will reflect less development.

Statement III : Distance Matrix for the 15 Major States

STATE	AP	AS	BH	GU	HY	KA	KE	MP	MH	OR	PN	RJ	TN	UP	WB
AP	0	3.92	3.54	3.25	6.44	2.38	3.62	3.37	6.10	3.54	7.23	3.47	2.84	3.54	3.12
AS		0	2.76	6.92	7.58	5.66	5.82	3.63	8.83	2.41	10.18	3.75	6.35	3.77	5.07
BH			0	6.83	7.77	5.11	5.78	2.00	8.69	1.75	10.17	2.98	5.61	1.86	4.79
GU				0	4.61	3.25	4.72	5.43	4.68	6.51	5.78	5.12	3.65	5.81	4.22
HY					0	4.89	5.95	6.45	6.18	7.41	4.09	5.94	6.03	6.36	5.36
KA						0	3.30	3.86	5.04	4.95	6.59	3.71	2.41	4.11	3.21
KE							0	5.17	6.91	5.50	7.40	4.67	4.20	5.00	4.79
MP								0	7.35	2.04	8.71	1.83	4.50	2.26	3.59
MH									0	8.51	7.76	7.25	6.34	8.02	5.94
OR										0	9.70	2.09	5.67	2.32	4.55
PN											0	8.42	7.33	8.70	7.45
RJ												0	4.85	2.56	3.60
TN													0	4.52	3.81
UP														0	3.54
WB															0

Source : Statement I.

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Weighted Monetary Aggregates : Rationale and Relevance for India

Narendra Jadhav *

Introduction

THE question of the appropriate definition of money is one of the most recurring issues in economics. Economic theory has not provided a clear-cut, complete and unequivocal answer to this question and it probably, cannot. On the one hand, there are transaction theories of money which view money essentially as an inventory held for transaction purposes. Accordingly, the medium of exchange function of money is emphasised and its narrow concept covering currency and demand deposits is favoured. On the other hand, asset theories follow a broader approach, in which, money and other assets are regarded as alternative ways of holding wealth. In that case, both the fundamental functions of money, i.e., the medium of exchange as well as store of value, are emphasised and broader measures of money stock covering currency, demand deposits and other money substitutes are preferred.

In view of the ambivalence associated with the proper definition of money, monetary authorities all over the world present alternate measures of money, leaving the choice to individual researchers and to the dictates of specific situations. The classification of monetary aggregates currently used by most central banks is based either on the functional characteristics of monetary assets or the insitutional distiniction between banks and non-banks. For example, in India the distinction between M1 and M3 is based on separation of time deposits with banks (which are deemed to be less liquid) from assets like currency and demand deposits with banks (which are highly liquid). Furthermore, the distinction between M1 and M3 on the one hand and M2 and

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M4 on the other, is based solely on the institutional differentiation between banks and post office saving organisation.

These developments on the operational side have broadly reflected the corresponding evolution of the theory of monetary aggregation. The earliest theoretical work was based on the medium of exchange function of money. Both, currency and demand deposits were deemed to constitute money since demand deposits can be used for transaction purposes. It was Friedman who argued for extending the definition of money to include time deposits on the ground that money serves to bridge the gap between receiving and making of payments. Gurley and Shaw (1960) went a step further and advocated yet another extension that included not only the assets with banks but also those with other financial depositories or intermediaries, which led to even broader monetary aggregates.

Surprisingly, in the subsequent period, the link between theoretical developments and operational practices has become considerably weaker; in that, subsequent theoretical refinements have not been adequately or universally absorbed in the compilation of monetary aggregates by authorities. It is evident that differences in alternate monetary aggregates in most countries are still confined exclusively to their composition based on whether or not to include a specific asset **in its entirety**, in a specific aggregate much the same way as recommended by Friedman and Gurley-Shaw before the early 1960s.

An important strand of research, initiated by an Indian economist, Chetty, way back in 1969, forcefully argued that each monetary asset has a certain degree of "moneyness" associated with it. The fundamental issue in monetary aggregation is **not** which assets are to be included in the measure of money stock, but **how much of each** monetary asset is to be included. A logical approach to monetary aggregation, therefore, is to construct monetary aggregates covering all assets, weighted by their degree of "moneyness".

Since the early 1980s, with changes in financial markets of the industrial countries including the deregulation of financial institutions and innovations in financial instruments, the issue of the appropriate measurement of money has again come into a sharp focus. Building on the earlier work by Chetty (1969) a promising new line of research has emerged at the Federal Reserve Bank of New York led by Barnett, Offenbacher, Spindt and others.

These innovations in the theory and practice of monetary aggregation may have some relevance for developing countries like India. The Indian economy, for example, has witnessed a significant financial deepening and disintermediation in recent years[1]. It is important, therefore, to understand the rationale behind the weighted monetary aggregates, to critically review the alternate approaches to make them operational and to examine their relevance for compilation of monetary aggregates in a developing economy like India. That is precisely the primary objective of this paper.

The study is organised as follows: Section I presents the rationale behind the notion of weighted monetary aggregates. Section II provides an analytical appraisal of the available approaches for constructing weighted monetary aggregates and examines their operational relevance in the context of developing countries. Section III attempts a critical survey of relevant empirical studies in the Indian context. Finally, Section IV presents conclusions.

I

Rationale for Weighted Monetary Aggregates

In devising monetary aggregates, a distinction needs to be maintained between the concept of money and measure of money. Logically, conceptualisation of money must precede its measurement[2].

In a fundamental sense, money stock in any economy can be conceptualised as a quantity aggregate that reflects the source of monetary services that could be generated in the economy. Since monetary services in an economy are rendered by various financial assets like currency, demand deposits, saving deposits, time deposits and the like, it is necessary to combine the potential flows of monetary services by each of these assets into one or more aggregates.

The conventional monetary measures are simple-sum monetary aggregates because they are derived by simple summation over relevant assets. Thus, a measure of narrow money in India, M1, is obtained by simply adding currency with public and demand deposits while a

1. See Jadhav (1988) for discussion on some aspects of recent financial deepening and disintermediation in India.

2. This principle has recently been emphasised by Bhole (1987).

measure of broad money, M3, is obtained by a further addition of time deposits to M1[3].

The unsatisfactory nature of simple-sum monetary aggregates has long been recognised in literature. Hawtrey (1930), Gurley (1960), Friedman and Meiselman (1963) and Kane (1964) have pointed out some limitations of the conventional approach. Indeed, Fisher observed way back in 1922 (in a general context) that the "simple-sum index was the worst index" because it possessed two undesirable properties, i.e., "bias and freakishness".

In the context of monetary aggregation, two shortcomings of the simple-sum aggregates are especially noteworthy:

1) The simple-sum monetary aggregates implicitly assign equal weights to all components, which is inconsistent with economic theory. To give an extreme example, if one wished to obtain measure of transportation vehicles, it is absurd to aggregate over physical units such as cars and bullock carts by simple summation. A meaningful economic measure would be a weighted - sum aggregate, with weights reflecting relevant value-shares. The same principle ought to apply to monetary aggregation.

2) The simple-sum aggregates would be justified in terms of economic theory only if the components included in them were perfect substitues of each other. Mathematically, it would mean that the elasticity of substitution between any pair of components is infinite. In other words, simple summation of currency and time deposits (as is done for M3 in India) would be justified only if the degree of "moneyness" associated with these two assets is the same. The conventional simple-sum monetary aggregates are undesirable because they treat distant (or imperfect) substitutes for currency as perfect substitutes, which is irreconcilable with economic intuition and the overwhelming empirical evidence.

Thus, the simple-sum measures can, in principle, badly distort monetary aggregates. The conventional monetary aggregates are "accounting" measures and hence, may not be suitable for meaningful economic analyses. As observed succinctly by Friedman and Schwartz (1970):

3. 'Other deposits' with RBI which are included in M1 are omitted here for expositional convenience.

"This (simple summation) procedure is a very special case of the more general approach. In brief, the general approach consists of .... defining the quantity of money as the weighted sum of the aggregated value of all assets, the weights for individual assets varying from zero to unity with a weight of unity assigned to that asset or assets regarded as having the largest quantity of 'moneyness'.... . The more general approach has been suggested frequently but experimented with only occasionally. We conjecture that this approach deserves and will get much more attention that it has so far received" (p. 151).

Indeed, the early 1980s have witnessed a growing interest in the concept of weighted monetary aggregates. There is an ever increasing flow of research studies dealing with different aspects of the problem. Various strands in this area of research are examined in the next section.

II

Alternate Approaches to Weighted Monetary Aggregates: An Analytical Appraisal

Alternate approaches to construction of weighted monetary aggregates can be divided into three broad groups :

a) Substitution Approach
b) User-cost Approach
c) Policy-oriented Statistical Approach

A. *Substitution Approach*

The basic premise of this approach, based on the pioneering work of Chetty, is that the degree of 'moneyness' associated with any financial asset depends on the elasticity of substitution between that asset and a reference asset that is designated to be the most liquid asset. Thus, "moneyness" of time deposits would depend upon the elasticity of substitution between time deposits and say, currency.

For expository purpose, suppose that narrow money (M) is to be aggregaed with time deposits (T). Chetty stipulates a one consumer economy with the consumer's utility over these two assets given by the CES type utility function:

$$\text{(Eq.1)}\ u = [\ \beta_1\ M^{-\varrho} + \beta_2\ T^{-\varrho}]^{-1/\varrho}$$

In this utility function, as is known, the elasticity of substitution between the two assets (σ) is given by

$$\sigma = \left(\frac{1}{1+\rho}\right)$$

Suppose that the consumer has cash holdings of $\bar{M}$ and wishes to allocate them between M and T. If T is the cash value of time deposits in the next period and if R is the interest rate on time deposits of the current period, then the budget constraint of the consumer can be written as

$$\text{(Eq. 2)}\ \bar{M} = M + \left(\frac{T}{1+R}\right)$$

The slope of the budget line is -(1 + R), which implies, in the parlance of microeconomic theory, that (1 + R) can be considered as the ratio of "prices" of money to time deposits.

The consumer's utility maximisation subject to the budget constraint yields the following marginal conditions:

$$\text{(Eq. 3)}\ \frac{\partial u}{\partial M} = \lambda$$

$$\text{(Eq. 4)}\ \frac{\partial u}{\partial T} = \frac{\lambda}{1+R}$$

where (λ) = Lagrange multiplier.

Dividing (eq.3) by (eq. 4), we get,

$$\frac{\left(\frac{\partial u}{\partial M}\right)}{\left(\frac{\partial u}{\partial T}\right)} = \frac{\beta_1}{\beta_2}\left(\frac{M}{T}\right)^{-(1+\rho)} = 1+R$$

Taking logarithms, rearranging terms and adding a disturbance term, we get the following regression model :

$$\text{(Eq. 5)}\ \log\left(\frac{M}{T}\right) = \left[-\frac{1}{1+\rho}\log\left(\frac{\beta_2}{\beta_1}\right)\right] + \left(\frac{1}{1+\rho}\right)\log\left(\frac{1}{1+R}\right) + \epsilon$$

It may be noted from eq. (5) that estimate of the elasticity of substitution[4] between the two assets is directly given by the slope coeffi-

4. The relationship between the elasticity of substitution referred to by Chetty and the traditional interest elasticity has, at times, caused needless confusion. For a recent example of misinterpretation, see Bhole (1987), p. 899.

The conventional interest elasticity is defined as $e = \left(\frac{\partial \log M}{\partial \log R}\right)$ which measures % change in M for one % chage in R, whereas, the elasticity of substitution referes to the Hicks - Allen measure defined as $\sigma = \frac{\partial \log (M/T)}{\partial \log (1/1+R)}$ which measures the % change in the ratio of M to T induced by a percentage change in the relative "prices".

cient ($\frac{1}{1+\varrho}$). Also the slope coefficient yields estimate of (ϱ) which on substitution in the intercept term provides estimate of ($\frac{\beta_2}{\beta_1}$). Chetty assigns the value 1 for (β_1) on the grounds of ordinality of the utility function and thus derives the estimate for (β_2).

Having obtained estimates of the relevant parameters ϱ , β_2 (with β_1 assumed to be unity), the "adjusted" measure of broad money stock (M*) is obtained by substituting these values in the utility function. Thus,

$$M^* = \left[M^{-\varrho} + \beta_2 T^{-\varrho}\right]^{-1/\varrho}$$

where M* = "adjusted" money stock

The same method can be readily extended to more than two assets. Subsequent researchers have added further refinements to the approach[5].

The substitution approach is well-grounded in the economic theory and is, therefore, intuitively appealing. On the analytical plane, however, it is beset with some unpleasant features:

1. In Chetty's specification of the relative interest term, it is not clear whether the relevant degree of substitution is measured by elasticity or semi-elasticity.[6]

2. In Chetty's formulation, once the estimates of relevant parameters are obtained, estimates of the "adjusted" money stock are derived by inserting them into the utility function. In this process, the analytical link between the elasticity (or semi-elasticity) of substitution and the degree of "moneyness" if the relevant assets becomes obscure.

3. The original model of the substitution approach applied by Chetty to Indian data for the period 1945 to 1966 yielded unduly large elasticities of substitution. For example, the elasticity of substitution between narrow money (M) and time deposits turned out to be as high as 34.7, which meant that the two were 'very good substitutes' of each other in the Indian context (or equivalently, the "moneyness" of time deposits was as high as the "moneyness" associated with currency or demand deposits).

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5. For example, see Boughton (1981), Husted and Rush (1984).

6. This is because, mathematically, $\left[\log \frac{1}{1+\varrho}\right] \approx -R$. See Husted & Rush (1984) p. 175.

Subsequent research has shown that this somewhat counter-intuitive result emanated from shortcomings in Chetty's empirical specification. Boughton (1981), for example, has demonstrated that the elasticities of substitution between money and each of the tested substitutes were "much lower than earlier estimates (by Chetty)".

Inspite of the obvious appeal of the substitution approach, it has received, at best, a lukeworm response from monetary authorities[7]. From the operational point of view, the principal shortcoming of the substitution approach is that it involves estimation of model parameters. This parameter sensitivity means that the approach is illequipped to deal with a changing payments mechanism or the spectrum of financial assets, and therefore, has limited operational relevance in the context of developing countries like India.

B. User-Cost Approach

This approach, popularised by the FED economists like Barnett, Offenbacher and Spindt, aims at providing parameter-free money stock measures in accordance with the recent developments in the theory of economic aggregation.

In this approach, conceptually, alternate monetary assets are viewed as durable goods and therefore, their "prices" are represented by the corresponding user costs. The user cost of any real durable good is nothing but its imputed one-period holding cost. Accordingly, user-cost of a durable good is given by its purchase price in current period **minus** discounted expected resale value of the depreciated good in the next period. The same principle can be applied to a monetary asset in order to derive the relevant user cost[8]

Each monetary asset, as a durable good, generates monetary services. A unit of monetary services may be defined as that amount of monetary asset in question which buys one unit of a commodity basket in the base period. Suppose a consumer hold X units of the assets and has to pay Xp units of the asset to buy one unit of a commodity basket in the base period, then he holds (X/Xp) units of monetary services.

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7. C. Rangarajan (1988), (Presidential Address to the 71st Annual Conference of the Indian Economic Association (p. 11), for a recent example.

8. The concept of user cost of money in this form was suggested first by Diewert (1974).

Unlike the other durable goods where the service flow is expected to be reduced in the next period owing to physical depreciation, for monetary assets there is no depreciation.[9] On the contrary, interest bearing monetary assets appreciate in terms of their ability to generate monetary services. For example, if (r_t) is the nominal interest rate on the asset, then a consumer holding (X/Xp) units of monetary services at t would hold $\left[\frac{X(1+r_t)}{X_P}\right]$ units of monetary services in the next period.

Now, the consumer has to pay (Xp) units of the asset to buy one unit of moetary services in period t (i.e. its purchase price in current period is Xp). The discounted expected resale value in the next period is given by $\left[\frac{(1+r_t)X_P}{1+R_t}\right]$ and hence the user cost of the monetary asset in question is given by

$$\text{(Eq. 6)}\ \pi = X_p - \left[\frac{(1+r_t)X_p}{1+R_t}\right]$$

where R_t = reference rate of interest used for discounting.

Once the usser-costs of alternate monetary assets are obtained, the relevant monetary aggregate can be derived in a straightforward manner : Suppose that there are (u) monetary assets with balances M1, M2, ... Mn.

Let $\pi_1, \pi_2 \ldots\ldots\ldots \pi_n$ be the corresponding user costs.

Then the "moneyness" associated with the (i^{th}) asset is simply the corresponding user cost evaluated value share in the total. Thus, "moneyness" of (i^{th}) asset

$$\text{(Eq.7)}\ S_i = \frac{\pi_i M_i}{\sum_{i=1}^{n} \pi_i M_i}$$

and the weighted monetary aggregate is given by

$$\text{(Eq. 8)}\ M^* = \sum_{i=1}^{n} S_i M_i$$

The monetary aggregate thus derived can also be expressed as statisti-

9. For expositional convenience, it is assumed here that there is no change in the general price level. Donovan (1978), however, has shown that price movements do not affect the result.

cal index numbers. Indeed, the early versions of the approach used the Divisia method to construct the relevant index numbers and hence were also called "Divisia monetary aggregates"

Divisia monetary aggregates (Qt) over n assets with balances M_{1t}, M_{2t} M_{nt} at time t are defined such that

$$\text{(Eq. 9)} \ (\log Q_t - \log Q_{t-1}) = \sum_{i=1}^{n} S^*_{it} \ (\log M_{it} - \log M_{it-1})$$

$$\text{where } S^*_{it} = \frac{1}{2} (S_{it} + S_{it-1})$$

In other words, the monetary aggregate based on Divisia index is such that percentage change in the index is equal to the weighted average of percentage changes in individual monetary assets, relevant weights being the user-cost evaluated value shares.

An important advantage of the User-Cost approach to weighted monetary aggregates is that the relevant measures are parameter-free. Unlike the Substitution approach, therefore, this approach is readily adaptable to the changing financial milieu without any cumbersome reestimation requirement. On the other hand, there are some conceptual and practical problems, especially in the context of developing countries :

1. In the User-Cost approach, "money" is regarded as a capital aggregate akin to Friedman's conception presented in his "Restatement of the Quantity Theory of Money" (1956). Accordingly, demand for money by wealth holders is treated as a problem in capital theory. In that sense, a money good is analytically indistinguishable from any other 'capital good'. As pointed out by Spindt (1985), "this conception of money is insufficiently narrow for the analytical and empirical purposes of some monetary economists who .... emphasize the primary significance of money's distinctive role as means of payment" (p. 177). In this regard, several other studies have argued that the special role of money goods in the trading process constitutes the fundamental property of money, because it results in an important asymmetry between money goods and other goods as sources of effective demand[10]. The User-Cost approach involves an unduly broad connotation of monetary services, which, apart from the general acceptability as a means of payment, also covers many other things such as liquidity, divisibility, surety of nominal value, etc, and is, therefore, conceptually imprecise.

10. See Spindt (1985), p. 177.

2. Construction of weighted monetary aggregates or indices in this approach depends critically on measurement of user costs of relevant monetary assets. Typically, in such efforts the user costs of monetary assets are proxied by the following formula:

User cost of (i^{th}) monetary asset during time 't' = $R_t - r_{it}$

Where R_t = the expected maximum available yield on the chosen benchmark asset during time 't';

r_{it} = own rate of return on the (i^{th}) asset during time 't'.

In this regard, Judd and Scadding have rightly observed that such an approach to computig user costs is useful "for a world in which interest rates on monetary assets are unregulated".[11] In developing countries like India where the interest rate structure is an administered one, however, use of this kind of formula can be potentially hazardous. After all, if the primary purpose of constructing weighted monetary aggregates is to eliminate (or atleast alleviate) the potential distortions in the measurement of money stock, it would be ironical if new distortions (such as those involved in computation of user costs) are allowed to creep in. Such distortions may defeat the very purpose of constructing the weighted monetary aggregates, ostensibly in the name of improvement. Thus, with the User-Cost approach, possibility of remedy turning out to be worse than the disease cannot be ruled out, especially in the context of developing countries.

C. Policy-Oriented Statistical Approach

According to this approach, money stock is best measured as that aggregate of financial assets which, when introduced in quantitative relationships among money, output and prices, gives the best results in terms of certain preconceived and predetermined criteria.

Roper - Turnovsky method is a variant of this broad approach that seems to have received the maximum attention in the relevant literature. According to the Roper - Turnovsky method, the optimal monetary aggregate is the one which minimises the forecast variance in nominal income. Thus,

$$M(RT) = \sum_{i=1}^{n} \emptyset_{it} M_{it}$$

where M_{it} = i^{th} monetary asset during time t,

$\emptyset_{it}$ = optimal weight for (i^{th}) asset during time t.

11. Judd & Scadding (1982).

The optimal weights $\theta_{it}^{'s}$ are derived by minimising the forecast variance in nominal income using a Vector Autoregressive System (VAR).

This approach is also beset with several conceptual and operational problems:

1. In economic analysis, as in any scientific process, the purpose of empirical work is to test adequacy of concepts and verify theoretical hypotheses. Empirical state, therefore, comes only **after** the relevant concepts are already defined and hypotheses are rigorously derived from a suitable economic model. The fundamental flaw of this approach is that it is characterised by a logical 'frog-leap'[12]. It aims directly at the measurement of money without its prior conceptualisation. Indeed, the conceptualisation is sought to be done in terms of measurement, rather than the other way round.

2. Even when the lack of theoretical underpinnings is ignored, the Policy-oriented Statistical Approach does **not** lead to a determinate empirical definition of money. It has been pointed out that there is no generally agreed criterion as a standard for making judgement[13]. Roper - Turnovsky's criterion is only one of the several possible candidates. With different criteria, a whole spectrum of monetary aggregates could be derived and it does not seem possible to claim universal superiority of one measure over all others. Even **if** it were possible to identify a criterion that is globally optimal, the composition of monetary aggregates may differ widely as between different countries, time periods, functional forms and models. Finally, even when these issues are resolved **somehow**, the future stability of estimated empirical regularities cannot be taken for granted. Needless to say, therefore, that the analytical foundations of this approach are weak and rather tenuous.

3. The only redeeming feature of this approach is the excellent forecasting ability of the resultant monetary aggregates. Even this feature is not as attractive as it may appear, **prima facie**: (i) Better forecasting ability of these aggregates is hardly surprising because it is embedded in their very construction. Moreover, this attribute applies **exclusively** to the target chosen with which to minimise the forecast variance; it does not necessarily apply to other targets. For example, Roper - Turnovsky method which uses weights that minimise forecast

12. Bhole (1987) has also made this point. Generally, this sub-section has drawn on Bhole (1987) to some extent.

13. Ibid.

variance in respect of nominal income are not likely to be equally effective in predicting inflation.

(ii) Better forecasting ability may be a necessary condition for optimality of monetary aggregate, but is **not** a sufficient one. It may be argued that there is another condition which is not only necessary but more vital in a fundamental sense; monetary aggregates must be anchored with sound theoretical base and proper conceptualisation. Often, it is not realised tha Roper - Turnovsky aggregate may have better forecasting performance but can actually assign negative "moneyness" to some assets, which defies any sensible economic interpretation !

In recaptulating the analytical appraisal, thus, it may be emphasised that the available approaches for constructing weighted monetary aggregates are riddled with several problems, conceptual, empirical as well as operational. These have to be borne in mind while evaluating any country - specific study.

III

Weighted Monetary Aggregates : A Critical Survey of Studies in the Indian Context

In the Indian context, early studies on the subject seem to have focused on empirically demonstrating the need for differentiating among monetary assets on account of differences in their degrees of "moneyness". Subrahmanyam (1977), Kamaiah & Bhole (1982) or Kamaih and Subrahmanyam (1983) are some noteworthy examples in this regard. Since their basic contention regarding limitations of the simple -sum monetary aggregates is acceptable in entirety, detailed discussion of these studies is unwarranted.

On the more substantive side, Ghose, Madhur and Roy (1984) made a systematic attempt to construct weighted monetary aggregates for India. According to these authors, the traditional monetarist model provides a reasonably good explanation of inflation in the Indian economy between 1960 and 1975 and in the early 1980's. There is, however, a "complete breakdown in the 5-year period between 1975 and 1980 during which the actual inflation rate was 10 per cent per annum lower than the conventional model would have predicted". The authors, among other things, made an effort to examine whether the "missing inflation" could be explained by the weighted monetary aggregates.

The findings of this study were as under.

1. The weights derived using the Substitution Approach (i.e., Chetty's model) are "unreasonable and cannot be used in any aggregation".

2. Weighted monetary aggregates in the form of Divisia indices were constructed for M3 covering the relevant period. Analysis of temporal behaviour of these aggregates revealed that the growth rate in Divisia M3 was only marginally lower than the simple-sum M3 which led them to conclude that "replacing simple M3 by a Divisia index in the monetarist model does not explain the inflation puzzle of the late 1970s" (p. 54).

More recently, Subrahmanyam and Swami (1989) have come out with an extensive study of weighted monetary aggregates based on the User-Cost approach. They have experimented with three aggregates in the superlative class - Divisia, Diewart linear and Fisher's ideal index as well as one non-superlative one, i.e., geometric index.

Performance of these weighted monetary aggregates was compared with the simple-sum aggregates over the period 1950-51 through 1984-85 in respect of information content, causality and stability. The overall conclusion of this study is quite revealing: "the alleged superiority of the superlative monetary aggregates over their simple-sum counterparts could not be established convincingly. On the contrary, the simple sum aggregates emerge out to be more informative about the goal variable of NDP yielding more plausible and stable patterns of income and interest elasticities" (p. 27).

These findings are somewhat discouraging, but not surprising, given the multitude of conceptual, operational and empirical problems that arise in the institutional setting of developing countries like India. Indeed, what is surprising is the fact that there exists at least one study, i.e., Kannan (1989) which finds that on the basis of criteria like stability, predictability and causality, that Roper - Turnovsky method "turns out to be the best weighting method". Since this study stands out in its conclusions, a closer scrutiny is called for.

A critical evaluation of the study reveals several unsatisfactory features:

(i). The empirical analysis is couched in terms of demand and time deposits without explicitly recognising the break in their time series due to a significant structural change introduced in the bifurcation of saving deposits into the two categories of deposits.

In India, saving deposits have both "transaction" as well as "saving" characteristics. It is necessary, therefore, to merge the "transaction" balance with demand deposits and the residual, deemed to be "saving" balance, with time deposits.

In accordance with the recommendations of the Second Working Group on Money Supply (1977), the part of saving deposits which was permitted to be withdrawn without notice was lumped with demand deposits. As a result of this criterion (which was in force from 1961 to 1977), an overwhelmingly large part of saving deposits (about 85%) was clubbed with demand deposits. Effective March 1, 1978, however, the accounting procedure was changed drastically. According to the new procedure (which is applicable to-date), that portion of saving deposits on which interest is actually paid is treated as time deposits, while the residual is deemed to be demand deposits. As a result of this change, the earlier pattern of bifurcation is reversed, in that, nearly 85 per cent of saving deposits are now treated as time deposits.

It is clear, therefore, that the long term time series of demand and time deposits have been subject to major structural shifts in 1978. The Study, however, does not show adequate awareness of this phenomenon[14]. As a result, the data series for demand and time deposits as well as econometric results derived from them are questionable.

(ii). As a proxy for interest rate on demand deposits, the study uses "the GDP deflator for the public administration sector". Rationable for this proxy is difficult to understand. Barrow and Santomero (1972) and Klein (1974) have suggested methods for computing "implicit" rate of return on demand deposits. In the Indian context, Subrahmanyam and Swami (1989) study has used this method. Similar attempt could have been made.

(iii). In computation of relevant user costs, the Study does not specify the reference interest rate used for discounting. In the Indian context, this choice would have an important bearing on the final results.

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14. At one point, it is observed in the Study that the growth rate in demand deposits for 1981-86 is much lower than that of 1970-80. A dummy variable is used for accommodating the shift; but, the dividing line used is 1980 and not 1978 when the shift really occurred.

(iv). Even the broad conclusion drawn by the Study regarding the Roper - Turnovsky method outperforming others does not follow from the tests conducted in the study.

Of the three criteria used, i.e. predictability, stability and causality in the assessment of relative performance of the Roper - Turnovsky method vis-a-vis others, only the latter two are independent As stated earlier, better predictability is embedded in the derivation of weights in the Roper - Turnovsky method. Using this criterion for the judgement would, therefore, tantamount to a circular reasoning. In respect of causality, the Roper - Turnovsky approach does only marginally better than the simple-sum aggregates, whereas, in respect of stability criterion, the simple-sum aggregate actually outperforms the Roper - Turnovsky method (Table 2, p.8). Under these circumstances, it is difficult to see why the Roper - Turnovsky approach is adjudged to be the "best" one.

The unmistakable conclusion, therefore, is that the case for use of weighted monetary aggregates in India is yet to be established convincingly.

IV

Summary and Conclusions

1. The recurring issue of the appropriate measurement of money has come into a sharp focus once again in view of the financial deepening witnessed in the Indian economy in the recent years. In this regard, rather than the simple-sum monetary aggregates compiled at present, monetary aggregates duly weighted by the degree of "moneyness" of its components appear to be quite appealing. Given the intuitive appeal of the weighted monetary aggregates, feasibility and usefulness of such aggregates needs to be examined rigorously.

2. A detailed analytical appraisal of the available approaches for constructing weighted monetary aggregates reveals that there are several conceptual, practical and empirical problems in translating the incontrovertible principle into hard numbers, especially in the institutional setting of developing countries.

3. A review of major studies in the Indian context shows that empirical attempts have not succeeded in generating weighted monetary aggregates that decisively outperform the simple-sum aggregates. The only study that claims to have accomplished this task, is unsatisfactory on several grounds. The case for

the use of weighted monetary aggregates in India is, therefore, far from established.

4. An accurate measure of money stock that is wellgrounded in economic theory and bears a predictable relationship with nominal income is critical for the effective conduct of monetary policy. Inability of the weighted monetary aggregates to outpperform the simple sum aggregates reflect deficiencies of operationalisation rather than conceputalisation. Concerted efforts must, therefore, continue to resolve the operational problems rather than discarding the otherwise appealing concept of weighted monetary aggregates.

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The Technical Efficiency of Jute Mill Industry

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Introduction

JUTE mill industry has traditionally been of considerable economic importance in the national economy of India. It has a large employment potential and a significant capability to earn foreign exchange. However, in the past couple of years, especially during the later part of the 1980s, the redoubtable position of this industry as a major supplier of packaging material has rapidly been lost to synthetic materials mostly because of price disadvantages. Additional problems for the domestic industry arose in the form of speculative price reactions in the jute fibre market and price undercutting resorted to by chief competitors in the international market. All these reasons, coupled with the technological inertia with which the industry was inhabited, led to a belief that the decline in performance of the industry was but symptomatic of an impending sun-set despite official emergency measures (mandatory use of jute packaging order and the institution of a large modernization and development fund) to retrieve the situation.

On account of the reasons mentioned above, it then seems reasonable to presume that over these years, the productive efficiency of the industry has suffered considerable strain and could form an important subject for empirical assessment. This study intends to assess the magnitude of a specific dimension of productive efficiency, viz., technical efficiency. Technical efficiency is, in the present context, the ratio of actual to potential output. Mathematically, $y/f(x)$ is the appropriate measure where $f(x)$ is the core of the operationalised production frontier with x as the vector of inputs and y, as usual, the measure of output. Beyond this definition, more attention is focussed on the error term attached to the core $f(x)$ of the specified production frontier. The error term

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constitutes two components signifying two different shocks on production operations. There is a symmetric component which incorporates random shocks[1] beyond the control of the management and an asymmetric component which encapsulates all other shocks[2] which can be appreciably controlled by the management. In the literature, such a model is referred to as stochastic because the frontier itself is rendered random owing to the existence of asymmetric component. The usefulness of such a characterization follows from the derived measure of mean efficiency which captures the influence of asymmetric shocks and thereby informs about the extent of inefficiency due to reasons other than those related to uncontrollable shocks. In other words, much of the estimated inefficiency can then be attributed to problems associated with factors such as poor managerial efficiency, work stoppages, material bottlenecks and low employee effort, etc (all of which characterise the asymmetric component and constitute systematic shocks).

I

The Literature

Although, at present there exists a large corpus of literature on the important issue of technical efficiency of production, the basic conceptualisation had begun as early as 1957 when Farell provided a definition of efficiency in production with the help of an efficient unit isoquant. In his illustration, overall productive efficiency constitutes technical (best use of given resources) and allocative (right use of factor proportions) efficiency, both of which must be fully realised to attain maximum productive efficiency. The abovementioned concepts of technical and allocative efficiency have found useful application in studies related to various industries[3]. While initially there was much interest in estimating technical efficiency vis-a-vis, a standardized norm (e.g., production frontier), later developments made

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1. Machine performance and errors of observation and measurement etc.

2. "The economic meaning of the asymmetric or one sided, non-positive error, derived from a normal ($0, \sigma u^2$) distribution is that each firm's production must be either on or below the frontier" (Lee and Tyler, 1978).

3. For example, U.S. steam electric generating plants (Kopp and Smith, 1978), U.S primary metals industry (Aigner et al, 1977), U.S. Agriculture (Aigner et al, 1977), French manufacturing (Meeusen and van den Broeck, 1977), Brazilian manufacturing (Lee and Tyler, 1978), U.S. Class 1 Railroads (Kumbhakar, 1988), among a number of others.

it possible to quantify allocative efficiency with respect to an operationalised cost frontier as well (Schmidt, P. and Lovell, C.A.K., 1979). Frontiers have been defined as deterministic or stochastic based on the property (viz., deterministic or stochastic) of the core of production frontier. Both maximum likelihood and COLS (Corrected Ordinary Least Squares - a variant of OLS, where $E(u) \neq 0$) methods have been utilized to operationalise frontiers. While maximum likelihood methods turn considerably complex in case of composite error specifications assumed for stochastic models, the use of COLS is warranted not only due to its computational simplicity but also because of the Monte Carlo evidence quoted below:

"The comparison of MLE (Maximum Likelihood Estimation) and COLS (Corrected Ordinary Least Squares) varies, depending on which parameters are of most interest. For the coefficients of all regressors except the constant term there was little difference between COLS and MLE. The computational simplicity of OLS would then be a good reason to prefer it to MLE. For the constant term and variance parameters, the choice of estimator depends on the true value of λ[4] and sample size. For all sample sizes below 400 and for λ less than 3.16 COLS is preferred. But even for higher sample sizes and variance ratios, the additional efficiency of the MLE may not be worth the extra trouble required to compute it". (Olson et al, 1980)

While, until recently, it was only possible to compute industry-wide mean efficiency level within a stochastic framework, recent literature provides plausible measures of individual efficiency levels based on certain assumptions. For example, in Jondrow et al (1982), unit wise efficiency estimates are readily obtained from the conditional distribution of the asymmetric component given information on the form of the distribution of the composite error specified in a stochastic frontier model. The literature on the estimation of frontier functions has been further enriched by contributions showing feasible methods of estimating efficiency in relation to flexible frontiers (Greene, W. H., 1980) and in cases where technical and allocative inefficiencies are assumed to be correlated

4 λ is interpreted to be an indicator of the relative variability of the two sources of random error. It is defined as σ_u/σ_v where σ_u and σ_v are the parameters of the asymmetric and symmetric terms, respectively. $\lambda^2 \rightarrow 0$ implies $\sigma_v^2 \rightarrow \infty$ and/or $\sigma_u^2 \rightarrow 0$ so that symmetric error dominates in the determination of ϵ (D. Aigner et al, 1977).

(Schmidt, P and Lovell C.A.K., 1980). With increasing complications in model building, the majority of studies utilize maximum likelihood methods because it remains no more possible to derive closeform analytical central moments in such cases. To estimate the parameters of the model, the relevant log likelihood function is optimized with the aid of one of the several numerical optimization methods available to-day.

II

Methodology

Let the i^{th} firm's production technology be $y = f(x)e^{\varepsilon}$ where y is the maximum output obtainable from a vector of inputs x_i and ϵi (=vi + ui) is the composite error structure described above. The error component v_i represents the symmetric disturbance and is assumed to be independently and identically distributed as N (0, σ^2_v). The error component u_i is assumed distributed independently of v_i and satisfies $u_i \leq 0$. It follows a half-normal distribution truncated above at zero. The above model facilitates (as shown below) estimation of the relative variability of u and v thereby provides evidence on their relative sizes.

The estimation procedure starts with the logged form of the following specification:

$$Y = X\beta + \varepsilon$$

Where, $\varepsilon = v + u$ and β is K x 1 coefficient vector and n is the number of observations in the sample.

The above form is estimated by the COLS (Corrected Ordinary Least Squares) method[5] and the residuals are used to compute the estimates of higher order central moments of f(ε). These provide consistent estimates for equation with the analytical moments of the convolution of v and u (which in the present case is

$$f(\epsilon) = \frac{2}{\sigma} f^*(\epsilon/\sigma)\ [1 - F^*(\epsilon \lambda \sigma^{-1})], -\infty < \epsilon \leq +\infty$$

and $\sigma^2 = \sigma^2_u + \sigma^2_v$, $\lambda = \sigma_u/\sigma_v$ and f*(.) and F*(.) are the standard normal density and distribution functions respectively). The second and third central moments of the convolution are

5. In this method, the mean of f(ε), say, μ is simultaneously added to and deducted from the constant and the error term respectively, in order to obviate the problem of non-fulfilment of the condition E (ε) = 0, necessary for OLS application.

$$\mu_2 = \left(\frac{\pi - 2}{\pi} \right) \sigma_u^2 + \sigma_v^2$$

and

$$\mu_3 = \frac{2\sigma_u^3}{\sqrt{2\pi}} \left(1 - \frac{4}{\pi} \right)$$

The above two equations can be used to extract σu^2 and σv^2 since (as already stated) the higher order mean corrected moments are themselves consistently estimated from the computed least squares residuals. Finally, the mean technical efficiency[6] in the present model can be written as:

$$E(e^u) = 2e^{\sigma u^2/2} [1 - F^*(\sigma_u)]$$

Individual unit efficiencies can be computed based on a solution provided in Jondrow et al (1982). This is based on the information of u_i available in ε_i. Hence, given ε_i, the conditional distribution of ui could lead us to either its mean or mode as a point estimate of u_i. Specifically, the conditional distribution of u given ε is a reparameterized truncated normal distribution the mode of which is:

$$M(u/\epsilon) = \begin{cases} -\epsilon(\sigma_u^2/\sigma^2) & \text{if } \epsilon < 0 \\ 0 & \text{if } \epsilon \geq 0 \end{cases}$$

where $\sigma^2 = \sigma_u^2 + \sigma_v^2$

Expression M (u/ε) is the mode of f (u/ε) and hence a point estimate revealing unit-wise inefficiency levels. In fact, the point estimate M(u/ε) could also be interpreted as a maximum likelihood estimator. We bank on M (u/ε) to estimate a few unit-wise efficiency scores.

III

Data and Results

The present study used information on value added, fixed capital and employment for the year 1986-87 regarding 32 jute mills provided by the office of the Jute Commissioner. The important indicators for these 32 mills correspond to 60 percent of net value added, 75 percent of employment and 70 percent of the total invested capital in the industry. Thus it is reasonable to assume the representativeness of the sample included in the study. The production function was estimated by ordinary least squares and the residuals were used to compute the other

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6. Noticeable is the fact that this measure of mean technical efficiency is 'pure' in the sense that it provides the expectation over the asymmetric term only.

parameters. The empirical results are presented below.

(Estimates for the Jute Mill Industry - 1986/87)

Elasticity of output w.r.t.		R^2	$\hat{\sigma}_u^2$	$\hat{\sigma}_v^2$	$\hat{\lambda}$	Mean Efficiency (Percent)
Capital	Labour					
0.11	1.43*	0.42	0.914	-ve	large	54.0
(0.55)	(4.33)					

Note (a) Figures in brackets represent t-stastic..

(b) σu is the parameter of the asymmetric error distribution..

(c) σv^2 is the variance of the symmetric error component.

(d) $\hat{\lambda}$ is a ratio ($= \sigma u/\sigma v$) indicating the dominance of one term over the other. For example, if λ is larger then the asymmetric component swamps the symmetric component.

(e) Obtaining a negative value of σv_2 implies that $\sigma_e^2 < [(\pi - 2)/\pi\, \sigma u^2]$ and indicates a large value for λ. Large values for λ suggest that the asymmetric term dominates in the determination of efficiency (Schmidt et al, (1977).

(f) * Denotes that the coefficient is significant at one percent.

From the results presented in the table above, one notes a poor mean technical efficiency of mere 54.0 per cent obtained by the industry during 1986-87. This means that output in the industry during this year was almost 46 per cent below (on an average) the operationalised frontier. As it is well known that the mean is sensitive to extreme values, the parameters were reworked after deleting the extreme observation. This had in fact increased the estimate of mean efficiency to 58.7 percent.[7]

A large value for λ implies that mills within the industry differed considerably amongst themselves regarding technical inefficiency. In order to observe the behaviour of technical efficiency across mills, efficiency scores were evaluated based on $M(u/\epsilon)$. These results facilitate one to identify efficient/inefficient mills. Based on individual efficiency scores the following conclusions were drawn.

7. The mean of the one sided disturbance in a cost function characterisation, $(^1/p)$ u {where p is the returns to scale}, is between 0.25 and 0.30 which implies that cost of production is, on average 25% to 30% above the frontier level because of systematic overapplication of factor inputs.

(a) While seven units were found inefficient, the rest within the sample behaved efficiently vis-a-vis the operationalised frontier. Of the inefficient units, six units had fixed assets considerably larger than the average holding within the sample. This means that these firms were not only technically inefficient but also perhaps ineffectively allocating their resources too.

(b) The average capital intensity (fixed capital per employee) for the group of inefficient mills was almost 235 per cent higher than that estimated for efficient mills. Again, this implies both the existence of allocative inefficiency and capacity underutilization[8] which essentially underpins the deficient role of the management in the enterprise.

(c) The average value added to sales ratio for the group of inefficient mills was also significantly lower than that estimated for efficient mills. This ratio varies among individual of firms on account of not only variations in prices/contracts in both inputs and output markets but also efficiency in production.

(d) The above results prove that internal technical in efficiency (rather than exogenous or uncontrollable shocks only) was principally responsible for such a low score of mean efficiency on an industry-wide basis during the year 1986-87.

The broad profile of the group of inefficient mills sketched above sustains the important fact that these firms are systematically underutilizing the employed resources. While rationalization of production operations might be a necessity, a micro-level study of these identified mills can return more fruitful insights into the existence of inefficiency.

Finally, it would be worthwhile to mention that although the empirical estimate of efficiency for 1986-87 is discovered to be quite low, it would nevertheless be more useful to compute a measure of efficiency over a period of time. A static snapshot such as in the present study can only broadly reveal the possible magnitude of problem that confronted the industry during the year of concern.

8. Capacity underutilization as an indicator of inefficiency is but the cause of factors (classified as systematic and unsystematic shocks to production operations) influencing the measure of efficiency in production.

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BOOK REVIEWS

Statistical Analysis of Compositional Data

by J. Aitchison (Chapman & Hall, London - 1986, pp. 416, Price £ 25)

MANY of the standard statistical methods are generally applicable for unconstrained data. But in practice, in many disciplines, the statisticians are confronted with data sets which are subject to some inherent constraints such as data obtained through a typical household budget survey. The variables of interest in this case are the shares of each commodity group in total expenditure incurred by each sample unit. Obviously, the shares are subject to the unit-sum constraint (the total of all shares would add up to unity). For answering such interesting questions as, 'To what extent does the pattern or budget share of expenditures depend on the total amount spent' or 'Are there some commodity groups which are given priority in the allocation of expenditure', recourse to the standard statistical methods may not be appropriate. In fact, Karl Pearson first pointed out as early as in 1897, the dangers involved in interpreting correlations between ratios, where numerators and denominators contain common parts - If $x_1 = f(w_1, w_3)$ and $x_2 = f_2(w_2, w_3)$ be twofunctions of the three variables w_1, w_2, w_3 and these variables be selected at random so that there exists no correlation between w_1, w_2 or w_1, w_3 or w_2, w_3 there will still be found to exist correlation between x_1 and x_2. Thus a real danger arises when a statistical biologist attributes the correlation between two functions like x_1 and x_2 to organic relationship.

Another example may be considered to put the problem in clear perspective. Suppose one is interested in analysing the profitability of the banks. It is obvious that profitability of a bank will depend on the cost of raising the funds and return received on the deployed funds. The cost of funds will in turn be determined by the composition of funds and prices of each type of fund. A bank having relatively more current account deposits will pay relatively less for its working fund as compared to a bank having more deposits in the form of fixed deposits. Similarly, a bank having relatively more exposure to the priority sector lending will be placed disadvantageously compared to a bank with relatively more exposure to large and medium industries, in ceteris paribus condition. Given this scenario, how does one answer a question like this - 'Will the composition of working funds of a bank have any impact on its cost of funds'. If one simply regresses cost per unit of fund on, say, share of current deposits to total deposits, one is ignoring a lot of other relevant information like share of savings deposits, share of borrowing etc. On the other hand, it is not possible to estimate a response surface of the following type:- Cost per unit of fund = F (share of current deposits, share of savings deposits, share of term deposits, share of borrowed funds, share of other non-interest bearing funds). This is so because the independent variables are subject to the unit-sum constraints.

J. Aitchison, (co-author of the classic monograph, 'The Lognormal Distribution'), has examined the problems associated with statistical analysis of compositional data in a number of his recent papers. The present monograph is a text book presentation of the results he has obtained in this regard in his various research articles. It is straightforward, Aitchison observes, to recognise that the sample space for a compositional data is not the entire real space of specified dimensions but, a restricted part of it, termed the simplex. Let the subscripted letters $x_1, x_2 \ldots\ldots, x_D$ denote a D part composition $(x_1, x_2 \ldots\ldots, x_D)$ satisfying the conditions (i) that each component is non negative, $x_1 \geq 0, \ldots x_D \geq 0$, and (ii) the unit sum constraint, $x_1 + \ldots + x_D = 1$. Aitchison throughout his book confines his attention to the strictly positive simplex viz, none of the x_i is equal to zero. His treatment of the case when one of the x_1 takes zero value is rather sketchy and appears to require more rigorous formulation. Presently, we may note that a D part composition vector is completely specified by the components of a d-part sub-vector such as $(x_1, \ldots\ldots, x_d)$ where $d = D-1$. This implies that a D-part composition vector actually belongs to a d-dimensional subspace. To circumvent the unit sum constraint imposed on original D-part composition, Aitchison proposes to work with a correlation structure based on product-moment covariances of ratios such cov $(x_i/x_k, x_j/x_d)$ where x_i, x_j, x_k, x_d are co-ordinates of the D part composition vector. The variances and covariances of ratios are awkward to manipulate and therefore he proposes to adopt a new concept of correlation based on covariances of the logarithms. The new covariance structure is free of many problems associated with the covariance structure based on original compositions. The author makes the assumption that this transformed set of variables $y_i = \log (x_i/x_D)$ $(i = 1, \ldots, d)$ follows a multivariate normal distribution. This interpretation allows the author to introduce a new probability distribution of the original D-part composition vector X. He calls it additive logistic normal distribution. Once this reparametrization is carried out, it is possible to use a battery of statistical procedures based on multivariate normality.

The applicability of this procedure hinges crucially on the normality of log ratios. That the author is well aware of this limitation of his proposed methodology for analysing compositional data is amply made clear. It would be preposterous to believe that all compositional data will turn out to be logistic normal and no doubt modifications to statistical procedures will have to be made in the light of further experiences. It is to be seen whether this restrictive assumption of normality can be removed and more general procedures for tackling the compositional data are arrived at. Nevertheless the present book by Aitchison provides the right stimulus for further research in this new area.

The book is divided into 14 chapters and 4 appendices. Chapters 1 and 2 are introductory in nature, giving the description of the contexts of the problem. The author discusses a number of interesting real life problems of compositional data analysis with the help of data sets from different disciplines like geophysics, medicine, budget analysis, etc. In appendix D-5, twenty five such data sets are furnished and all the concepts and methodologies introduced and discussed in this book are illustrated with one or other of these data sets. This is a major attraction of this book. The core of the book is in the chapters 6 and 7 where Logistic Normal Distributions and Log Ratio Analysis of Compositions are discussed. In the remaining chapters, the methodologies developed in these two chapters are extended and applied to various real life problems. A micro-computer based software package for statistical analysis of compositional data is also available as a companion to this book on request from the publisher on payment of $ 195. It has been stated that the programme is IBM PC compatible, user friendly and has a substantial graphic facility.

The book is on the whole well written and contains several illustrations of the methodology with live data, which enhances the utility of the book. The availability of Software package is a welcome addition and serves a useful aid to research workers. It is hoped that the next edition of this book will incorporate further research in this highly interesting and relevant area involving application of statistical methods and techniques.

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Poverty Alleviation - The Indian Experience

G. Morley Mohan Lal

(Himalaya Publishing House, Bombay, 1988,
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THE main maladies which act as a drag on the developmental efforts of underdeveloped countries can be traced to the problems such as low growth rates of Gross Domestic Product, high population growth rates, illiteracy, poverty, inequality, malnutrition and unemployment. These problems are widely prevalent and are universally obtaining in all developing countries including India and have received wide attention of planners, economists and administrators in recent decades. The alleviation of poverty has been recognised as one of the main policy planks and an important goal of the Government of India.

In every plan period specific measures are incorporated to accomplish this task and even targets have been set out in the plan documents for lifting specific percentage of target group above poverty line. Thus, in the Sixth Five-Year Plan, removal of poverty was the foremost objective and concerted efforts were made in this direction by taking up several specific programmes for the economic development and upliftment of the target group of rural poor. The programmes incorporated in the Sixth Plan for the purpose mainly related to (i) the resource and income generating programmes like the IRDP with the sub-components such as TRYSEM and DWCRA, (ii) special area development programmes like DPAP, DDP and SLPP, and (iii) employment generating programmes such as NREP, RLEGP. The various schemes formulated by the Central and State Governments and their appraisal in the plan period forms the main focus of this highly absorbing book.

While discussing the meanings, objectives, outlays, achievements and short-comings, the author has given conceptual background of the programmes wherever necessary and also highlighted the suggestions for improvement. He has also incorporated at appropriate places the findings of evaluation and assessment studies of the various programmes.

The book is divided into two parts; Part I deals with the poverty scenario in Rural India, approach to Rural Development in India, the concepts, meaning and operational strategies of Integrated Rural Development and also various poverty alleviation programmes with the sub-components such as Training of Rural Youth for Self-Employment (TRYSEM), Development of Women and Children in Rural Areas (DWCRA), National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP), Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP), Special Live Stock Production Programme (SLPP) and land reforms whereas in Part II various reports of expert groups, evaluation reports and Committee reports are discussed alongwith their findings. Detailed rural development statistics, several aspects of poverty related parameters like nutritional requirements, selected indicators such as land use pattern, census (population) details, social amenities and rural banking and credit developments have been incorporated and adequately dealt with in this publication.

Chapter 1 deals with introduction and genesis of the problem. The author has rightly stated that the mere increase in the GNP is not a panacea for the painful problems of a developing economy such as higher rate of population growth, structural and institutional bottlenecks, chronic unemployment and under employment, low levels of technology and resource base, striking inequalities in the distribution of wealth and incomes and mass poverty. The development plans, he feels, must aim at specific targets for reducing poverty, unemployment and inequality. Alleviation of poverty, increased job opportunity and a minimum level of employment are, according to the author, the important components of development. This chapter discusses the poverty scenario in India, the persistent nature of poverty and strategies and methodologies for rural development in the Sixth Plan.

In Chapter 2, different forms of rural development planning viz., sectoral planning, area planning, site-bounded project planning, target group programme planning, socialist economic planning, etc., methods of planning such as 'top down' and 'bottom-up' planning, blueprints versus recursive planning, the meaning of Integrated Rural Development (IRD), the classification of IRD by sectoral focus, by area focus and by scope of activities, the forms of integration, areas of integration, etc. are explained at length.

Rural development concept has undergone substantial changes in its objectives over a period of time from the emergence of the Community Development to Integrated Rural Development with resource upgradation and orientation towards income generation from resources so acquired. The author has dealt with in great detail the different changes in the objectives of rural development and has also highlighted different definitions of Rural Development.

The latest strategy of rural development is the outcome of a long evolutionary process. The different stages in the evolution of the present rural development strategy are adequately described. During the first two decades of economic planning, emphasis was laid on the need to maximise the rate of growth of the GNP mostly in conformity with the conventional approach through stepping up the rate of investment in the economy, the goal being increased production. The strategy followed during the first two decades of Indian Planning was production-oriented rather than welfare-oriented. During the decade ended 1970, emphasis was shifted to a more intensive development of the rural economy through various programmes which were mostly area-specific. In the decade 1970-80, a wide variety of development programmes was launched which sought to make a determined and multipronged attack on the multi-dimensional problems of poverty and unemployment. The elements in the operational strategy of IRDP, the largest and most important programme, are incorporated in this chapter.

Chapter 3 is divided into 3 parts: Part (a) deals with Integrated Rural Development Programme (IRDP) while Part (b) concerns itself with the Industries, Services and Business (ISB) Component under IRDP and Part (c) is devoted to Training of Rural Youth for Self-Employment (TRYSEM) component of IRDP. The objectives of IRDP definition of poverty line, demarcation of target group, fixing the level of assistance to be provided to the beneficiary, assistance to be allotted per block per year, the major stages in block level planning, etc. are elaborated. For ensuring credit support for IRDP, the different aspects on which action is required to be taken by Government agencies and financial institutions have been spelt out. The findings of evaluation studies which focus sharply on the shortcomings in the programme as also the fair degree of achievements find a suitable mention. There are pointers to the type of improvements necessary in the monitoring mechanism and effective implementation of procedures of the schemes.

The Industries, Business and Services (ISB) component was incorporated in the IRD Programme with the objective of maximising the employment opportunities in the secondary and tertiary sectors. The major role of NABARD in financing ISB component assumes greater importance. The review of refinancing schemes formulated by NABARD indicated that a substantial proportion of lending was made to Business and very little to Industries. A number of important suggestions have been made to improve the programme and modalities of its effective functioning.

Training of Rural Youth for Self-Employment (TRYSEM) was launched on 15th August 1979 as a centrally sponsored scheme for providing technical skills to the rural youth from families below the poverty line to enable them to take up self-employment. The detailed discussion of the programme in the chapter along with review of the progress made in the Sixth Plan and the major issues thrown open by evaluation studies provides a good insight to the readers of the inherent merits of the scheme and the loopholes in implementation which have limited their usefulness in alleviating rural poverty.

The author has discussed the scheme on the Development of Women and Children in Rural Areas (DWCRA) in its various aspects such as objectives and guidelines for implementation of the programme, the plan of action, assignment of responsibility, commitment of UNICEF, etc. The State-wise performance of the programme in the Sixth Plan has also been reviewed in this chapter.

The objectives and salient features of National Rural Employment Programme (NREP) and achievements during the Sixth Plan, the problems and deficiencies in the implementation and working of NREP based on Limited Spot Studies constitute the main subject matter of Chapter 4. In addition, the various aspects of Rural Landless Employment Guarantee Programme (RLEGP) such as objectives, period of operation, implementing agency, criteria for allocation of Central assistance, wage and non-wage component, wages to be paid to the labourers, etc. are discussed in this chapter.

In India, nearly two-thirds of the cultivated area is rainfed and drought is almost a recurrent phenomenon in many parts of the country. In order to combat drought and also to develop deserts, Drought Prone Areas Programme (DPAP) and Desert Development Programme (DDP) were launched by the Government. Special Live Stock Development Programme is another area development programme aiming at raising incomes of small and marginal farmers and agricultural labourers. The detailed discussion on the various aspects of the programme such as Sixth Plan allocation, achievements of these programmes find a place in the Chapter 5. The general observations of the Task Force on Drought Prone Areas Programme and Desert Development Programme have also been incorporated in this chapter.

In the last Chapter 6, the subject matter pertains to land reform and its various ramifications. Land reforms aim at removing the impediments for the increase of agricultural production and eliminating exploitation and social injustice. The land reform measures such as abolition of intermediary tenures, provision of security to tenants, imposition of land ceiling on agricultural holdings, preparation and maintenance of land records and consolidation of agricultural land holdings are discussed in greater details in this chapter.

The author has brought together all the available material and reports, reviews, evaluation studies, etc. on poverty alleviation measures in one place and at the same time incorporated valuable detailed statistical data from official and authentic sources.

The author has presented some of the poverty indicators for rural India. However, it would have been better if he could have endeavoured to incorporate some of the indicators of poverty in developing countries like Indonesia, Burma, Malaysia, Sri Lanka, Pakistan etc. in order to have a glance at the comparative picture. He could have further discussed some of the poverty alleviation programmes undertaken by these countries. The author has, no doubt, discussed in greater details the achievements and short comings of various poverty alleviation programmes implemented by the Government of India. He could have perhaps made some of his own suggestions for the new programmes for consideration by the Government for incorporating them in Five Year Plans in future.

Nevertheless the book provides a large degree of insight into the multi-dimensional aspects of the problems of poverty as also the measures adopted by the Central and State Governments for alleviation of poverty. The book is a valuable addition to the available literature on the subject of poverty which has been of great concern to the Planners and has rightly been given the key emphasis in the recent plan documents. A later edition of this book incorporating a more recent review of these schemes in the Seventh Five Year Plan in the light of changes in policy, would considerably facilitate sustaining the interest of the research workers in probing further into the increasing dimensions of poverty syndrome not only in rural areas but in urban areas as well.

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