Poverty, as a proxy of deprivation, is not a recent phenomena. It is rather as old as human existence itself. Its marked evidence may be traced at various stages of history of man-kind; though in recent times it has drawn much attention of social scientists and economists both at the national and international levels\(^1\). Consequently, continual effort is going on to search for development paths that would result in "growth with equity" and "elimination of poverty". In India, wherein several such experimentations have taken place, researchers and policy makers have applied themselves to the task of assessing the effects of such development policies from time to time. Expectedly no two studies, worth mentioning, have reported identical results. One can trace these difficulties to the choice of the norm, conceptual framework, selection of indices, and the origin and coverage of data itself. In this backdrop, it is therefore, essential to have a synoptic view of the various issues involved in poverty measurements.

4.1 Concept of Poverty

Poverty is of course a matter of deprivation. The deprivation has both absolute and relative aspects. The
issues related to the general notion of "relative deprivation" have considerable bearing on the social analysis of poverty because being poor has clearly much to do with being deprived. And, for a social being, the concept of deprivation will be a relative one. If the "relative deprivation" suggests a situation wherein the person or the unit possesses less of something than others do, the "absolute deprivation" indicates the non attainment of some minimal level of living required for healthy survival and productive participation in economic activity. As Sen (1981) observes "Indeed there is an irreducible core of absolute deprivation in our idea of poverty, which translates reports of starvation, malnutrition and visible hardships into a diagnosis of poverty without having to ascertain first the relative picture. Thus the approach of relative deprivation supplements than supplants the analysis of poverty in terms of absolute dispossession". It is in this context that both poverty and inequality are, in general, interrelated; inequality being associated with the aspect of "relative deprivation" and "poverty" termed as "absolute deprivation". But still, the concept of poverty is different from the concept of inequality, as a transfer of income from a richer person to another one in middle income group may reduce inequality but leaves poverty unaltered, whereas a similar
transfer from top to bottom rung would reduce both. So, both poverty and inequality are distinct though closely related concepts.

After stating this distinction between "absolute" and "relative" poverty, we now focus our attention on the latter, i.e. "absolute poverty" and its measurement.

Empirical estimation of absolute poverty involves two major steps viz. "identification" of the "group of people" who may be treated as "poor" and aggregation of their poverty characteristics into an overall measure of poverty. Once the "poor" are identified (with reference to some chosen norm), their numerical strength, proportion or extent and intensity of deprivation is to be translated into a suitable index.

But the task is not that easy as it seems to be and both these issues have been the subject of discussion for quite some time. A brief summary of the main issues underlying the debate follows.

4.2 The Choice Of A Suitable "Poverty-Norm" or "Poverty Line"

The specification of suitable "poverty line" is based on certain "basic needs" of the people which may be specified either in terms of commodities such as wheat, rice etc. or in terms of "characteristics" of such commodities such as calories, protein and vitamins and the like. Though characteristic requirements do not specify commodity
requirements, it is obvious that the former must have a priority over the other. This is because calories are necessary for survival, irrespective of the fact of its being obtained from wheat or rice. Therefore much stress is laid on the "minimum nutritional requirements" essential for biological survival. But translation of the "minimum nutritional requirements" into "minimum food requirements" does depend on the choice of commodities. The normal consumption behaviour of the people is taken into account while considering a transformation of the "minimal nutritional requirements" to "minimal diet requirements" or "recommended consumption basket". In this manner one can arrive at the "minimum level of income" for making the recommended consumption basket affordable.

However, the selection of "minimal nutrition requirements", itself generated a lively debate. For instance, Sukhatame (1978) and Dandekar (1981) are of the opinion that "calorie intake" criteria should be adopted for meeting the minimum nutritional requirements. According to this criteria the quantitative formulation of the minimum calorie intake is made, below which there is under-nutrition, irrespective of the individual items that contribute to the calories.

Sukhatme (op.cit.) argues that protein malnutrition undoubtedly prevails but generally it is the indirect result of inadequate energy in the diet. He
observed that an increase in income resulted in the increased intake of energy - rapidly to start with but gradually thereafter, indicating that an appreciable number of people remained undernourished for want of adequate income. At the same time it was shown that "concentration and quality of protein in the diets of the people even in the lowest income group is adequate to meet protein needs of an individual, provided energy needs are met". Therefore, economists adopted minimum energy or calorie requirement, as the criteria for estimating the extent of poverty. Keeping this norm in view the first and second FAO committee on energy requirement used an energy expenditure of 3200 calories for the reference man and and 2300 calories per reference woman. Earlier, in 1944, for the first time, in India, such "calorie intakes" were recommended. These were revised in 1958, 1968, 1980, 1986. Dandekar and Rath (1971) used 2250 calories per day, while the planning commission used 2400 calorie per day/per person for rural and 2100 calories for urban area, which amounted to a norm of 2350 calories for the population as a whole.

However, while Sukhatme (1978) does hold the opinion that a person who cannot afford a diet which meets his minimum energy needs for a healthy active live, is both poor and undernourished; he differed with Rath &Dandekar (1971) on the level of energy intake one should choose in order to specify the poverty line. They pointed out that
there are considerable variations in the daily calorie intake and energy expenditure, which are both intra-individual and inter-individual. It was assumed that "nutritional requirements in terms of calories cannot be stated in terms of a single figure (whether per capita or per consumer unit) but should be formulated in terms of a range determined by a standard deviation of about 400 calories from the average are single figure; and it is only below the lower limit of this range that there is undernutrition or nutritional poverty". Accordingly, the much cited Dandekar and Rath (1971) study and the like were attacked for having overestimated the nutritional poverty in India.

Sukhatame's own approach was criticised by Krishnaji (1981) who considered it to an understatement of the adequate nutrition. If Sukhatme's procedure recommends a norm of $R + 2 \text{S.D.}$ where $R$ refers to mean requirement of the "reference" adult and S.D. stands for standard deviation; Krishnaji's modification puts it at $[R-2(\text{S.D.})_W]$ as the cut-off point where $R$ is as defined before, while $(\text{S.D.})_W$ refers to the intra-household variability.

Dandekar (1981) pointed out an error in manipulating the above formulation of "calorie intake" by Sukhatme; stating that because the energy requirement of an
individual household is variable, average requirement of a group of households is also variable, which was over looked by Sukhatme.

In contrast to the practice of "calorie intake", Rao (1981) questions the validity of the practice of measuring poverty on the basis of calorie intake alone. He argued that "Poverty has to be identified with deficiency in the total level of living. And total level of living includes not only energy requirements but also balanced diet needed for health, and the other components of basic needs essential for human existence at a tolerable level".

But at the operational level, this option has several limitations; it is difficult to choose a single schedule of items as "balanced diet" for the entire country. One has to appropriately account for physical characteristics of the population and variation in physio-climatic conditions in the context of a continent sized country. As Dandekar (1981) puts it "in the application of the balanced diet approach to determine the poverty line, the composition of the balanced diet is abandoned and only its aggregate cost is retained. I don't see that this is an improvement over the method which ensures that the households on the poverty line have the specified calorie intake, particularly if we see that a diet adequate in calories is almost always a balanced diet".
Thus the debate around this issue is still wide open. One can recommend a calorie requirement with or without a blend of protein, vitamins, minerals and the like, drawing support from one or other celebrity. We find considerable merit in Chaudhri's (1982) argument "That most of the malnourished suffer mainly from calorie deficiency rather than protein deficiency......People who don't suffer from calorie deficiency also do not suffer from protein deficiency. On the other hand people who suffer from protein deficiency suffer simultaneously from calorie deficiency, that is to say they simply do not have enough to eat".

Therefore, without loss of generality one can explore the issues of poverty by choosing the appropriate calorie norm. Table 4.1 provides a snap-shot of the important studies in the area.

On can easily see the predominance of calorie norm as the starting point in empirical estimation of poverty. However, for our study we shall rely on an updated version of the poverty norm used by Bardhan (1971) and Ahluwalia (1978) that provides necessary purchasing power for obtaining the "balance diet" fulfilling the accepted calories norm. As argued by Julka (1986), two poverty norms N and N serve the purpose. The line N equal to Rs. 698/- per capita per annum (1979-80 prices) is the conservative norm and N equal to Rs. 767.80/- per capita per annum (1979-80 prices), is the moderate norm.
<table>
<thead>
<tr>
<th>Author</th>
<th>Basis/Description</th>
<th>Norm (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert group Planning</td>
<td>Not exactly mentioned</td>
<td>Rs.20/- per capita per month (1960-61 prices)</td>
</tr>
<tr>
<td>Commission (1962)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bardhan (1970)</td>
<td>2250 Calories per day</td>
<td>Rs.180/- per capita per annum (1960-61 prices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for rural</td>
</tr>
<tr>
<td>Minhas (1974)</td>
<td>Not available</td>
<td>Rs. 200/- per capita per annum for rural (1960-61 prices)</td>
</tr>
<tr>
<td>Dandekar and Rath (1971)</td>
<td>2250 calories per capita per day</td>
<td>Rs.180/- per capita per annum for rural (1960-61 prices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rs.270/- per capita per annum for urban (1960-61 prices)</td>
</tr>
<tr>
<td>Ojha (1971)</td>
<td>2250 calories per day with 518 gm per head/per day for rural</td>
<td>Rs.15-18 per capital per day for rural (1960-61 prices)</td>
</tr>
<tr>
<td></td>
<td>With 43.2 gm per head/per day for urban.</td>
<td>Rs.8-11 per capita per day for urban (1960-61 prices)</td>
</tr>
<tr>
<td>Vaidayanathan (1974)</td>
<td>Not mentioned</td>
<td>Rs.240/- per capita per annum for rural (1960-61 prices)</td>
</tr>
<tr>
<td>Bhatty (1974)</td>
<td>Not mentioned</td>
<td>Rs.30/- per capita per annum for rural (1968-69 prices)</td>
</tr>
<tr>
<td>Ahluwalia (1978)</td>
<td>2250 calories per capita per day</td>
<td>Rs.180/- per capita per annum for rural (1960-61 prices)</td>
</tr>
<tr>
<td>Iyengar and Gopalakrishna (1985)</td>
<td>2300 calories per day</td>
<td>Rs.52.72/- per unit per day at (1973-74) prices for rural</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rs.65/- per unit per day at (1973-74 prices) for urban.</td>
</tr>
</tbody>
</table>
4.3 **Indices for the Measurement of Poverty**

As discussed earlier, we know that the phenomenon of absolute poverty presents itself differently in different income profiles. Even in the same distribution profile, one can highlight it differently depending upon one's subject sensibility and issue sensitivity. In correspondence with varied aspects of poverty the measures of poverty also vary over a wide range, reflecting several blends of sensibility and sensitivity. Some of the commonly used measures are:

i) The Head-Count Ratio

ii) The Poverty - Gap Ratio \((I_1)\) and Poverty - Gap Ratio \((I_2)\)

iii) Normalised Absolute Deprivation Index

iv) Sen's Poverty Measure

v) Kakwani's Index

vi) Thon's Index of Poverty

vii) Anand's Poverty Measure

viii) Foster, Green and Thorbecke's Poverty Measure

ix) Chakraborty's Measure

x) Beckerman's Relative Burden of Poverty Measure

xi) Clark and Ulph's Measure

xii) Takayama's Censored Gini Index

Before taking up the description of these measures, a word about the unit of analysis might be added. As argued earlier, a household/family, no doubt, is the natural unit of analysis in the context of rural societies. However, we cannot apply a uniform poverty norm on the family basis by virtue of their having differing size and age composition. Therefore a dichotomous classification of households would see us resorting to per capita transforms.
Such a transformation can be carried out either by using numerical size or standard consumer equivalent units as divisors.

Let $Y_i$ be the income of the $i$th household and $Z$ be the poverty norm, $i=1,...,n$.

Define
\[ y_i = \frac{Y_i}{w_i} \quad \text{and} \quad y'_i = \frac{Y_i}{w'_i} \] (4.1)

where, $w_i =$ the size of the $i$th household in biological units (persons)

$w'_i =$ the size of the $i$th household in consumer - equivalent units. (4.2)

Let these $y_i$'s be arranged in the ascending order of magnitude such that $p$ denotes the number of units with $y_i \leq Z$ i.e.

$y_1 \leq y_2 \leq \cdots \leq y_p \leq y_{p+1} \leq y_{p+2} \cdots \leq y_n$ (4.3)

These $y_i$'s take into account the variability of family size and the consumption needs of different families. The income gap (or poverty gap) of the $i$th unit is

$g_i = (Z - y_i)$ (4.4)

The total poverty gap for the poor is

$g = \sum_{i=1}^{p} g_i = \sum_{i=1}^{p} (Z - y_i)$ (4.5)

and the average poverty gap:

$g^* = \frac{g}{p}$ (4.6)
(i) **Head-Count Ratio**

A standard measure of poverty, the head-count ratio, $H$ is given by:

$$H = \frac{p}{n}$$

(4.7)

i.e. $H$ is the proportion of the households that happen to be identified as poor. Ever since quantitative study and measurement of poverty began, this index has been in use inspite of several drawbacks. The measure, is insensitive to the extent of shortfall of incomes of the poor from the poverty line and is also insensitive to the distribution of incomes among the poor.

Both these weaknesses provide sufficient ground for rejecting this index as a measure of poverty, though Bowley's (1923) assertion, "There is, perhaps, no better test of progress of the nation than which shows what proportion are in poverty", contributes to the popularity of this measure, inspite of above mentioned drawbacks.

(ii) **Poverty-Gap Ratio**

Another important index of poverty is the "poverty-gap ratio", or "income-gap ratio", which is defined in two alternative way, a la' Sen (1981),

$$I_1 = \frac{g}{pZ} = \frac{g^*}{Z} = 1 - \frac{\bar{y}}{Z}$$

(4.8)

and

$$I_2 = \frac{g^*}{\mu}$$

(4.9)
where, $\bar{y}$ = mean income of the poor
$\mu$ = mean income of the whole population

This measure is completely insensitive to transfers of income among poor so long as nobody crosses the poverty line by such transfers. Yet the measure reflects the intensity of poverty suffered by poor and the inequality of income among the poor.

(iii) Normalised-Absolute-Deprivation Index

A measure which captures the common features of $H$ and $I_j$ is known as "normalised absolute deprivation index" - defined as product $HI_1$ such that

$$HI_1 = \frac{P}{n} \sum_{i=1}^{P} \frac{(Z - y_i)}{pZ}$$

(4.10)

$$= H - H \bar{y} \frac{Z}{Z}$$

where, $\bar{y}$ = average income of the poor.

This measure is an improvement over both the head count ratio ($H$) and poverty gap ratio ($I_j$), because it takes into account the number of poor (being a function of $H$) as well as the aggregate shortfall of the income of all the poor from specified poverty line. But the measure is still inadequate as it is completely unaffected by the transfer of income among poor. As Sen (1981) observes, "Any combined measure based only on these two must also show no response, whatsoever, to such a change, despite the obvious increase in
aggregate poverty, as a consequence of this transfer in terms of relative deprivation". Still the measure will give adequate information on the intensity of poverty, if all the poor have same income.

A poverty measure which takes into accounts both the absolute as well as the relative deprivation aspects of poverty is proposed by Sen (1973, 1976).

(iv) Sen's Index (1973, 1976)

Sen (1973) not only offered an index of poverty, but also gave a different touch to poverty measures. This is his axiomatisation of poverty or the "axiomatic approach" to measure poverty.

The procedure consisted of first developing the axiom and then formulating the index. These axioms are generally agreed upon characteristics which poverty indices should possess. A brief discussion of these axioms is given below.

Let \( S \) be the set of \( n \) individuals in a society. Let \( y_i \) denote the income of the \( i \)th individual. Consider two states of this society having income vectors \( y \) and \( x \), respectively, such that

\[
\begin{align*}
\mathbf{y} &= [y_1, \ldots, y_n] \\
\mathbf{x} &= [x_1, \ldots, x_n]
\end{align*}
\]

Let \( P(y) \) and \( p(x) \) be their corresponding poverty measures in \( S \) with \( z \) as the poverty line (assumed to be given). Let \( T(y) \)
and $T(x)$ be the poor in the set $S$, i.e.

$$T(y) = \{i(y_i < z, \ i \in S)\} \quad (4.11)$$

$$T(x) = \{i(x_i < z, \ i \in S)\} \quad (4.12)$$

Then the following axioms are considered.

a) **Monotonicity Axiom**

According to this axiom, given other things, a reduction in the income of someone below the poverty line must increase the poverty measure, i.e. if for some

$$j \in [T(x) \cap T(y)] : x_j > y_j \quad \text{and for all } i \in S \text{ such that } i \neq j : x_i = y_i$$

Then $P(x) < P(y) \quad (4.13)$

b) **Weak Transfer Axiom**

The axiom says that a pure transfer of income to a poor person below the poverty line from a richer person, without making either cross the poverty line, must reduce the poverty measure, i.e. if for some

$$j \in [(T(x) \cap T(y)) \cup (S-T(x)) \cap (S-T(y))]$$

and

$$k \in T(x) \cap T(y) : [(x_j > y_j \geq y_k \geq x_k) \text{ and } (x_j - y_j) = (y_k - x_k)]$$

for all $i \in S$ such that $i \neq j, k : x_i = y_i$ then

$$P(x) > P(y) \quad (4.14)$$

Yet another axiomatic approach to measure the extent of poverty is given by "focus axiom", again by Sen, that makes
poverty a characteristic of the poor and not of the total nation.

c) **Focus Axiom**

If \( x_i = y_i \) for all \( i \in T(x) \cup T(y) \)

Then \( P(x) = P(y) \). \hspace{1cm} (4.15)

But the main argument against this is that poverty is a characteristic of a nation and hence poverty indices should reflect the relative burden of poverty as well.

Taking into account these axioms, Sen (1973, 1976) formulated the general definition of a poverty measure as a "weighted sum of the poverty gaps of the poor".

\[
P = A(n,p,Z) \sum_{i \in T} v_i g_i
\]

where \( v_i = \text{weight on the poverty gap } g_i \text{ of person } i, \)

\( i = 1 \ldots p \)

\( A(n,p,Z) = \text{normalising parameter} \).

Let \( r(i) \) denote the rank of poor person \( i \) among the poor, \( i=1 \ldots p \).

If \( v(i) \) is taken to be equal to \( r(i) \), in the definition of poverty measure, it will account for the distribution of income among the poor. This choice of weight is referred in an axiom of "ranked relative deprivation" by Sen (op. cit.).

d) **Ranked Relative Deprivation (Axiom R)**

If poverty is measured as in Eq.(4.16) with the weight \( v_i \) on \( i \)'th person's poverty gap equalling \( i \)'s income
rank among the poor:

\[ v_i = r(i) \]

(4.17)

the axiom captures the notion of relative deprivation in a single way.

In case, all the poor have the same income, the problem of relative deprivation among the poor does not arise. In such situation, an index based on the combination of head count ratio (H) and poverty gap ratio (I₁) may serve as a good measure of poverty. One of the simplest of such measures explained above as "normalised absolute deprivation index" is adopted as an axiom by Sen presented below.

**Normalised Absolute Deprivation (Axiom A)**

If for all \( i \in T : y_i = \bar{y} \), then

\[ P = H I_1 \]

(4.18)

When both these axioms R and A are imposed on the general format of the poverty measure, the precise index of poverty given by Sen (173, 1976) emerges as

\[ P = \frac{2}{(p+1)nZ} \sum_{i=1}^{p} (Z-y_i)(p+1-i) \]

(4.19)

where \((p+1-i)\) is the choice of weights \( v(i) \) for ith person's poverty gap; which denotes the ranks of income of poor among the poor.

Since the Gini coefficient, \( G \) for any \( p \)-membered population with mean income \( \bar{y} \) can be written as [Sen (1973)]
\[ G = 1 + \frac{1}{p} - \frac{2}{n^2 \gamma} \sum_{i=1}^{n} (p+1-i) y_i \] (4.20)

A little simplification yields
\[ P = H[I_{1} + (1 - I_{1})G] \] (4.21)

Where \( G \) denotes the Gini coefficient for the poor in the population.

When all the poor have the same income, the Gini coefficient \( G \) equals zero and \( P \) equals \( HI_{1} \). Given the same average poverty gap and the same proportion of poor population in total population, the poverty measure \( P \) increases with greater inequality of incomes below the poverty line, as measured by the Gini coefficient.

The measure is quite popular in literature and several variants of Sen's measure have been considered in studies on poverty.

(v) \textbf{Kakwani's Index}

One measure which allows the transfer of sensitivity to be increasing, or constant, or decreasing with the level of income was suggested by Kakwani (1980), which is based upon the different weighting procedure as adopted in Sen's measure. The measure is

\[ P(K) = \frac{1}{\sum_{i=1}^{p} \phi(K)} \sum_{i=1}^{p} (Z-y_{i})(p+1-i)^{k} \] (4.22)

Where, \( \phi(K) = \sum_{i=1}^{p} i^{k} \)}
If $k = 1$ then $\phi_p(1) = \frac{P(P+1)}{2}$, $P(K)$ reduces to Sen's poverty measure $P$.

If $k = 0$, $P(K) = \frac{P}{Z} \sum_{i=1}^{P} (Z-y_i) = \frac{P}{Z} \sum_{i=1}^{n} \frac{Z-y_i}{n}$ \hspace{1cm} (4.23)

which is suitable index only in case all the poor have same income i.e. "normalised absolute deprivation index". As Clark & Ulph (1981) say, "If each weight is raised to some power $k \geq 1$, then Sen's index will become more sensitive to transfer among those with large poverty gaps".

(vi) **Thon's Index of Poverty**

Another index of poverty which may be put in the general definition of poverty measure as suggested by Sen is Thon's (1979) index which is defined as

$$T = \frac{2}{Z(n+1)} \sum_{i=1}^{P} \frac{Z-y_i}{(n+1-i)} \hspace{1cm} (4.24)$$

The index captures the particular characteristics of a poverty measure that it should record an increase whenever there is transfer of income from a poorer person to a richer person. This is due to the fact that the measure is normalised weighted sum of poverty gaps of the poor, with the weights being decided by the ranks of poor person among all the people in the community, and not by the income rank of the person among the group of poor as in Sen's index.

(vii) **Anand's Poverty Measure**

An alternative expression of Sen's measure can be
obtained by replacing $I_1$ by its equivalent $(1-\frac{\bar{y}}{Z})$.

Thus with Anand (1977), we can write Sen's index as

$$P = \frac{H}{Z} [Z - \bar{y}(1-G)]$$

or Anand's index is given by

$$A = \frac{PZ}{\mu}$$

i.e. $A$ differs from $P$ only by a multiplicative constant.

This difference reflects normalisation per unit of national mean income rather than the poverty line income. Moreover, $A$ has the feature of being sensitive to the income of the non poor as well. A rise in the income of a non poor person, given other things, will reduce $I_1$, and hence $A$ will be reduced accordingly. Hence if a rise in the income of anyone can be taken to be reduction of the poverty of nation, then $A$ is preferred to $P$ since $P$ is insensitive to income rise of the rich. But at the same time, $A$ has the disadvantage of being insensitive to the income of poor, as reduction in the income of poor does not result in the increase of this measure, though the measure $P$ does possess this characteristic. Hence the choice among both these indices of poverty depends on the purpose for which the measure is employed.

(viii) **Foster, Green and Thorbeck's Poverty Measure (1984)**

In contrast to Sen's (1976) measure which adopts a "rank order" weighting scheme, this measure takes the
weights to be the shortfalls themselves. It is defined as:

$$P_a(y) = \frac{1}{n} \sum_{i=1}^{p} \left( \frac{Z-y_i}{z} \right)^a$$

for each $a \geq 0$ (4.26)

where $a$ can be viewed as a measure of poverty aversion: a larger $a$ gives greater emphasis to the poorest poor.

The measure $P_0$ is simply the "head count ratio", while $P_1$ is HI, a renormalisation of the income-gap measure.

In the above measure, deprivation depends on the distance between a poor household's actual income and the poverty line; not the number of households that lie between a given household and the poverty line.

Suppose that the population is divided into $m$ collection of households $J=1 \ldots \ldots m$ with ordered income vectors $y^{(J)}$ and population sizes $n_j$. Then the measure $P_a$ can be shown to be additively decomposable with population share weights i.e. for any income vector $y$ broken down into subgroup income vectors $y^{(1)}, \ldots, y^{(m)}$,

$$P_a(y) = \sum_{j=1}^{m} n_j \frac{n}{n} P_a(y^{(j)})$$

(4.27)

This particular property takes into account the fact that the total poverty is a weighted average of the subgroup poverty levels. In fact, increased poverty in a subgroup will increase total poverty at a rate given by the population share $n_j/n$, the larger the population share, the greater the impact.
In fact, Sen's measure and its variants, that rely on rank-order weighting, fail to satisfy the basic condition that an increase in subgroup poverty must increase total poverty.

(ix) **Chakraborty's Measure**

Another measure which is also additively decomposable is given by Chakraborty (1983). The measure is defined as

\[ P_c = \frac{1}{n} \sum_{i=1}^{i=p} \left( 1 - \left( 1 - \left( \frac{i}{n} \right) e \right) \right), \text{ where } 0 \leq e \leq 1 \quad (4.28) \]

The parameter \( e \) here determines the degree of sensitivity of the measure \( P_c \) to transfers of income. The index varies with \( e \) thereby indicating that measure attaches greater weights to transfers lower down the income scale.

The main advantage of the measure is that it is additively decomposable. Let the population be divided into \( K \) groups (according to some characteristics) and the \( i \)th group is having population \( n_i \) where \( i = 1, 2, \ldots, K \). Let \( p_i \) be the number of poor persons in the \( i \)th group then the overall poverty index can be written as

\[ p = \sum_{i=1}^{K} \frac{n_i}{n} P_{c_i} \quad (4.29) \]

where \( P_{c_i} \) is the poverty index defined by Chakraborty (1983) for group \( i \).
Beckerman's Relative Burden of Poverty Measure

Another measure of poverty, reflecting the relative burden of poverty of the nation compared with its aggregate income is a simple measure used by Beckerman (1979).

\[ B = \frac{p}{n} \frac{g_P}{P \mu} = \frac{g}{n \mu} \]  

(4.30)

H \( I_2 \) is equal to the ratio of aggregate poverty gap to total national income and expresses that percentage of total national income that should be transferred in case a redistribution is required to remove the poverty.

The measure though insensitive to the distribution of income amongst the poor is quite popular in studies regarding poverty.

Clark, Hemming and Ulph's Measure

While taking into account the ethical interpretation of the poverty measures, poverty may be measured using the following index analogous to Sen's index.

\[ P = H I_1 \left( \frac{g^*}{g} \right) \]

where \( g^* = \frac{1}{p} \sum_{i=1}^{p} g_i^{1/a} \)  

(4.31)

or \( g^* \) is defined as "equally distributed equivalent poverty gap" i.e. that poverty gap which if shared by all the poor, would be regarded as yielding the same level of welfare as the existing level and distribution of gaps.
Here $\bar{g} = \text{mean poverty gap.}$

This measure was given by Clark, Hemming and Ulph (1981). It has the following properties,

1. It is increasing in $H, I_1$ and $g^*.$
2. The measure is increasing in $a.$ When $a = 1,$ the measure reduces to $H I_1.$
3. The measure lies in the closed interval $(0,1).$
4. When $a > 1,$ $P$ denotes a group social welfare function which is strictly concave in income.

(xii) **Takayama's Censored Gini Index**

Another interesting variant of the poverty measures gaining popularity in this field is an index proposed by Takayama (1979), based on the idea of "censored distribution" as explored by Hamda and Takayama (1978). Takayama's measure is the translation of usual Gini ratio of inequality to the "censored income distribution" called Takayama's poverty index. The censored income distribution is obtained from the actual distribution by replacing all incomes above poverty line by incomes exactly equal to the poverty line i.e.

$$y_i = Z \text{ for all } i > p \quad (4.32)$$

where, $i = 1 \ldots n$

The Gini index of this "censored distribution" is Takayama's index of poverty given as
\[
T = \frac{\frac{1}{n(n-1)} \sum_{i} \sum_{j} |y_i^*-y_j^*|}{2 \sum_{i=1}^{n} \frac{y_i^*}{n}}
\] (4.33)

where, \( y_i^* = \begin{cases} y_i & \text{if } y_i \leq Z \\ Z & \text{otherwise} \end{cases} \) (4.34)

Other measures of poverty can also be obtained by applying different measures of inequality to this censored distribution.\(^7\)

This measure has a direct appeal as a poverty measure since it ignores the information of actual income of those people who are not poor but counts them in poverty line income. However, there is a major drawback. The measure is oblivious of the expectation that a decrease in the income of the poor, given everything else, must increase the value of the poverty index. A person in the censored distribution may be relatively rich and a decrease in his income will reduce the inequality in censored distribution, but in an equally obvious sense the community must now be having more—not less poverty.

The definition and the properties of all the indices listed above illuminate the varying aspects of poverty prevailing in a society. Therefore, all these measures may be relevant for some specific purpose or the other and their relative superiority can not be determined a
priori. However, certain axioms, as formulated by Sen (1973,76) as the test for legitimacy of poverty indices, have become so popular in studies regarding measurement that the set has attained the status of being the "acceptance" criteria. Accordingly, all the indices of poverty, as discussed above, have been viewed with reference to the satisfaction of these axioms in a summary form (Ref. table 4.2).

4.4 Measurement of Poverty and Existence of Negative Incomes

Throughout our discussion about the phenomena of poverty, the malady was conceived in the context of annual flows of income. The adequacy or inadequacy of these flows in the wake of a chosen consumption basket/the poverty norm was thought to be measured through one or the other index. If current flows are taken to be the sole reference points then one can envisage a state of distribution where some of the current incomes are negative. An inclusion of this aspect into current status poverty measurement, particularly the adequacy of incomes and affordability of the prescribed bundle, needs slight modifications in some of the above formulations. This has been necessitated because of the occurrence of the Gini Lorenz ratio, portraying the distribution of income amongst the poor, as an argument in some of the poverty indices.

While describing the case of negative incomes in the context of relative poverty (inequality) we have already
### Table 4.2

**Legitimacy of Poverty Measures: A Summary**

<table>
<thead>
<tr>
<th>Poverty Index</th>
<th>Axioms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monotonicity</td>
</tr>
<tr>
<td>Head count ratio</td>
<td>x</td>
</tr>
<tr>
<td>Poverty gap ratio - $I_1$</td>
<td>v</td>
</tr>
<tr>
<td>Poverty gap ratio - $I_2$</td>
<td>v</td>
</tr>
<tr>
<td>Absolute Deprivation Index</td>
<td>v</td>
</tr>
<tr>
<td>Sen's index</td>
<td>v</td>
</tr>
<tr>
<td>Anand's index</td>
<td>v</td>
</tr>
<tr>
<td>Kakwani's index</td>
<td>v</td>
</tr>
<tr>
<td>Thon's index</td>
<td>v</td>
</tr>
<tr>
<td>FGT index</td>
<td>v</td>
</tr>
<tr>
<td>Chakraborty's index</td>
<td>v</td>
</tr>
<tr>
<td>Beckerman's Index</td>
<td>v</td>
</tr>
<tr>
<td>Takayama' index</td>
<td>x</td>
</tr>
<tr>
<td>Clark, Hemmings and Ulph's measure</td>
<td>v</td>
</tr>
</tbody>
</table>
incorporated the desired modifications (Ref. section 3.2b-IV(c) and the same can be used in the present context. Since a repetitive description will be both monotonous and undesirable, a detailed description of the procedure is avoided. However, Takayama's censored Gini is picked up as an illustrative example.

**Takayama's Censored Gini and Negative Income**

Let $Y_1, Y_2, \ldots, Y_n$ be random sample of size $n$, from some unknown income distribution $F(Y)$, having differentiable density $f(y)$, and finite mean $\mu$.

Let $Y_i$ denote the income of the $i$th household. Though some of the income may be negative but the total income is positive (Ref. section 3.2b-IV(c))

Let $Y_1 \leq Y_2 \leq \ldots \leq Y_n$

and let $y_i = \frac{Y_i}{\bar{w}_i}$, $y_i' = \frac{Y_i}{\bar{w}_i'}$ as defined in Eq.(4.1).

Order these $y_i$'s as $y_1 \leq y_2 \leq \ldots \leq y_n$

Then Takayama's censored Gini ratio is estimated as (Ref.Eqs. 4.33 & 4.34)

$$\hat{T} = \frac{1}{n(n-1)} \sum_{i,j=1}^{n} |y_i - y_j|$$

where, $y_i^* = y_i$ \quad if $y_i \leq z$

$= 0 \quad$ otherwise
In case there are some negative entries in the distribution profile, Takayama's censored Gini index ($\hat{T}$) may exceed one. This assertion follows from the fact that the definition of $\hat{T}$ is same as that of Gini ratio $G$ (Ref. sec. 3.2b-IV(c)) with the exception that in case of $\hat{T}$ the random sample is taken from the censored population instead of the total population. Hence, following Chen et al. (1982) it may be argued that in such a case where negative entries are also included in the data profile; there is a need to adopt a modified version of $\hat{T}$ to avoid any bias in the interpretation of poverty.

Thus following Chen et al. (1982), we propose two modified versions of $T$ to be employed in case some negative entries are present in the data profile.

The first modified version of Takayama's censored Gini ratio is

\[
\hat{T}^* = \frac{1 + \frac{1}{n-1} + \frac{2}{n-1} \sum_{i=1}^{k} y^{**} - \frac{1}{n-1} \sum_{i=k+1}^{n} y^{**(1+2(n-i))}}{1 + \frac{2}{n-1} \sum_{i=1}^{k} (i y^{**})} \tag{4.35}
\]

where, \( k \) is so defined that

\[
\sum_{i=1}^{k} y^{**} = 0 \tag{4.36}
\]

and

\[
y^{**}_i = \frac{y^{*}_i}{n\bar{y}^*} = \text{income share of the } i\text{th unit} \tag{4.37}
\]

where, \( i = 1 \ldots n \)
The another modified version of Takayama's censored Gini ratio, called $\hat{T}^{**}$, based on the different choice of $k$ is given as:

$$\hat{T}^{**} = \frac{1 + \frac{1}{n-1} \sum_{i=1}^{k} iy_1** + \frac{1}{n-1} \sum_{i=k+1}^{n} y_1**(-1+2k)}{1 + \frac{1}{n-1} \sum_{i=1}^{k} iy_1** + \frac{1}{n-1} \sum_{i=k+1}^{n} y_1**((1+2k))}$$

where, $k$ is so defined that

$$\sum_{i=1}^{K+1} y_1** < 0 \quad \text{but} \quad \sum_{i=1}^{K+1} y_1** > 0 \quad (4.39)$$

Both these versions of Takayama's censored Gini ratio satisfy all the conventional properties of $\hat{T}$ and lie between 0 and 1.

In the preceding pages we have confronted a galaxy of measures for gauging inequality and poverty. We noticed that each index tried to convey a specific dimension of deprivation and attached varied importance to the extent of deprivation of various divisions of the income profile. Therefore, the choice of an appropriate measure becomes a matter of assertion with or without the needed support flowing from "legitimacy of axioms" and "propriety conditions". As table 4.2 suggests, some of the indices do satisfy certain axioms, while others are relevant in different contexts.
Hence, in this study, instead of taking into account all the above indices, we have picked up only those of the indices for which tests of significance are available or have been proposed by us. As pointed out earlier, Gini ratio has been the selected measure of inequality, while among poverty indices we have picked up head count ratio, poverty gap ratio and Takayama's censored Gini ratio. To develop the tests of significance for these selected indices of deprivation is the subject matter of the next chapter.
Notes and References
(Chapter 4)


2. Miller & Roby (1971, pp 143) do advocate this view which reads, "casting the issues of poverty in terms of stratification leads to regarding poverty as an issue of inequality.... Our concern becomes one of narrowing the differences between those at the bottom and the better-off in each stratification dimension".

3. For details ref. Sen(1981). Besides these, empirical identification of the poor, particularly taxonomic terms, is developing fast as a sub-theme of poverty studies for some exercises on these lines see Gaiha & Kazmi (1981), Julka et al. (1989c, 1990).

4. One may agree with Rein's (1971) assertion that "almost every procedure in the subsistence level definition of poverty can be reasonably challenged".
5. It is interesting to see that if we put \( p=n \) and \( Z=\mu \), \( \mu \) being the mean income of whole community, we obtain a class of inequality measures \( \eta(k) \) corresponding to the class of poverty measure \( P(k) \)

\[ \eta(k) = \frac{1}{n} \sum_{i=1}^{n} (\mu - \gamma_i)(n+1-i)^k \]

when \( k=1 \), it can be proved that \( \eta(k) \) approximates the Gini index for large \( n \). Thus \( \eta(k) \) is a general class of inequality measures of which the Gini index is a particular number.

6. We may note that

\[ P = \frac{pg^*}{nZ} \]

which may be interpreted as "the aggregate gap of the poor which, if equally shared would yield the same level of welfare of the poor as the actual aggregate gap distributed as it is, expressed as a proportion of the aggregate gap when each member of the population has a zero income".