Poverty, Inequality and Unemployment

Some Conceptual Issues in Measurement

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The Indian poor may not be accustomed to receiving much help, but they are beginning to get used to being counted. The poor in this country have lately been lined up in all kinds of different ways and have been subjected to several sophisticated head-counts.[1] *Measurements of two related phenomena, viz, inequality and unemployment, have also received much attention recently.*[2] *This note is concerned with tackling some conceptual issues thrown up by these measurement exercises. In particular, the object is:*

(i) to discuss briefly the relation between the concepts of poverty, inequality and unemployment;
(ii) to review some recent analytical results on the welfare aspects of inequality measurement;
(iii) to present an axiomatic framework for inequality measurement aiming to throw some light on measures like the Gini co-efficient;
and (iv) to propose, in the light of (iii), an alternative measure of poverty, which is, in some important ways, superior to the measure used in the poverty debate.

I

Poverty, Unemployment and the Income Criteria

POVERTY as a concept is closely related to inequality. Given the average income level, a higher level of inequality (reflected by the usual measures) will tend to be associated with a higher level of poverty. Furthermore, the so-called "poverty line" may sometimes be drawn in the light of the socially accepted "minimal" standard of living, and the latter can be influenced by the average income level, so that poverty measures, thus defined, may catch an aspect of *relative* inequality as well.

The famous study group (set up by the Planning Commission) that sanctified in 1962 the magic figure of Rs 20 per month at 1960-61 prices as the poverty level had considered nutrition, but did not specify any particular nutritional norm nor any set of prices as a justification for its choice of Rs 20. That number has been widely used, along with other rules of thumb, e g, Bardhan's Rs 15 for rural and Rs 18 for urban areas, and Dandekar and Rath's Rs 15 for rural and Rs 22.50 for urban areas. While other estimates were also done by Ojha, Dandekar and Rath, and Bardhan, using specific nutritional standards,[3] many of the poverty estimates are based on minimal levels that directly or indirectly take note of the prevailing social ideas on the subject of "poverty". The number of the poor in such a context is also partly a reflection of relative inequality, and the same authors would have presumably used different norms if they were to estimate poverty in, say, the United States.

Thus the identification of poverty with inequality, though illegitimate, is not as easily dismissable as it may appear at first sight. However, even if the minimal level is determined entirely by the actual distribution of income (e g, equated to some fraction of the mean, or the mode), the number of the poor will still be a very gross measure of inequality, concentrating as it does only on one thing. As it happens it is, in fact, also a gross measure of poverty. In Section 6 there will be an occasion to discuss this measure further.

Poverty has been identified not merely with inequality but also with unemployment. This has occurred recently in many studies across the globe, e g, in the ILO "country reports", especially in the Kenya report. In India a somewhat similar view has been taken by Dandekar and Rath (1971), who have defined "an adequate level of employment . . . in terms of its capacity to provide minimum living to the population". In his four-fold classification of unemployment, Raj Krishna (1973) identifies this approach to unemployment as "the Income Criterion". He observes that Dandekar and Rath "abandon the time criterion altogether for measuring unemployment and, in effect, reject the distinction between poverty, considered as consumption below a certain minimum, and unemployment, considered as an involuntary failure to get income-yielding work for the normal number of working days in a year" (p 475). A person may be working for long hours and be paid for his efforts, but if his remuneration rate is low, he may still end up being classified as "unemployed".

Whether it makes sense to stretch the concept of unemployment into the field of poverty as such remains an open question, which I have tried to discuss elsewhere (Sen 1973), even though it should be observed that Dandekar and Rath's own use of their estimates is hardly affected by whether they call these people "poor" or "unemployed".

In this context I would like to make one remark on Raj Krishna's illuminating classification of the concepts of unemployment and in particular on his definition of "the Income Criterion". Suppose we reject the Dandekar-Rath view. We shall then be left with Raj Krishna's other trade categories, *viz*, "the Time Criterion", "the Willingness Criterion" and "the Productivity Criterion". Can we do without an income concept in the study of unemployment even if we reject the definition of an unemployed as a person who "earns an income per year less than some desirable minimum"? I would argue that we cannot since a relevant distinction is concerned with whether the work in question produces an income for the person concerned, i e, whether the emoluments received by a person is *conditional* on his work. The distinction is quite crucial in the context of pre-capitalist economic formations.

Contrast two cases. In both the cases a person receives his economic support from the joint family and also works on the family farm. In case A he would cease to receive the support if he would stop working, while in case B he would receive the support anyway, even if he did not work. "The Time Criterion" cannot discriminate between the two cases since he works the same amount in both cases. Nor can "the Willingness Criterion", since he may be equally willing or unwilling in both cases. Nor can "the Productivity Criterion", since he may be equally productive in both cases; his removal may or may not affect the output in either case. But is there not a relevant distinction in the fact that in case A the person's income will cease if his work ceases, while in case B it will not?

The distinction is important for economies like India, and is of relevance to many different problems. First, it is important in developing a conceptual framework for the coverage of the workforce. The right of an ablebodied man to receive economic support without working typically differs from that of a woman or a child depending on social traditions. Second, it is also relevant in calculating the supply price of a labourer from a joint family moving to the town for employment there rather than continuing to work in the joint farm, since the emigrant's calculations of his own gains would depend on whether and to what extent his farm income is conditional on his being on the farm and working there. Third, a substantial short-run influx of migrant labourers from their town jobs to their family farms at peak periods of harvesting and sowing, which has been frequently interpreted to mean the absence of unemployment in terms of "the Productivity Criterion", need not necessarily imply any such thing. It is possible that the farm output would still be the same (with others working harder), but the right of the migrant labourer to a part of the fruits of the joint farm would be compromised by his inability to participate in the work at crucial moments. In this case the person would be unemployed in the farm in terms of "the Productivity Criterion", but employed in terms of an "Income Criterion", which has nothing to do with the Dandekar-Rath "Income Criterion" which Raj Krishna discuses.

I shall not go further into the question here: I have tried to spell out elsewhere (Sen 1973) the relevance of this conceptual category for unemployment studies in pre-capitalist formations varying with rules relating ownership, work, economic support, and income. Poverty may be an odd measure of unemployment, but to catch one important dimension of the problem of unemployment, we do need some income criterion, in addition to the criteria based on time, willingness and productivity.

II

Standard Inequality Measures

In the empirical literature many measures of inequality have been used, and they do not often rank alternative income distributions in the same way. The variance, the co-efficient of variation, the standard deviation of logarithms, the Lorenz curves, the Gini co-efficient, the income share of the bottom x (say, 10) per cent of the population, and other examples abound in the empirical literature. What underlying view of social welfare, or planning objectives, do they respectively imply?

As is well known, the mean-variance analysis used in a system in which social welfare is taken to be the sum of individual welfares would make sense only if individual welfare is a quadratic function of individual income, and this is quite a restrictive assumption. For variance as a measure of relative inequality there is the further difficulty that it is not mean-independent, i e, x may be a *relatively* more equal distribution in a uniform way than y, but x can still have a higher variance if the mean income is higher for x than for y. This problem can be avoided by using instead the co-efficient of variation, but the limited nature of the underlying welfare function remains.

The standard deviation of logarithms is, in some ways, even more of a special case in terms of its welfare interpretation, even though it has the attractive characteristic, in contrast with the co-efficient of variation, that the sensitivity of the measure to a small transfer of income from a person with income y to one with income (y + d) diminishes sharply as we consider higher and higher y. But it can be shown that even a perverse result is possible in the sense that a transfer from a poorer person to a richer man can, under certain circumstances, *reduce* the standard deviation of logarithms for relatively high incomes.[4] A social welfare function that permits this is obviously open to some serious objection.

The rest of the paper will be concerned with the Lorenz curve, the Gini co-efficient, and some poverty measures. I shall not discuss any further the welfare aspects of other inequality measures. Nor the problem of output heterogeneity and relative prices in the context of inequality measurement. These and other related questions I have tried to go into elsewhere (Sen 1973a).

III

Lorenz Curve Comparisons

The Lorenz Curve shows the percentage of income received by the bottom x per cent of the population with x varying from 0 to 100. See Diagram 1, curve OBA. The great advantage of Lorenz curve comparisons is that we can say something about comparative levels of social welfare without specifying anything very particular about the exact welfare function. If distribution x has a uniformly higher Lorenz curve (higher at some places and lower nowhere) than distribution y involving the same total income, then social welfare W from x must be larger than social welfare from y, no matter which W(.) function we choose as long as W(.) is a symmetric and strictly quasiconcave function of the vector of individual incomes.[5] (In fact, even quasi-concavity is not necessary, on which I shall comment presently.) Suppose we know that social welfare W depends on individual incomes:

$$W = W(y_1, \ldots, y_n) \qquad (1)$$

Further, no special importance is attached to who has which income, i e, a permutation of the incomes between the persons leaves W unchanged (symmetry), and the social welfare level from any weighted average of two income distribution vectors is larger than the minimum of the social welfare levels of the two (strict quasi-concavity), which implies — roughly — that the ratio of the weight on person i's income *vis-a-vis* that on j's income will go down as i gets relatively richer *vis-a-vis* j. Then, even without knowing anything more about the nature of the social welfare function W(.), we can tell that a higher Lorenz curve implies more social welfare for the same total of income. The argument can be easily extended to variable population sizes as well under a relatively innocuous assumption, and a higher Lorenz curve implies a larger mean social welfare for the same mean level of income.[6] Thus the practical importance of a higher Lorenz curve is indeed substantial, even without specifying a great deal about the objectives of planning. Such statements as "the distribution

TABLE 1: PERCENTAGE SHARE OF CONSUMPTION ENJOYED BY THE BOTTOM x PER CENT OF THE INDIAN RURAL POPULATION: 1964-65

x%	NSS(%)	NCAER(%)
10	3.48	3.77
20	8.47	8.66
30	14.54	14.41
40	21.59	21.08
50	29.70	28.57
60	39.01	37.08
70	49.68	46.61
80	62.13	57.61
90	77.31	71.37
100	100.00	100.00

of income is worse from the welfare point of view" can be made in these cases without the need to specify any particular social welfare function.

In fact, Lorenz curve comparisons can be shown to have another rather extraordinary property.[7] If x has a higher Lorenz curve than y but the same total income, then we can move from y to x through a finite sequence of single transfers from richer to poorer persons. Thus a higher Lorenz curve implies a more equal distribution in this strictly descriptive (rather than normative) sense. It is also the case that with a symmetric and strictly quasi-concave welfare function W(.), such a sequence of rich-to-poor transfers must necessarily increase social welfare W. But quasi-concavity is not necessary for this purpose. What then is the necessary and sufficient condition to be satisfied by the welfare function W(.) to have the property of yielding a higher W wherever the Lorenz curve shifts upwards? The type of concavity required is strict S-concavity.[8] This can be satisfied by some welfare functions which are not strictly quasi-concave, e g, the negative of the Gini co-efficient. Essentially any welfare function that responds positively to the type of rich-to-poor transfers that is involved in moving to a higher Lorenz curve will do. The condition to be imposed on the welfare function is perfectly transparent and is, in fact, much easier to follow than the rather technical concepts of concavity, quasi-concavity and S-concavity.[9]

IV

Lorenz Comparison Indeterminacy and the Gini Co-efficient

If we compare two distributions and the Lorenz curve of one is uniformly above that of another, we are in luck as far as inequality measurement is concerned. Even if the total income varies, we can say that the change from the first to the second involves an inequality-increasing shift in the distribution of income combined with a change in total income. But sometimes two distributions do not have this property and the Lorenz curves may cross. Typically, the Lorenz ranking is a partial ordering.

A good example is given by two alternative estimates of the distribution of rural consumption in 1964-65 based respectively on the National Sample Survey data and the data of the National Council of Applied Economic Research.[10] Table 1 presents the percentage shares of the bottom x per cent of the rural population taken in cumulative decile groups. It is clear that the NCAER Lorenz curve starts above the NSS curve but falls below it later. The theorems stated in the last section on Lorenz comparisons will not now yield anything whatsoever. We must take a more specific view of the welfare objectives.

Consider two of the widely used measures in India: (i) the share of the bottom 10 per cent: NCAER with 3.77 per cent as opposed to 3.48 per cent is a better distribution; (ii) the Gini co-efficient (or the Lorenz Ratio as it is frequently called): NSS is a better distribution having a value of 0.29 as opposed to NCAER's 0.32. The former criterion is a perfectly obvious one. Its merits are clear and so are its defects. But the Gini co-efficient is more opaque since it measures the distance between the diagonal "line of equal division" and the Lorenz Curve, e g, the shaded area OBA in Diagram 1. Unlike in Lorenz comparisons, the Gini co-efficient comparisons are always conclusive since one real number must be greater than, equal to, or less than, another. But what does it stand for?

A number of papers written recently have queried the welfare implications of the Gini co-efficient, it has been asked: What class of welfare functions will be maximised if the Gini co-efficient is minimised for distributions of a given total income? It has appeared that the class of welfare functions corresponding to the Gini co-efficient is highly restrictive. Atkinson (1970) raised his additively separable eyebrows at the Gini co-efficient's lack of strict concavity, and Newbery (1970) formally proved a theorem showing that no additive social welfare function based on strictly concave individual utility functions can order distributions of a given total in precisely the opposite order to the ranking of the values of the Gini co-efficients. Additivity is, of course, a restriction and is possibly quite objectionable, as noted in Sen (1972), (1973a), and Sheshinski (1972), but it can be easily demonstrated that a relaxation of additivity *alone* will not eliminate this problem of the Gini co-efficient in a framework of individualistic social welfare. In fact, as stated in the last section, the negative of the Gini co-efficient is not strictly quasi-concave, which would of course rule out non-additive welfare functions as well if they are strictly quasi-concave (see Dasgupta, Sen and Starrett 1973 and Sen 1973a).

This seems a bit sad since the Gini co-efficient is so widely used. What does the Gini co-efficient stand for exactly? In the next section an axiomatic framework is presented yielding axioms that are necessary and sufficient for the planner to wish to minimise the Gini co-efficient of distributions of a given total income.

V

An Axiomatic Framework

Consider the welfare value of an income vector y given by:

$$W(y) = \sum_i y_i v_i(y), \quad (2)$$

where y_i is the income of the i-th person (i e, the i-th component of y) and $v_i(y)$ a weight on y_i. Note that this functional form as such is not very restrictive, since v_i can vary with any component of y, and whatever the shape of any general W(.) function, we can represent it in the form of (2) by choosing an appropriate set of v_i.

I shall now propose four axioms. I should explain at the outset that I do not intend to lay down my life fighting for the acceptance of these axioms, but they are somewhat appealing within a specific framework, and what is more important, they correspond exactly to the Gini co-efficient, helping us to understand it. Let us define (y,i) as the state of being in individual i's shoes with the distribution y, i e, having y_i income while the distribution is y.

Axiom E (*Weighting Equity*): If everyone prefers (y, i) to (y, j), then:

$$v_j(y) > v_i(y).$$

Axiom O (*Ordinal Information*): If

everyone prefers (y, i) to (y, j) and also (y, m) to (y, n), and there is no (y, k) such that anyone prefers (y, i) to (y, k) and (y, k) to (y, j), and there is no (y, p) such that anyone prefers (y, m) to (y, p) and (y, p) to (y, n), then v_j (y) $- v_i(y) = v_n(y) - v_m(y)$.

Axiom L (*Limit Equality*): All distributions y of a constant total income Y over a constant population must have the same maximal v_i (y). and the same minimal v_i (y) for variations in i.

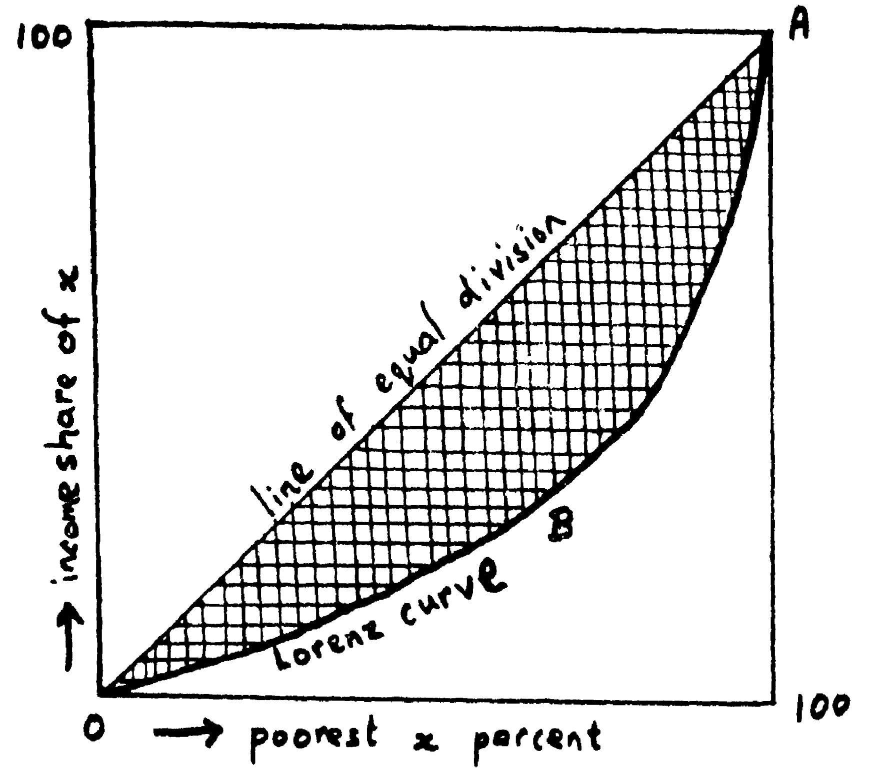
Axiom M (*Independent Monotonicity*): For all y, all individuals regard (y, i) to be at least as good as (y, j) if and only if $y_i > y_j$.

Axiom E requires that a person whose position is regarded by all to be worse than that of another should enjoy a higher weight on his own income.[11] Axiom O suggests that in constructing the weights only ordering information can be used with no information on intensity of preference other than how many positions lie in between the two alternatives in the person's preference scale, which is part of the ranking data. So that if everyone prefers (y, i) to (y, j) with no intermediate alternative, and (y, m) to (y, n) again with no intermediate alternative, then the weight on j's income should exceed that of i by precisely as much as the weight on n's income over that of m. Axiom L wants all income distributions to have weights lying within the same range as long as they are distributions of the same total income over the same population. Axiom M makes each person decide his preference on the basis of his income alone and it is assumed that he prefers more to less.

Theorem: A welfare function W(.) satisfying Axioms E, O, L and M must rank all alternative distributions of a given total income over a given population, with distinct income for each individual, in exactly the same way as the negative of the Gini co-efficient.

The proof is easily provided but is omitted here,[12] but the strategy of it lies in showing that Axioms E, O, L and M imply that W(y) must be a positive linear (strictly, affine) transformation of the rank-order weighted sum of individual incomes. More specifically, if i stands for the i-th poorest man (with the poorest being 1, next poorest 2, etc, taking individuals in either order in the case of a tie), then:

DIAGRAM 1



$$W(y) = A + B \sum_{i=1}^{n} (n+1-i)\, y_i \quad (3)$$

where A and B are constants for a given total income and given population, with $B > 0$. It is, of course, easily demonstrated that the Gini coefficient can be written as:

$$G(y) = 1 + (1/n) - (2/n^2 z) \sum_{i=1}^{n} (n+1-i)\, y_i \quad (4)$$

where z = mean income, and n = population size. It is obvious that given z and n, minimising G is equivalent to maximising W.

Perhaps the most controversial axiom is Ordinal Information. In trying to get a weighting system based on ranking information only without arbitrary distinctions, we come close to a rank-order weighted sum of individual incomes. The Gini co-efficient amounts to this also since the Lorenz curve is constructed taking the poorest person's income at every point, the next poorest person's income at all points but one, and so on until the richest man comes in by the skin of his teeth at the last point. Hence the correspondence with rank order weighting.

Axiom O also brings out one of the main limitations of the Gini measure. The weights depend on rank orders and weight difference between two persons with given incomes will change if the number of people with incomes in between changes. The difficulty arises from trying to get a set of cardinal weights from ordinal information only and that too confined to the ranking of the different persons' positions only in the distribution in question.

VI

Measurement of Poverty

Finally, some remarks on poverty measures. Let y^* be the minimal acceptable level of income. In the framework of (2), consider the following system of weighting :

(i) If $y_i \geq y^*$, then $v_i = (1/y_i)$

(ii) If $y_i < y^*$, then $v_i = 0$. (5)

Taking (2) with (5), we get

$$W(y) = N(y_i \geq y^*), \quad (6)$$

where N ($y_i \geq y^*$) is the number of people with income no lower than the poverty line. Maximising (6) for a given population will amount to minimising poverty as defined in the Minhas-Bardhan-Ojha-Dandekar-Rath-Vaidyana - than debate. The extreme nature of (5) is apparent. While rule (i) satisfies the Axiom of Weighting Equity, rule (ii) violates it robustly.


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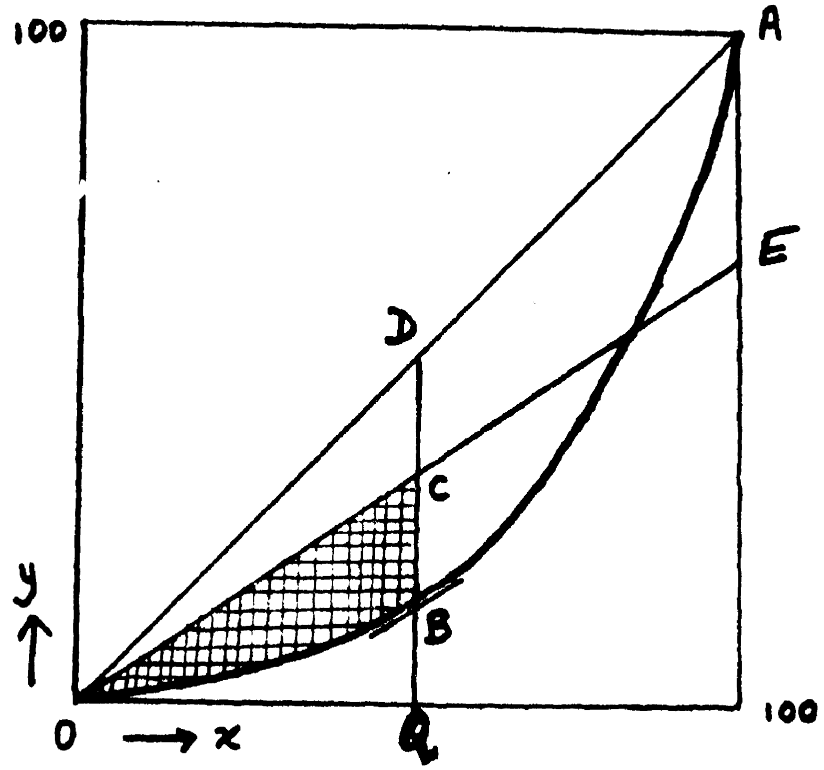
DIAGRAM 2



It also emphasises the sharp break at y^*, which makes it worthwhile for public policy makers, seeking credit for achievements in "garibi hatao", to concentrate on people just below the level of y^*. Pushing them a little higher up brings in rich dividends in terms of this poverty measure, while the credit for pushing up even poorer people is likely to be zero in this measure unless they are pushed up quite a bit. The concentration on the "potentially viable" small farmers in the recent schemes of rural development reflects an approach that is closely aligned to the conception of poverty given by (6). While there is no doubt that the poverty debate that took place recently has contributed much to our understanding of certain important aspects of the Indian economy, the nature of the measurement used provides scope for public policy being concerned with the relatively richer among the poor, ignoring greater suffering.

How should we modify the poverty measure to take note of these problems? At least two changes would seem to be needed: (i) we should be concerned not merely with the number of people below the poverty line but also with the amounts by which the incomes of the poor fall short of the specified poverty level, and (ii) the bigger the shortfall from the poverty level, the greater should be the weight per unit of that shortfall in the poverty measure.

The following additional notation will be used:

q = the number of people at or below the poverty line, i e, $y_q = y^*$;

r_i = the weight on the poverty gap of person i;

$A(Y,n)$ = a parameter dependent on total income Y and population size n. Satisfying (i) and (ii), we can consider the following general form for the poverty measure P:

$$P = A(Y,n) \sum_{i=1}^{q} (y^* - y_i)\, r_i \qquad (7)$$

with $r_i > r_j$ whenever $i \leq j$.

In the light of the justification of the system of rank order weighting in the Gini co-efficient, a case for using rank order weights in the poverty measure can also be constructed. A simple measure, closely aligned to the Gini measure of inequality, will be:

$$P = (2/n^2 z) \sum_{i=1}^{q} (y^* - y_i)(q - i + 1) \qquad (8)$$

In fact a slight variation helps to make the poverty measure independent of the absolute size of the population, i e, making the value of P unaffected by multiplying the population in each income group by the same positive number:

$$P = (2/n^2 z) \sum_{i=1}^{q} (y^* - y_i)\,(q - i + \tfrac{1}{2}) \qquad (9)$$

It is easily checked that putting $q = n$ and $y^* = z$, we get the Gini co-efficient as a special case of this poverty measure.

In Diagram 2, the poverty measure is roughly represented by the shaded area OBC, where the slope of OE represents the poverty level normalised in percentage units. It differs from the Gini co-efficient (area OBA), which is a measure of *relative* inequality, in two ways, *viz*, (a) in being concerned only with the people who lie below the poverty line (leaving out area DBA), and (b) in calculating the income differences from the poverty level and not from the average income of the distribution itself (leaving out area ODC). On the other hand, it differs from the standard poverty measure q, represented in Diagram 2 by OQ, in being sensitive to the size of the income gaps of the poor, and in putting more weight on the relatively poorer both (a) by noting their larger income gaps as well as (b) by putting in greater weights *per unit* on their income gaps.

I would argue that as a measure of poverty, P is superior both to the usual head-count as well as to the standard measures of *relative* inequality. Furthermore, the data requirement to estimate P is less than what is needed to draw the Lorenz curve or to calculate the Gini co-efficient, both of which are frequently performed.

Notes

1 See, especially, Minhas (1970), (1971), Bardhan (1970), (1971), (1973), Ojha (1970), Dandekar and Rath (1971), and Vaidyanathan (1971).

2 The literature on income distribution is vast, and includes, among others, Lydall (1960), Ojha and Bhatt (1964), (1964a), Randive (1965), Ahmed (1965), Iyengar and Bhattacharya (1965), Swamy (1967), (1967a), Mukherjee (1969), (1972), Bardhan and Srinivasan (1971), Srinivasan and Vaidyanathan (1971), Vaidyanathan (1971), Ahmed and Bhattacharya (1972), and Bardhan (1973). For an excellent critical evaluation of the literature on unemployment, see Raj Krishna (1973).

3 See also Panikar (1972).

4 See Atkinson (1970), and Dasgupta, Sen and Starrett (1973).

5 See Dasgupta, Sen and Starrett (1973). This is an extension of an important earlier result by Atkinson (1970). The assumptions of additive separability and strict

concavity used there are dropped in Dasgupta, Sen and Starrett (1973). See also Rothschild and Stiglitz (1973). See Bardhan (1973a) for empirical uses with Indian data.

6 See Dasgupta, Sen and Starrett (1973), Theorem 2.

7 See Kolm (1969), Atkinson (1970), and Dasgupta, Sen and Stiglitz (1973).

8 See Berge (1963).

9 There is a minor error in the presentation of our results in Dasgupta, Sen and Starrett (1973). We defined strict S-concavity thus: "If for all bistochastic matrix Q, which is not a permutation matrix of order n, $F(Qx) > F(x)$, then F is *strictly* S-concave" (p 183). In fact, Q can permute some x without Q being a permutation matrix. Consider, for example :

$$x=\begin{pmatrix}2\\4\\4\end{pmatrix},\ Q=\begin{bmatrix}0&\frac{1}{2}&\frac{1}{2}\\0&\frac{1}{2}&\frac{1}{2}\\1&0&0\end{bmatrix},\ Qx=\begin{pmatrix}4\\4\\2\end{pmatrix}.$$

The correct definition should be: "If for all bistochastic matrix Q, $F(Q\ x) > F(x)$, whenever Qx is not x, nor a permutation of it, then F is strictly S-concave". A corresponding correction is needed in statement (i) of Lemma 2 and in Theorems 1 and 2 (p 182). I am most grateful to Penelope Rowlatt for raising a perceptive query concerning Lemma 2.

10 See Bardhan (1973a), Table 6. Note that the NSS data refer to July 1964 - June 1965 while the NCAER data are concerned with May 1964-April 1965.

11 The rationale of this axiom has some similarity with the Weak Symmetry Axiom proposed in Sen (1973a).

12 Proofs of this and some other related theorems are given in my "Aggregation and Income Distribution", paper to be presented in the International Seminar on Public Economics to be held in Siena in September, 1973. The theorem presented here holds for distributions with a distinct income for each person, i e, for distributions such that no two persons have the same income. To extend the result to cover all distributions, Axiom O° is used to supplement Axiom O in my Siena paper, requiring that if all individuals rank a set of positions as indifferent, they should be put in any arbitrary chain of unanimous strict preference. All possible chains yield the same result, and Axioms E, O, O°, I, and M make the theorem hold for *all* distributions of a given income.

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