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Caste Discrimination in the Distribution of Consumption Expenditure in India: Theory and Evidence

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### CASTE DISCRIMINATION IN THE DISTRIBUTION OF CONSUMPTION EXPENDITURE IN INDIA: THEORY AND EVIDENCE

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### CASTE-DISCRIMINATION IN THE DÍSTRIBUTION OF CONSUMPTION EXPENDITURE IN INDIA: THEORY AND EVIDENCE

### 1. MOTIVATION

While a great deal of work has been done by economists on the measurement of inequality and poverty, rather less appears to have been done with respect to a related phenomenon — that of 'discrimination'. Much of the work in this area — with specific reference to <u>segregation</u> — has been undertaken by sociologists (see, for example, the seminal contributions of Duncan and Duncan (1955a, 1995b).

In this paper we discuss a number of real-valued indices of discrimination, measured - for specificity - along the dimension of income. At this juncture it might be as well to issue a <u>caveat</u> to the effect that the term 'discrimination' carries with it connotations of <u>intentionality</u> which it may be hard to infer from a consideration of <u>outcomes</u>. Those who feel uncomfortable with the use of the term 'discrimination' may simply wish to replace it with the more neutral term 'relative disadvantage'. Now that this qualification is in place, we shall continue to employ the term 'discrimination' without further outbreaks of defensiveness.

In this paper we also seek a concrete application of our measurement - related concerns. This we do by estimating the extent of discrimination that obtains, in rural India, with respect to the distribution of consumption expenditure between the scheduled castes and tribes on the one hand, and the rest of the population, on the other  $^{1>}$ . It must be emphasized that our

2.2 Some Real-Valued Indices of Discrimination

In what follows, we present a set of five discrimination indices  $D^k(k=1,\ldots,5)$  which, we believe, are intuitively fairly immediately plausible. The first of these indices is given by :  $D^1(s^9) = 1-\mu^{s^9}/\mu$ ,

where  $\mu^{s^{9}}$  is the mean income of the reference group  $s^{9}$ .  $D^{1}$  simply measures the proportionate deviation of the mean income of the reference group from the overall mean income. If  $\mu^{s^{9}}$  is less than  $\mu$ ,  $D^{1}(s^{9})$  is positive, and we have a case of 'discrimination against' the reference group; and the other way around if  $\mu^{s^{9}}$  is greater than  $\mu$ .  $D^{1}$  is a very elementary index, and hardly requires any further explication. By taking the median and the mode, rather than the mean, as the relevant measure of central tendency, we can generate the following two simple variants of  $D^{1}$ :

$$D^{2}(s^{g}) = 1 - m^{s^{g}} / m;$$

 $D^{3}(s^{g}) = 1 - M^{s^{g}} / M.$ 

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If  $F^{s^9}(x_i)$  is the cumulative proportion of the reference-group population with incomes not exceeding  $x_i$ , and  $F(x_i)$  is the cumulative proportion of the entire population with incomes not exceeding  $x_i$ , then it is easy to verify that  $D^4$  is given by:

$$D^{1}(s^{g}) = \frac{1}{\mu} \sum_{i \in T} EF^{s^{g}}(x_{i}) - F(x_{i}) \Im (x_{i+1} - x_{i}), \qquad \dots (2.5)$$

where we adopt the convention that  $x_{n+1} = 0^{2^{>}}$ . In obvious notation, and employing the continuous analogue of the discrete distribution we have thus far used, we obtain the following from (2.5):

$$D^{1}(s^{g}) = \frac{1}{\mu} \int_{x}^{\overline{x}} (F^{s^{g}}(x) - F(x)) dx,$$
 ... (2.6)

where  $[\underline{x}, \overline{x}]$  is the support of F(x). The index  $D^1$  can be visualized as being proportional to the area enclosed between two cumulative density functions, as represented by the dotted area in Figures 1(a) and 1(b). (We have, for specificity, assumed the cumulative density functions to have the particular shapes that have been depicted in the figures).

From Figure 1, we obtain a lead for yet another discrimination index, namely, the <u>maximum</u> distance between the two cumulative density functions. More precisely, define a distinguished member of T, i<sup>\*</sup>, as:

$$i^* = \operatorname{argmax} | (F^{5^9}(x_i) - F(x_i)|.$$
  
i=T

Next, define the discrimination index  $D^4$  simply as:  $D^4(s^9) = F^{s^9}(x_i^*) - F(x_i^*)$ . ... (2.11) For the continuous distribution, we would have:  $D^4(s^9) = F^{s^9}(x^*) - F(x^*)$ , ... (2.12) where  $x^* = \underset{x \in \Sigma_x, x \exists}{|F^{s^9}(x^*) - F(x^*)|}$ .

It is immediate that  $D^4$  lies between -1 and +1 (all negative values signifying discrimination in favour of, and all positive values signifying discrimination against, the reference group). Notice from Figures 1(a) and 1(b) that the maximum distance between the two cumulative density functions,  $D^4$ , is the distance between the two points on the functions at which the slopes are equalized. At any point on the cumulative density function F(.), the slope (assuming differentiability) is simply the value of the density function f(.). Therefore, the value of  $D^4$  can be

represented by the dotted areas in Figures 2(a) and 2(b), which plot the density functions corresponding to the cumulative density functions of Figure 1(a) and 1(b) respectively<sup>3></sup>.

Now observe from Figures 2(a) and 2(b) that the income level  $x^{*}$  at which the two density functions intersect is itself A significant indicator of the extent of discrimination. Specifically, in a case in which the reference group is discriminated against (Figure 2(a)), other things equal the smaller is the value of  $x^{\#}$  the worse is the extent of discrimination since this would mean a greater degree of specialization by the reference group in 'low' income levels, and, conversely, in a case in which the reference group is discriminated in favour of (Fig 2 (b)), other things equal the larger is the value of  $x^*$  the worse is the extent of discrimination since this would mean a greater degree of specialization by the reference group in "high" income levels. This observation suggests that it might be useful to have a group-specific index of discrimination – call it  $D^{D}(s^{g})$ such that when  $s^{9}$  is discriminated against, viz.  $D^{4}$  is positive (respectively, s<sup>9</sup> is discriminated in favour of, viz.  $\mathbf{D}^4$ is negative),  $D^{5}(s^{9})$  is increasing in  $\mathbf{p}^4$ ×\* and declining in in  $D^4$ ). (respectively, is declining in  $\times^*$  and increasing The following specialization does the required job:

$$D^{5}(s^{g}) = \frac{x_{i}^{*}}{\mu} (1 - D^{4}(s^{g})) \text{ when } D^{4}(s^{g}) > 0;$$
  
$$= \frac{x_{i}^{*}}{\mu} D^{4}(s^{g}) \text{ when } D^{4}(s^{g}) < 0.$$

It is to be noted that in the case of the index  $D^5$ , in contrast to the other indices considered, discrimination becomes 'worse' as the value of the index becomes smaller.

For the case of the continuous distribution, we have:

$$D^{5}(s^{g}) = \frac{x^{*}}{\mu} \quad (1 - D^{4}(s^{g})) \text{ when } D^{4}(s^{g}) > 0; \\ = \frac{x^{*}}{\mu} \quad D^{4}(s^{g}) \quad \text{when } D^{4}(s^{g}) < 0. \end{cases}$$

### 2.3 <u>The Discrimination Indices and their 'Inequality'</u> <u>Counterparts</u>

In this section, which is in the nature of a slight digression, we shall consider the instructive exercise of evaluating the discrimination indices reviewed earlier for the grouping  $g^{O}$  under which — to recall — every individual is considered to constitute a group by her/himself. In what follows, and entirely for operational reasons of ease of manipulation, we shall work with a continuous distribution.

First, notice that under the grouping  $g^0$  we have: For all  $x = [\underline{x}, \overline{x}]$ :  $D^1(x) = 1 - x/\mu$ . Hence, the society-wide discrimination index under the grouping  $g^0$ is given by:  $D_1^g = |\int_{\underline{x}}^{\overline{x}} (1 - \frac{x}{\mu}) h(x) dx|$ ,

where h(x), the income-share of the unit with income x, is simply  $xf(x)/\mu$ , so that

$$D_1^{g0} = |\int_x^{\overline{x}} \frac{x}{\mu} (1 - \frac{x}{\mu}) f(x) dx|,$$

which can be shown to lead to

$$D_1^{g0} = \int_{\underline{x}}^{\overline{x}} \frac{x^2}{\mu^2} f(x) dx -1.$$

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The right hand side of (2.15) is nothing but the wellknown measure of dispersion, the square of the coefficient of variation  $C^2$ . We thus have, from (2.15), the following result:

$$D_1^{g0} = c^2$$
. ... (2.16)

In similar fashion, it is easily checked that

$$D_2^{gO} = \left| \int_{\underline{x}}^{\overline{x}} \frac{x}{\mu} \left(1 - \frac{x}{m}\right) f(x) dx \right|$$

$$= \frac{\mu}{m} \int_{\underline{x}}^{x} \frac{x^{2}}{\mu^{2}} f(x) dx - 1$$
$$= (1 + C^{2}) \frac{\mu}{m} - 1.$$

 $\overset{O}{What} D^g_{\mathcal{D}}$  does, in some sense, is to 'correct' for the skewness of the frequency distribution. Consider the measure of skewness  $s=1 - m/\mu$ . If  $\mu > m$ , we have a positively skewed density a negatively skewed function; and if  $\mu$  < m, we have density function (see Figure 3). Notice that the index  $D_{P}^{g}$ penalizes (respectively, rewards) a positively (respectively, negatively) skewed density function, vis-a'vis the square of the coefficient of variation C<sup>2</sup>. Exactly the same end is secured by the index  $D_2^{g^O}$ which, it is routine to verify, is given by

$$D_3^{g^0} = (1 + c^2) \mu/M - 1$$

Next, note that under the grouping  $g^0$  we have: For all  $x \in [x, \overline{x}]$ : ... (2.17)

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Vari Nore Now the Gini coefficient of inequality is given by the following well-known expression:

$$G = 1 - 2 \int_{\underline{x}}^{\overline{x}} F_{1}(x) f(x) dx, \text{ whence}$$

$$\int_{\underline{x}}^{\overline{x}} F_{1}(x) f(x) dx = \frac{1 - G}{2} . \qquad \dots (2.23)$$

Substituting for  $\int_{x}^{x} F_{1}(x) f(x) dx$  from (2.23) into (2.22), we obtain:

$$p_4^{g^0} = |F_1(m) - \{ 1 - \frac{1 - G}{2} \} | = \frac{1 + G}{2} - F_1(m).$$
 (2.24)

From (2.24) we note that  $D_4^{g^{\vee}}$  is a minor but interesting variant of the Gini coefficient of inequality G: it is sensitive to the income-share of the poorest one-half of the population; other things equal, an increase in this share causes the extent of measured discrimination to decline.

Finally, under the grouping  $g^0$  it is true that: For all x  $\leftarrow [x, \overline{x}]$ :

$$\mathbb{D}^{5}(x) = \frac{x}{\mu}, F(x) \text{ for all } x \leq m;$$

$$= \frac{-x}{\mu}, F(x) \text{ for } x > m$$

$$(2.25)$$

From (2.25), we have:

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$$D_5^0 = \left[ \int_{-\infty}^{m} \frac{x}{\mu} - \left( \frac{x}{\mu} + F(x) \right) f(x) dx - \int_{-\infty}^{\infty} \frac{x}{\mu} - \left( \frac{x}{\mu} + F(x) \right) f(x) dx \right] \dots (2.26)$$

Before proceeding further we take note of the fact that a Variant of the square of the coefficient of variation which is Nore sensitive to income-transfers at the lower than at the upper

$$D^{4}(x) = 1 - F(x) \text{ for all } x \leq m;$$
  
= -F(x) for all x > m. (2.19)

The rationale for (2.19) will become immediately clear by considering (2.12) in conjunction with Figure 4: there should be no need for further explanation in this connection.

From (2.19), we have:

$$D_{4}^{9} = \left| \int_{\underline{x}}^{m} \frac{x}{\mu} (1 - F(x))f(x) dx - \int_{m}^{\overline{x}} \frac{x}{\mu} F(x)f(x) dx \right|. \qquad (2.20)$$

Now, 
$$\int_{\underline{x}}^{\underline{m}} \frac{x}{\mu} (1 - F(x)) f(x) dx - \int_{\underline{m}}^{\overline{x}} \frac{x}{\mu} F(x) f(x) dx$$
$$= \int_{\underline{x}}^{\underline{m}} \frac{x}{\mu} (1 - F(x)) f(x) dx - \left[ \int_{\underline{x}}^{\overline{x}} \frac{x}{\mu} F(x) f(x) dx - \int_{\underline{x}}^{\underline{m}} \frac{x}{\mu} F(x) f(x) dx \right]$$
$$= 2 \int_{\underline{x}}^{\underline{m}} \frac{x}{\mu} f(x) dx - \int_{\underline{x}}^{\overline{x}} \frac{x}{\mu} F(x) f(x) dx. \qquad (2.21)$$

Letting  $F_1(x) = \frac{1}{\mu} \int_{\underline{x}}^{\overline{x}} yf(y) dy$  stand for the first-moment

distribution function of x, we obtain from (2.21) the following:

$$D_{4}^{g} = \left[ F_{1}(m) - \int_{\underline{x}}^{x} F_{1}(x) F(x) dx \right]$$
  
=  $\left[ F_{1}(m) - \left\{ 1 - \int_{\underline{x}}^{\overline{x}} F_{1}(x) f(x) dx \right\} \right]$ 

... (2.22)

end of the distribution is yielded by the following inequalit; index  $4^{>}$ :

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$$H = \int_{-\infty}^{\overline{x}} \frac{x^2}{\mu^2} F(x)f(x)dx - \frac{1}{2}.$$
 (2.27)

Letting H<sub>1</sub> stand for the value of the H coefficient of inequality in the distribution of income among units with incomes not exceeding the median income m, it is fairly straightforward, in the light of (2.26), to obtain through routine manipulation the following result:

 $D_{\rm g}^{\rm g} = \hat{\rm H}$ , where

# $\hat{H} = \left( H + \frac{1}{2} \right) - 2 \left( H_1 + \frac{1}{2} \right) F_1^2(m).$

The index  $D_5^{g^0}$  has some 'mixed' properties. An increase in  $H_1$  (which measures inequality among the poorest half of the population) reduces the value of  $D_5^{g^0}$ : this, from an 'egalitarian' perspective, is scarcely a 'nice' property. But an increase in the income-share of the poorest one-half of the population ( $F_1$ (m)) reduces the value of  $D_5^{g^0}$  - which, from an 'egalitarian' point of view, is a nice property.

The indices  $D_k^{g^0}$  (k=1,2,3,4,5) are what we would ordinarily call <u>inequality indices</u>. Axiomatic rationalization of an inequality index is not always an easy task. Dur intuition is, in general, more straightforwardly reliable when we are dealing with inequality between two, rather than inequality among many, entities. The group-specific discrimination indices reviewed in section 2.2 are essentially predicated on such a binary - entity

logic - one which does not require any elaborate justification. Haying once obtained a group ~ specific discrimination index, it is a simple matter to derive a society-wide discrimination index (for the grouping under consideration) as a weighted sum of the group-specific indices; in the limiting case, when the grouping becomes the atomistic one, this exercise yields up an inequality index. A useful byproduct of our analysis on discrimination has, therefore, been the development of a procedure for deriving in an intuitively reasonable manner - various indices of inequality.

now We turn to analysis the evidence an of on in the caste-discrimination distribution of consumption expenditure in India.

### 3. CASTE AND CONSUMPTION EXPENDITURE

The National Sample Survey Organisation (NSSO) has provided data, for the year 1983, on the distribution of consumption different size-classes of expenditure across expenditure, separately for the Scheduled Castes, the Scheduled Tribes, and the In this section we report entire population. on a number of empirical exercises we have performed for rural India using these data. Details of data and methodology have been relegated to an appendix at the end of this paper.

For our purposes we have clubbed the Scheduled Caste and the Scheduled Tribe group together to constitute a composite Scheduled Castes and Tribes group, which we shall allude to, in abbreviated form, as the SCST group. The rest of the population is taken to constitute a group which we shall simply call 'Others'. From the grouped data on the distribution of consumption expenditure we have plotted the frequency distribution curves of consumption expenditure for the SCST group, for the 'Others', and for the

population as a whole (Figure 5). To emphasize contrast we have plotted the frequency distribution curves in two pairs - the first pair comprising the density functions for the SCST group and the entire population, and the second pair comprising the density functions for the 'others' group and the entire population. The visual appeal of the graphs - plotted at the all - India level and also for every State in the Indian Union - is immediate. In virtually every case the frequency distribution curve for the SCST group has a short right tail while that for the 'Others' has a relatively long right tail; the frequency distribution curve for the SCST group clearly demonstrates 'specialization' in relatively low expenditure levels compared to the population as a whole, while the frequency distribution curve for the 'Others' group displays specialization in relatively high expenditure levels compared to the population at large; and the density function for the SCST group intersects that for the entire population from above while the density function for the 'Others' group intersects that for the entire population from below. The cumulative visual message of these graphs is striking, and leaves the observer in no doubt regarding the systematically inferior status experienced by the Scheduled Castes and Tribes.

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Tables 1-3 provide statewise data on the three measures of central tendency in the distribution of consumption expenditure the mean, the median and the mode. These data have been provided for the population as a whole, for the SCST group, and for the 'Others'. At the all-India level the mean consumption expenditure for 'Others' exceeds that for the SCST group by a proportion o f nearly 32 per cent; and the corresponding figures for the median and the mode are, respectively, 28 per cent and 25 per cent. In a society which - judged according to the values of the measures of central tendency in the distribution of consumption expenditure is performing relatively 'poorly', these substantial disparities

between the Scheduled Castes and Tribes on the one hand and the rest of the population on the other emphasize not only the relative but also the absolute disadvantage experienced by the former group. Indeed, it is instructive to consider the mean consumption expenditure of the Scheduled Castes and Tribes in relation to the poverty line which, in 1983-84, can be taken to be of the order of Rs.79.05 <sup>5></sup> . At the all-India level the proportionate gap between the mean consumption and the poverty line is just about 15 per cent (while the corresponding figure for the 'Others' is 51 per cent): On average, the SCST group is living in circumstances not far removed from the standard of absolute impoverishment widely used in the Indian poverty literature. Of particular concern should be the fact that in two states - Bihar and Orissa - the mean consumption level is actually less than the poverty line. A particularly stark and unpleasant formulation of an implication of this fact would be the following. It is easy to demonstrate that if one wishes to minimize the proportion of the population in poverty in a situation in which the average level of consumption falls short of the poverty line, then the means to this end is to distribute consumption in such a way that a finite proportion of the population (equal to the proportionate gap between the poverty line and the mean consumption) consumes nothing at  $all^{6>}$ . This is reminiscent of the defined in Webster's New procedure of <u>triage</u>, Collegiate Dictionary as 'the sorting out and allocation of treatment to patients and especially battle and disaster victims according to a system of priorities designed to maximize the number of survivors'.

Tables 4-8 present information on the values of the five discrimination indices we have reviewed earlier, for each of the States of the Indian Union. The numbers in these tables are largely self-explanatory, so we shall confine ourselves only to a

very quick appraisal of some salient features of these numbers. The most significant feature is that when the SCST group is the DSC reference group each of the five discrimination indices (i=1,...,5) is positive in every State; and when the 'others' group is the reference group each of the five discrimination indices  $D_{i}^{0}$  (i=1,...,5) is negative in every State: with remarkable consistency, the Scheduled Castes and Tribes constitute the relatively disadvantaged group, while the "Others" constitute the advantaged group.

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Next, to obtain a preliminary idea of the division of the states into those which display relatively more discrimination and those which display relatively less discrimination, we proceed as follows. For each discrimination index, and given that the grouping g is the one (Scheduled Castes and Tribes, 'Others'), we first list those States for which discrimination is more acute than at the All-India level: for the first four indices, these states are the ones for which  $D_{i}^{g}$  (i=1,...,4) is greater than the value of D<sup>g</sup>, at the all- India level; for the fifth index, these States are the ones for which  $D_5^9$  is <u>less</u> than the value of D<sup>g</sup> at the all-India level (recall that for the fifth index discrimination becomes 'worse' as the vale of the index becomes list those States smaller). Similarly, we for which discrimination is less acute than at the all-India level. This exercise yields the following two lists.

List A: States in which discrimination is more acute than the all-India level according to the index

ม <sup>ฎ</sup> 1	ມ <sup>ູ</sup> ອ	D <sup>9</sup> 3	D4 2	D <sup>4</sup> 5
Gujarat	Haryana	Haryana	Gujarat	Gujarat
Haryana	Madhya Pradesh	Madhya Pradesh	Haryana	Haryana
Karnataka	Orissa	Maharashtra	Karnataka	Karnataka
Kerala	Punjab	Orissa	Madhya Pradesh	Kerala
Orissa	Rajasthan	Punjab	Orissa	Maharashtra
Rajasthan		West Bengal	Punjab	Tamilnadu
Tamilnadu			Rajasthan	Uttar Pradesh

List B: States in which discrimination is less acute than at the all-India level according to the index

0 1	ea Sa	D <sup>g</sup> <sub>3</sub>	D <sup>9</sup> 4	D <sup>g</sup> 5
Andhra Pradesh	Andhra Pradesh	Andhra Pradesh	Andhra Pradesh	Andhra Pradesh
Assam	Assam	Assam	Assam	Assam
Bihar	Bihar	Bihar	Bihar	Bihar
Madhya Pradesh	Gujarat	Gujarat	Kerala	Madhya Pradesh
Maharashtra	Karnataka	Karnataka	Maharashtra	Orissa
Punjab	Kerala	ke <b>r</b> ala - '	Tamilnadu	West Bengal
Uttar Pradesh	Maharashtra	Rajasthan	Uttar Pradest	٦
West Bengal	Tamilnadu	Tamilnadu	West Bengal	
	Uttar Pradesh	Uttar Pradesh		
	West Bengal			

Now let us award a positive point to every occasion on which a given state figures in List A and a negative point to everv occasion on which a given State figures in List B; the net score of any State will be taken to be the algebraic sum of the points If the net score is positive, we shall certify awarded it. the state as being 'high' on discrimination; if the net score is negative, we shall certify the state as being 'low' on discrimination. Given the two preceding lists, it is easv to States (along with their net verify that the scores in parentheses) can be classified as follows. The \*hiah discrimination' States are + Haryana (5), orissa (3), Punjab (3), Rejesthan (3), Gujarat (1), Karnataka (1) and Madhya Pradesh (1). The 'low discrimination' States are Andhra Pradesh (-5), Assam (-2), Kerala (-1), Maharashtra (-1), and Tamilnadu (-1). At least at the 'polar extremes' it may be possible to assert with some confidence that Haryana, Orissa, Punjab and Rajasthan display relatively acute discrimination, while Andhra Pradesh, Assam and Bihar display relatively mild discrimination. We here merelv observe the externality of this finding. This is only a 'first cut" at the problem, and we do not undertake an examination of causal factors for regional variations in a the extent of caste-discrimination in the distribution of consumption This problem constitutes material for expenditure. detailed further investigation.

### 4. CONCLUDING OBSERVATIONS

In this paper we have proposed a number of real-valued indices of discrimination, and we have traced the link between measures of discrimination and measures of inequality. We have also reviewed some aspects of estimation and computation of these indices from grouped distributional data. In these respects the paper could be seen to be primarily a contribution to methodology. In addition; we have also sought to furnish some orders of

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magnitude of the extent of caste-based disparity in the distribution of consumption expenditures that obtains in rural India. Our findings, in this connection, perhaps constitute not so much 'findings', properly speaking, as a confirmation of one's worst suspicions - namely, that in the matter of caste discrimination in India, there is much cause for disquiet.

#### STATEWISE DATA ON MEAN CONSUMPTION EXPENDITURE Table 1:

	Mean Consumption Expenditure (In Rupees) of		
STATE	Scheduled Castes & Scheduled Tribes	Others	The Entire Population
Andhrapradesh	96.94	122.08	115.57
Assam	108.76	114.46	113.01
Bihar	77.63	99.61	93.75
Gujarat	92.47	131.54	119.26
Haryana ,	113.62	159.68	149.13
Karnataka	91.15	126.03	118.14
Kerala	105.06	152.80	145.22
Madhyapradesh	82.06	116.11	101.75
Maharashtra	91.58	116.59	110,98
Orissa	78.68	111.00	97.48
Punjab	132.04	182.32	170.31
Rajasthan	101.33	140.76	127.48
Tamilnadu	87.84	120.32	112.21
Uttarpradesh	88.58	108.63	104.26
West Bengal	92.70	11077	104.61
India	91.64	120.71	112.31

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anta anta aku aku aku datu datu datu anta gatu titu kak new anta titu tan ang ang ang ang ang	Median Consumption Expenditure (In Rupees) of			
STATE	Scheduled Castes & Scheduled Tribes Others		The Entire Population	
Andhrapradesh	84.99	102.69	97.96	
Assam	101.75	104.96	104.24	
Bihar	69.77	87.16	82.53	
Gujarat	83.63	112.74	104.09	
Haryana	103.39	139.01	128.85	
Karnataka	80.09	104.37	98.67	
Kerala	91.64	118.57	114.16	
Madhyapradesh	71.59	101.89	85.62	
Maharashtra	79.04	100.30	94.79	
Orissa	70.99	97.55	86.05	
Punjab	111.28	160.90	144.55	
Rajasthan	81.51	110.38	100.95	
Tamilnadu	76.32	96.55	91.51	
Uttarpradesh	77.06	91.38	87.98	
West Bengal	80.73	98.66	91.65	
India	79.45	101.45	94.55	

### Table 2: STATEWISE DATA ON MEDIAN CONSUMPTION EXPENDITURE

STATEWISE DATA ON MODAL CONSUMPTION EXPENDITURE Table 3:

Modal Consumption Expen (In Rupees) of			penditure f	
	Scheduled		<b></b>	
SIAIE	Castes &		lhe	
	Scheduled		Entire	
	Tribes	Others	Population	
Andhrapradesh	82.06	96.39	92.41	
Assam	101.35	103.25	102,93	
Bihar	68.82	83.50	79.56	
Gujarat	82.87	106.32	99.77	
Haryana	102.18	133.14	122.67	
Karnataka	77.94	96.90	92.08	
Kerala	87.83	106.05	103.28	
Madhyapradesh	65.53	98.92	80.10	
Maharashtra	75.00	95.33	89.52	
Orissa	70.11	94.04	83.54	
Punjab	104.31	155.76	136.04	
Rajasthan	74.02	98.75	91.17	
Tamilnadu	73.55	88.39	84.49	
Uttarpradesh	73.78	85.45	82.52	
West Bengal	77.45	97.72	88.94	
India	75.98	95.11	88.75	

Table	4:	STATEWISE DATA ON THE GROUP-SPECIFIC DISCRIMINATION
		INDICES D <sup>1SC</sup> (FOR SCHDEULED CASTES AND TRIBES), D <sup>10</sup>
		('OTHERS') AND THE SOCIETY-WIDE DISCRIMINATION INDEX
		$D^{19}$ FOR THE GROUPING g = (SCHEDULED CASTES AND TRIBES,
		OTHERS).

STATE	D <sup>1<sup>SC</sup></sup>	<sup>10</sup> م	 10 <sup>3</sup> ×10 <sup>3</sup>
Andhrapradesh	0.16126	-0.05625	10.57
Assam	0.03757	-0.01283	1.35
Bihar	0.17204	-0.06244	11.60
Gujarat	0.22459	-0.10304	25.36
Haryana	0,23809	-0.07077	14.29
Karnataka	0.22844	-0.06679	18.18
Kerala	0.27654	-0.05224	18.07
Madhyapradesh	0.19356	-0.14108	13.64
Maharashtra	0.17480	-0.05049	7.69
Orissa	0.19280	-0.13873	28.77
Punjab	0.22469	-0.07052	4.15
Rajasthan	0.20513	-0.10436	25.19
Tamilnadu	0.21722	-0.07225	20.42
Uttarpradesh	0.15039	-0.04191	6.12
West Bengal	0.11385	-0.05893	4.88
India	0.18409	-0.07480	14.08

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Table 5: STATEWISE DATA ON THE GROUP-SPECIFIC DISCRIMINATION INDICES  $D^{2}$  (FOR SCHDEULED CASTES AND TRIBES),  $D^{2}$ ('OTHERS') AND THE SOCIETY-WIDE DISCRIMINATION INDEX  $D^{2}$  FOR THE GROUPING g = (SCHEDULED CASTES AND TRIBES, OTHERS).

STATE	D <sup>2<sup>SC</sup></sup>	D <sup>2<sup>0</sup></sup>	D <sup>2<sup>9</sup></sup> ×10 <sup>3</sup>
Andhrapradesh	0.13239	-0.04833	10.38
Assam	0.02395	-0.00683	0.18
Bihar	0.15462	-0.05615	10.45
Gujarat	0.19660	-0.08309	16.76
Haryana	0.19761	-0.07885	28.25
Karnataka	0.18828	-0.05774	17.24
Kerala	0.19725	-0.03858	14.07
Madhyapradesh	0.16385	-0.18995	54.62
Maharashtra	0.16615	-0.05817	15.54
Orissa	0.17500	-0.13361	31.26
Punjab	0.23019	-0.11308	35.48
Rajasthan	0.19261	-0.09334	20.18
Tamilnadu	0.16593	-0.05511	15.53
Uttarpradesh	0.12418	-0.03862	8.32
West Bengal	0.11917	-0.07646	15.24
India	0.15967	-0.07293	18.38

STATEWISE DATA ON THE GROUP-SPECIFIC DISCRIMINATION Table 6: INDICES D<sup>3<sup>SC</sup></sup> р<sup>30</sup> (FOR SCHDEULED CASTES AND TRIBES), ('OTHERS') AND THE SOCIETY-WIDE DISCRIMINATION INDEX <sup>29</sup> م FOR THE GROUPING g = (SCHEDULED CASTES AND TRIBES, OTHERS).

STATE	D <sup>3<sup>SC</sup></sup>	σ <sup>30</sup>	D <sup>3<sup>9</sup></sup> ×10 <sup>3</sup>
Andhrapradesh	0.11200	-0.04307	10.51
Assam	0.01535	-0.00311	1.10
Binar	0.13499	-0.04952	9.51
Gujarat	0.16939	-0.06565	9.90
Haryana	0.16703	-0.08534	39.10
Karnataka	0.15356	-0.05235	18.47
Kerala	0.14959	-0.02682	8.48
Madhyapradesh	0.18190	-0.23496	75.35
Maharashtra	0.16220	-0.06490	21.73
Orissa	0.16076	-0.12569	30.69
Punjab	0.23323	-0.14497	59.19
Rajasthan	0.18811	-0.08314	13.72
Tamilnadu	0.12948	-0.04616	14.72
Uttarpradesh	0.10591	-0.03551	9.19
West Bengal	0.12919	-0.09872	27.38
India	0.14389	-0.07166	21.11

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Table 7: STATEWISE DATA ON THE GROUP-SPECIFIC DISCRIMINATION INDICES  $D^{4}$  (FOR SCHDEULED CASTES AND TRIBES),  $D^{4}$ ('OTHERS') AND THE SOCIETY-WIDE DISCRIMINATION INDEX  $D^{4}$  FOR THE GROUPING g = (SCHEDULED CASTES AND TRIBES,

OTHERS).

STATE	D <sup>4<sup>SC</sup></sup>	D4 <sup>0</sup>	D <sup>4<sup>9</sup>×10<sup>3</sup></sup>
Andhrapradesh	0,11592	-0.03701	4.87
Assam	0.04061	-0.01150	0.37
Bihar	0.13832	-0.04731	7.06
Gujarat	0.18613	-0.07790	15.29
Haryana	0.20783	-0.06001	11.03 -
Karnataka	0.15413	-0.04151	9.29
Kerala	0.19633	-0.03031	6.73
Madhyapradesh	0.16213	-0.13333	20.68
Maharashtra	0.15823	-0.04471	6.15
Orissa	0.16563	-0.10502	15.24
Punjab	0.23212	-0.08931	16.88
Rajasthan	0.14032	-0.06250	10.59
Tamilnadu	0.13422	-0.03861	7.64
Uttarpradesh	0.11542	-0.03061	3.43
West Bengal	0.11652	-0.05921	4.23
India	0,14272	-0.05461	8.32

Table 8: STATEWISE DATA ON THE GROUP-SPECIFIC DISCRIMINATION INDICES  $D^{5}$  (FOR SCHDEULED CASTES AND TRIBES),  $D^{5}$ ('OTHERS') AND THE SOCIETY-WIDE DISCRIMINATION INDEX  $D^{5}$  FOR THE GROUPING g = (SCHEDULED CASTES AND TRIBES, OTHERS).

STATE	 5 <sup>5C</sup> α	<sup>50</sup>	<sup>5<sup>9</sup>×10<sup>3</sup></sup>
Andhrapradesh	0.8032	-0.0351	141.3
Assam	1.0782	-0.0131	235.7
Bihar	0.7959	-0.0455	137.2
Gujarat	0.7166	-0.0702	116.8
Haryana	0.7118	-0.0578	82.6
Karnataka	0.7561	-0.0385	- 92.8
Kerala	0.6464	-0.0271	43.2
Madhyapradesh	0.7271	-0.1296	193.3
Maharashtra	0.7266	-0.0424	103.6
Orissa	0.7618	-0.1054	182.8
Punjab	0.6087	-0.0815	72.5
Rajasthan	0.6676	-0.0523	132.6
Tamilnadu	0.7716	-0.0357	109.7
Uttarpradesh	0.7874	-0.0285	123.3
West Bengal	0.8175	-0.0599	214.1
India	0.7465	-0.0511	136.1

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Figures 1(a) and (1b): Cumulative Density Functions for the Reference Group and for the Entire Population, under assumed conditions of (a) Adverse Discrimination against the Reference Group and (b) Discrimination in favour of the Reference Group.



Figure 1(b)

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Distribution Function:

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Figures 2(a) and 2(b): Density Functions for the Reference Group and for the Entire Population, under assumed conditions of (a) Adverse Discrimination against the Reference Group and (b) Discrimination in favour of the Reference Group.





Figure 4: The Cumulative Density Function of the Reference Group When the Grouping is Atomistic, under Assumed Conditions of (a) Adverse Discrimination against the Reference Group and (b) Discrimination in Favour of the Reference Group.

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### Figure 5: Graphs of Density Functions of Consumption Expenditure

Note:

a)

b)

In each of the graphs, consumption expenditure (x) is plotted on the abcissca and the density function of consumption expenditure f(x)/g(x)/h(x) is plotted on the ordinate.

c)

Each of the graphs appearing on the left hand side of the page presents the density function for the entire population f(x) and the density function for the Scheduled Castes and Tribes g(x), while each of the graphs appearing on the right hand side of the page presents the density function for the entire population and the density function for the 'Others', viz. the non-Scheduled-Castes and-Tribes, h(x).

In every relevant case, the density function for the Scheduled Castes and Tribes g(x) can be identified as the one which intersects from above the density function of the entire population f(x), while the density function for the 'Others', h(x), can be identified as the one which is intersected from above by the density function for the entire population f(x).





Figure 5 (Contd.)

Group When the Grouping is Atomistic, under Assumed Figure 4: The Cumulative Density Function of the Reference





## Figure 5 (Contd.)

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### Figure 5 (Contd.)









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Figure 5 (Contd.)

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#### APPENDIX

### A Clarification of some Computational Issues

Our source of data for the empirical exercises undertaken in paper is constituted by the National Sample this Survey Organization's Report Number 332 (38th Round; January - December 1983): Pattern of Consumer Expenditure of Scheduled Caste and Scheduled Tribe Households (September 1986). What we have are grouped data on the distribution of consumer expenditure: for each size-class of consumption expenditure we have the proportion of the population in that size-class and the average consumption expenditure for the size-class. With this information it is possible to generate a set of points in (F,F,) space where, given that x is a random variable signifying consumption expenditure, F(x) is the cumulative density function of x and  $F_{4}(x)$  the first moment distribution function of x:

 $F(x) = \int_{0}^{y} f(y) dy; F_{1}(x) = \frac{1}{\mu} \int_{0}^{y} yf(y) dy; \lim_{x \to 0} F(x) = \lim_{x \to 0} F_{1}(x) = 0;$   $\lim_{x \to \infty} F(x) = \lim_{x \to \infty} F_{1}(x) = 1; \text{ and } f(.) \text{ is the density function and}$  $\mu \text{ the mean of the distribution.}$ 

The Lorenz curve is simply the plot of  $F_1(x)$  as a function of F(x). We shall also find it convenient to represent the Lorenz curve by the equation q=q(p), where q(p) is the expenditure share of the poorest  $p^{th}$  fraction of spending units (see Kakwani, 1980). A key to many of the computational exercises undertaken in this paper resides in the estimation of the equation of the Lorenz curve. The equation of the Lorenz curve - along the lines suggested in Kakwani (1981) - can be estimated as follows.

Consider the function s(p) = p-q(p). It is clear that when p is zero, s(p) is zero and when p is unity, again s(p) is zero. Thus, s(p) is a double-valued function of p, which peaks at a value of p greater than, equal to, or less than one-half depending on whether the Lorenz curve is skewed toward (0,0), is symmetric, or is skewed toward (1,1) of the unit square. A useful estimating equation for the function s(p) is given by  $s(p) = ap^{(1-p)}$ ,  $a \in$  $[0,1] \alpha \in [0,1]$  and  $\beta \in [0,1]$ . This function can be estimated by the method of ordinary least squares in log-linear form. From the grouped observations on q and p afforded by the NSS data, the parameters a,  $\alpha$  and  $\beta$  have been estimated for the reference year of our study - separately for the SCST group, the 'others' group, and the entire population. Recalling the definition of the function s(p), it is clear that the estimated equation of the Lorenz curve is given by:

$$q(p) = p - ap^{\alpha} (1-p)^{\beta}$$
. (A1)

Now, at any point on the Lorenz curve corresponding to an expenditure level x, the slope of the curve is given by  $q'(p(x))=x/\mu$ . (This follows from noting that  $q'(p(x)) = F'_1(x)/F'(x) = (xf(x)/\mu)/f(x) = x/\mu$ ; see Kakwani (1980) in this connection). In view of (A1), we thus have:

$$(q'(p)=) 1 - ap^{\alpha}(1-p)^{\beta} \left(\frac{\alpha}{p} - \frac{\beta}{1-p}\right) = \frac{x}{\mu}$$
 ....(A2)

To obtain the median income m, it is clear from (A2) that all we have to do is to solve for x in (A2) when  $p = \frac{1}{2}$ :

$$m = \mu E_1^{-1} - (\frac{4}{2})^{\alpha} + \frac{1}{3} \cdot 2(\alpha - \beta)$$
 ...(A3)

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$$q''(p) = \frac{d}{d(Fx)} \left( \frac{dF_1(x)}{dF(x)} \right) = \frac{d}{dF(x)} (x/\mu) = \frac{d}{dx} (x/\mu)$$
$$= \left( \frac{1}{\mu} \right) / f(x) = \frac{1}{\mu f(x)} , \qquad \dots (A4)$$

whence 
$$f(x) = \frac{1}{\mu q''(p)} \cdot \dots \cdot (A5)$$

Given that  $q(p) = p - ap^{\alpha}(1-p)^{\beta}$ , it is easy to verify that  $q''(p) = ap^{\alpha}(1-p)^{\beta} \left[ \frac{\alpha(1-\alpha)}{p^2} + \frac{\beta(1-\beta)}{(1-p)^2} + \frac{2\alpha\beta}{p(1-p)} \right] \dots (A6)$ From (A5) and (A6), we obtain:

$$f(x) = \frac{1}{\mu_{ap}^{\alpha}(1-p)^{\beta} \left[ \frac{\alpha(1-\alpha)}{p^{2}} + \frac{\beta(1-\beta)}{(1-p)^{2}} + \frac{2\alpha\beta}{p(1-p)} \right]} \dots (A7)$$

Now, for selected values of p, say p=.1, p=.2,...,p=.9, we can obtain the corresponding value of x from (A2) and also the value of f(x) from (A7): we thus obtain a set of points in (x,f(x)) space – and this constitutes the procedure for plotting the frequency distribution curves in Figure 5.

Next, to obtain the modal value M of x, we have to find that value of x at which f(x) is maximized; the first-order condition for a maximum is to set  $f^*(x)$  equal to zero. Notice, first, that

$$q''(p(x)) = \frac{d}{dF(x)} \left( \frac{d^2 F_1(x)}{dF^2(x)} \right) = \frac{d}{dF(x)} \left( \frac{1}{\mu f(x)} \right) = \frac{\frac{d}{dx} \left( \frac{1}{\mu f(x)} \right)}{\frac{dF(x)}{dx}}$$

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$$= \frac{-f'(x)}{\mu f^{3}(x)}, \text{ whence}$$
  
f'(x) =  $-\mu f^{3}(x), q'(p), \dots$  ...(A8)
  
It can be verified that
  
 $q''(p) = ap^{\alpha-3}(1-p)^{\beta-3} [\alpha(1-\alpha)(\alpha-2)(1-p)^{3} - \beta(1-\beta)(\beta-2)p^{3}]$ 
  
 $-\alpha\beta p(1-p) ((6+\beta-3\alpha)p + 3(\alpha-1))], \dots$  (A9)
  
From (A8) and (A9) it is clear that setting f'(x) equal to zero is
  
equivalent to setting
  
 $\alpha\beta p(1-p)((6+\beta-3\alpha)p + 3(\alpha-1)) - \alpha(1-\alpha)(\alpha-2)(1-p)^{3} + \beta(1-\beta)(\beta-2)p^{3}$ 
value to zero. This, in turn, can be shown to be equivalent to the
  
following requirement:
  
Sa(1-\alpha)(\alpha-2) + (\alpha\beta(\alpha-3) - 9\alpha(1-\alpha)(\alpha-2))p + (9\alpha(1-\alpha)(\alpha-2))
  
 $+\alpha\beta(3(1-\beta)-2(\alpha-3))p^{2} + (3\beta(1-\beta)(2-\beta)-3\alpha(1-\alpha)(\alpha-2) + \alpha\beta((\alpha-3) - 0))p^{3} = 0.$ 
  
(A10) is a cubic equation. let the solution to this equation be
  
p\*. By plugging p\* into the left hand side of (A2) and
  
 $-\alpha\beta(1-\alpha)(\alpha-2) + \alpha\beta(\alpha-1) + \alpha$ 

$$M = \mu \left[ 1 - ap^{*\alpha} (1-p^{*})^{\beta} \left( \frac{\alpha}{p^{*}} - \frac{\beta}{(1-p^{*})} \right) \right]. \quad ... (A11)$$

Next, to obtain the value of  $x^*$ , namely the income level at which the density functions for the SCST group and for the entire population intersect, we proceed as follows. Let us denote all parameters pertaining to the SCST group by means of a bar over the relevant symbols. Now consider some initial value of  $\overline{p}$ , call it  $\overline{p}_1$ . Given  $\overline{p}_1$ , we can find the corresponding value of x - call it  $x_1 - which$  is obtained (from A2) as:

$$\vec{x}_1 = \vec{\mu} \left[ 1 - \vec{a} \cdot \vec{p}_1^{\vec{\alpha}} \cdot (1 - \vec{p}_1)^{\vec{\beta}} \left( \frac{\vec{\alpha}}{\vec{p}_1} - \frac{\vec{\beta}}{(1 - \vec{p}_1)} \right) \right].$$

Given  $x_1$ , we can find the corresponding value of p - call it  $p_1$  - again from (A2), as the solution to the following equation:

$$1 - a p_1^{\alpha} (1 - p_1)^{\beta} \left( \frac{\alpha}{p_1} - \frac{\beta}{1 - p_1} \right) = \frac{x_1}{\mu}.$$

Using (A7) it is now possible to check out if  $\overline{f}(x_1)$  is equal to  $f(x_1)$ ; if not, we perturb the value of  $\overline{p}$  from  $\overline{p}_1$  to some other value (call it  $\overline{p}_2$ ) and repeat the process just described; and we continue this process until the required equality between  $\overline{f}$  and f is achieved. The value of x at which  $\overline{f}$  and f are equal is  $x^*$ ; and, of course, it is simple - along the lines just described - to obtain the values of  $\overline{p}(x^*)$  and  $p(x^*)$ . All the quantities have now been computed which go into the calculation of the discrimination indices  $D^4$  and  $D^5$ .

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#### Notes

1> See also, in this connection, the recent important paper - on caste and consumption expenditure in North-eastern India - by Saggar and Pan.

2) To see that this is the case, consider the following. Letting  $t_i \in \{0,1\}$  stand for the number of reference-group individuals with income  $x_i$  and t for the total reference-group population, we have:

 $\sum_{i \in T} F^{s^{ij}}(x_i)(x_{i+1}^{-x_i}) = \frac{1}{t} Et(1)(x_2^{-x_1}) + t(2)(x_3^{-x_2}) + \dots$ 

+  $t(n)(x_{n+1} - x_n)],$  ...(\*)

where, for all iGT,  $t(i) \equiv \Sigma + t_j = 1^{-j}$ .

From (\*), we have:

 $\Sigma F^{5}(x_{i})(x_{i+1} - x_{i}) = \frac{1}{t} \left[ (t(1)x_{2} + t(2)x_{3} + \dots + t(n-1)x_{n}) - (t(1)x_{1} + t(2)x_{2} + \dots + t(n)x_{n}) \right]$  (un) (un)

 $= \frac{1}{t} \left[ -\{t(1)x_1 + (t(2) - t(1))x_2 + \dots + (t(n) - t(n-1))x_n\} \right]$  $= -\frac{1}{t} \left[ t_1 x_1 + t_2 x_2 + \dots + t_n x_n \right]$ 

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Similarly,  $\Sigma F(x_i)(x_{i+1} - x_i) = i \in T$ 

 $\frac{1}{n} \left[ \frac{1(x_2 - x_1) + 2(x_3 - x_2) + \dots + (n-1)(x_n - x_{n-1}) + n(x_{n+1} - x_n)}{n - 1} \right]$ 

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$$\begin{array}{l} - \text{ on } \\ \text{by } \\ = \frac{1}{n} \left[ \{ x_2 + 2x_3 + \dots + (n-1)x_n \} - \{ x_1 + 2x_2 + \dots + nx_n \} \right] \\ \\ = \frac{1}{n} \left[ -\{ x_1 + x_2 + \dots + x_n \} \right] \\ \\ \begin{array}{l} \text{ing.} \\ \text{oup } \\ \\ \text{oup } \\ \end{array} \\ \\ \end{array} \\ \begin{array}{l} \text{From (**) and (***), we have:} \end{array}$$

$$\sum_{i=T} \left[ F^{s^{g}}(x_{i}) - F(x_{i}) \right] \left[ x_{i+1} - x_{i} \right] = \frac{1}{\mu} \left[ \mu - \mu^{s^{g}} \right] = D^{1}(s^{g}),$$

as desired.

3)  $D^4$  is closely related to an index which — in the context of the measurement of segregation — Duncan and Duncan (1955) have called the 'index of displacement'.

4) The inequality index H is a subject of enquiry in on-going work undertaken by the present authors in collaboration with Professor Prasanta Pattanaik.

5) A poverty line represented by a consumption expenditure level of Rs.15 per capita per month at 1960-61 prices for rural India has enjoyed a popular vogue in the Indian poverty literature (see, for example, Bardhan (1970) and Ahluwalia (1978)). For 1983, this poverty line at current prices is obtained by updating the 1960-61 poverty line through the use of a price deflator: for this purpose we have employed the consumer price Index of Agricultural Labourers.

6) Here is a quick proof of this proposition. Let z be the poverty line,  $\mu$  the average income of a society,  $\mu^{P}$  the average income of the poor (defined as those individuals with incomes less

(1)×<sub>1</sub>

than the poverty line), n the size of the total population and q. the size of the poor population. following The is a straightforward accounting identity:  $q \mu^{p} + (n-q)(z+\delta) = n\mu,$ ...(+) Ref where  $\delta \ge 0$ , and  $z+\delta$  is the mean income of the nonpoor population. Manipulation of (+) yields: Ah1  $\frac{n\mu - \mu^{p}}{n - a} - z = \delta \ge 0,$ Per 323 from which, with further manipulation, one can obtain  $HI \geq 1 - \mu/z,$ ...(++) Bar where H = q/n is the proportion of the population in poverty or Rur the <u>headcount ratio</u> and I =  $1 - \mu^{P}/z$  is the proportionate deviation of the average income of the poor from the poverty line Dun or the income-gap ratio. Seg From (++), we have:  $H \ge (1 - \mu/z)/I.$ ...(+++) Dun (+++) tells us that if we wish to minimize H, than we should set I Occ at its maximum value of one. This implies that the minimized LX, value of H will be the proportionate gap between the poverty line and the average income of the society  $(1-\mu/z)$ , and that (since Kak I=1), each of the poor persons will receive precisely zero income. Est Kak Com Sac

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$$D^{1}(s^{g}) = \frac{1}{\mu} \int_{x}^{\overline{x}} (F^{s^{g}}(x) - F(x)) dx, \qquad \dots (2.6)$$

where  $[\underline{x}, \overline{x}]$  is the support of F(x). The index  $D^1$  can be visualized as being proportional to the area enclosed between two cumulative density functions, as represented by the dotted area in Figures 1(a) and 1(b). (We have, for specificity, assumed the cumulative density functions to have the particular shapes that have been depicted in the figures).

From Figure 1, we obtain a lead for yet another discrimination index, namely, the <u>maximum</u> distance between the two cumulative density functions. More precisely, define a distinguished member of T, i<sup>\*</sup>, as:

$$i^* = argmax | (F^{5}(x_i) - F(x_i)|.$$
  
 $i \in T$ 

Next, define the discrimination index  $D^4$  simply as:  $D^4(s^g) = F^{s^g}(x_i^*) - F(x_i^*)$ . ... (2.11) For the continuous distribution, we would have:  $D^4(s^g) = F^{s^g}(x^*) - F(x^*)$ , ... (2.12) where  $x^* = \underset{x \in \underline{X}, \times \exists}{\operatorname{argmax}} [F^{s^g}(x^*) - F(x^*)]$ .

It is immediate that  $D^4$  lies between -1 and +1 (all negative values signifying discrimination in favour of, and all positive values signifying discrimination against, the reference group). Notice from Figures 1(a) and 1(b) that the maximum distance between the two cumulative density functions,  $D^4$ , is the distance between the two points on the functions at which the slopes are equalized. At any point on the cumulative density function F(.), the slope (assuming differentiability) is simply the value of the density function f(.). Therefore, the value of  $D^4$  can be