Measuring inequality of poverty: theory and an application to India

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Abstract: The commonly used poverty indices measure the overall level of poverty in a society but fail to capture the differential intensity across different socioeconomic groups. This paper proposes a new measure, Inequality of Poverty Index (similar to dissimilarity index in the literature on inequality of opportunity) which captures inequality in distribution of poverty across different subgroups. It can be used to determine the major socioeconomic factors/characteristics/circumstances causing between-group disparity in poverty and effect of a specific factor on poverty relative to other factors and time. The paper also provides an application of the index and potential policy implications.

Key Words: Poverty, Inequality, Inequality of Poverty Index

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1. Introduction

Poverty and Inequality measures have remained the two most important tools for measuring welfare of a society. Economists, Sociologists, demographers and other researchers in the field of development studies have always used these two measures to capture the social improvements in a society. However, these two measures invariably have been used separately or independently of each other. Why cannot these two measures be combined to provide new insights in the poverty or inequality trends in a society? To elaborate the point consider the fact that, in many developing countries (for example, developing countries of Southeast Asia, Latin America or Africa) the societies are heavily divided along religious, ethnicity/ caste or regional lines with some countries (for example, India) having a complex combination of them. The commonly used poverty measures (for example headcount ratio, poverty gap ratio, income gap ratio etc.) if used in such a society, will tell about the overall level of poverty but will fail to capture the differential intensity of poverty across different socioeconomic subgroups, the groups which have been formed on the basis of religion, ethnicity, caste, gender or region. Moreover, if prevalence of poverty in some subgroups has historically remained higher than others, with the difference persisting over time, a simple poverty measure wouldn't do justice as it will fail to indicate the between-group disparity in poverty.

The common technique by which researchers have tried to address the issue of between-group disparity in poverty is to use a poverty measure that is additively decomposable, in the sense that the total poverty is a weighted average of the subgroup poverty levels (Anand, 1977; Ginneken, 1980; Foster, Greer & Thorbecke, 1984). The subgroups can be formed on the basis of ethnicity, religion, region or gender. Among all these measures, FGT (Foster Greer Thorbecke) generalized class index is the single most influential measure which has gained wide acceptance among researchers. However, it is very complicated and falls short on intuitive appeal. It becomes especially complicated when different socioeconomic factors/characteristics are combined together to form subgroups resulting in large number of subgroups (for example if gender, region, ethnicity, religion etc are combined together to form the subgroups). Also, it doesn't capture the disparity in poverty distribution across different subgroups in a strict sense of inequality and cannot be used to compare different societies on the principle of differential intensity of poverty across different subgroups.

Another approach which researchers have adopted to capture the between-group disparity in poverty is to use some kind of disparity ratio, for example the ratio of the head count ratio (HCR) of the subgroup with highest prevalence of poverty to the head count ratio of the subgroup with the lowest prevalence of poverty (Sundaram & Tendulkar, 2003a). Though, the binary disparity ratios

like above throw some light on the disparity between the subgroup with the highest prevalence of poverty and the subgroup with the lowest prevalence of poverty, they fail on many counts. They neither take into account the poverty in other subgroups nor the population shares of the socioeconomic subgroups affected by the stated levels of poverty. Perhaps, the most convincing method to measure intergroup disparity in poverty has been construction of a summary indicator of inter-group disparity analogous to the Gini coefficient, using a poverty indicator like HCR (Majumdar & Subramanian, 2001; Sundaram & Tendulkar, 2003a). In simple terms, estimate the HCRs for different subgroups first and then construct a Gini coefficient type indicator using the subgroup specific HCRs. The problem however arises about the interpretation and the policy content of such an indicator. Although, it is an interesting academic exercise and the summary indicator can be used to compare different societies, how will one interpret it and what policy implications can be derived from it?

If the objective is to estimate the inter-group disparity in poverty, then a simple index is needed which is intuitive in appeal, meaningfully interpretable, easy enough to be explained to policy makers and implementers alike, derived using a sound methodology and possesses certain properties which are desirable for such an indicator. This paper proposes such an index, referring it as Inequality of Poverty Index (or *D-index* of poverty) which measures the extent of inequality associated with the distribution of poverty across different subgroups.[1] The proposed index is a version of Dissimilarity index (*D*), widely used in sociology and applied to dichotomous outcomes. In present context, the *D-index* measures the dissimilarity in probability of falling below poverty line (i.e. falling in poverty) for groups defined by socioeconomic factors or characteristics (for example, religion, ethnicity/caste, gender or location) compared with the average probability of falling below poverty line for the population as a whole.

If the prevalence of poverty is equally distributed then an exact correspondence between population and poverty distribution should be observed. That is, if the poverty is say 30 percent (HCR) for the whole population then for each subgroup of the population it should be 30 percent. The *D*-index ranges from 0 to 1 (0 to 100 in percentage terms), and in a situation of perfect equality of poverty distribution, *D* will be zero.

[1] The idea for this index has been motivated from the inequality of opportunity index (Barros et al. 2008). The inequality of opportunity index (Barros et al. 2008) is an altogether different context and has been developed to measure the inequality of opportunity in access to basic services (for example access to education).

Probability (falling below poverty line) gaps are at the heart of the *D*-index (figure 1 illustrates this with an example) [INSERT FIGURE 1].

The horizontal line represents the average probability in the entire population that an individual will fall below poverty line. The bars represent the probability of falling below poverty line of specific groups. The *D*-index is a weighted average of the absolute differences of group-specific rates (p_j) from the overall average rate, $(\bar{p})$. The *D*-index in figure 1 will be higher than zero, and will capture the fact that female individuals living in rural areas have a much higher probability of falling below poverty line than their male counterparts in urban areas. There can be as many probability gaps as there are possible combinations of group-defining characteristics. For example, 5 religion groups, 4 ethnicity, 2 gender groups and whether one is in a rural or urban setting already generate 80 probability gaps. The exact procedure to calculate the p'_{js} involves an econometric specification which has been explained in the next section on theoretical framework.

The *D*-index of poverty has an important intuition or interpretation in the sense that, it can be interpreted as showing the number of poor individuals (as a fraction of all poor) that need to be transferred from the worse-off groups (groups with prevalence of poverty more than the average prevalence of poverty in society) to the better-off groups (groups with prevalence of poverty less than the average prevalence of poverty in society) to achieve equal poverty distribution. The *D-index* of poverty is insensitive to the size of the population (if proportion of population in each subgroup and proportion of poor in each subgroup are kept constant) and is insensitive to a balanced decrease or increase in poverty.[2] Intuitively neither the proportion of population in any subgroup, nor the proportion of population falling below poverty line (out of total falling below poverty line) in any subgroup change as a result of balanced increase/ decrease in poverty, therefore the inequality of poverty distribution will be insensitive to this type of balanced increase/decrease in poverty.

The major advantages of this index over any other acceptable measure capturing the inter-group disparity in poverty lie in its simplicity, interpretation and policy implications. Although a useful tool in itself, the index has properties that can lead to many important and significant policy implications. To start with, it can determine the major socioeconomic factor/characteristic/criteria/circumstance (for example, religion, location, ethnicity etc.) affecting inequality of a given poverty distribution across different subgroups, the relative effect on poverty of a specific factor/characteristic as

[2] By balanced increase or decrease, it is meant that increase/decrease in poverty among the groups is in the same way as the pre-existing prevalence of poverty was originally distributed. The precise definition of balanced increase (decrease) along with the proof of insensitivity towards balanced increase (decrease) has been provided in 'theoretical framework' section (property 3).

compared to others, and the relative importance of a specific factor/characteristic over time. These come from the fact that, it takes into account the contribution of each factor/characteristic in the predicted probability of falling below poverty line and different factors/characteristics can be controlled for obtaining the effect of a specific factor or characteristic. It directly informs about the extent of redistribution needed in terms of the number of poor individuals (as a fraction of all poor) that need to be shifted from the worse-off groups to the better-off groups in order to achieve equality in the distribution of poverty across different subgroups. Another important implication of the *D-Index* of poverty comes from its potential use to compare different societies, different states of a society or a society at different time points on the basis of inter-group disparity in poverty.

The objective of the paper is twofold. The first aim is to provide a theoretically sound methodology to measure inequality of poverty (i.e., inter-group disparity of poverty) following egalitarian ethics and relative deprivation concept (the relative deprivation concept in the sense that some socioeconomic groups may have larger prevalence of poverty than other groups). The second aim is to provide a suitable empirical application of the proposed measurement tool. The remaining of the paper is organized as follows: the next section discusses the theoretical framework; section 3 provides an empirical application of the proposed approach for India and section 4 finally concludes with results and added discussion.

2. Theoretical Framework

This section describes the procedure for computing the inequality of poverty index or the D-index of Poverty[3] and discusses its properties.

Following an approach similar to Barros et al. (2008), assume that there is a random sample of population with information on whether an individual 'i' falls or doesn't fall below poverty line ($I_i = 1$ if that individual falls below poverty line and $I_i = 0$ otherwise) and a vector of variables indicating his/her socioeconomic characteristics/circumstances/criteria (religion, ethnicity/caste, gender, location etc.), the total characteristic being *m*

$x_i = (x_{1i}, \dots, x_{mi})$.

[3] The section only gives the basic conceptual procedure for computing the Dissimilarity index of poverty. For complete discussion, refer Barros et al. (2008) which has a detailed description of the procedure for computing a similar kind of Dissimilarity index for estimating inequality of opportunity in access to basic services and from whose idea this paper is motivated. The framework in this section therefore follows similar notations as far as possible in order to maintain coherence and comparison.

With this information, the inequality of poverty index (*D-index* of poverty) can be estimated as follows. The dissimilarity index (*D-index*) in the present case is given by

$$D = \frac{E|P(I=1|x) - P(I=1)|}{2P(I=1)} \quad (1)$$

Since, $P(I=1) = E(P(I=1|x))$

D can be rewritten as

$$D = \frac{E|P(I=1|x) - E(P(I=1|x))|}{2E(P(I=1|x))} \quad (2)$$

which is the expression used in order to estimate D. The notations have their usual meanings, that is $P(I=1|x)$ is the group specific probability of falling below poverty line (group specific prevalence of poverty) and $E(P(I=1|x))$ is the average probability of falling below poverty line for the whole population (average prevalence of poverty in the society). This expression also indicates the central role of group specific rate of falling into poverty, in estimating *D-index* of poverty.

The above conditional probabilities can be estimated parametrically, non-parametrically or semi-parametrically. Separability restrictions or interactions can also be introduced. The following separable logistic model has been chosen in empirical application in the next section as the starting step for estimating D and is given below

$$Ln\left(\frac{P(I=1|x_1,\dots,x_m)}{1-P(I=1|x_1,\dots,x_m)}\right) = \sum_{k=1}^{m} f_k(x_k) \quad (3)$$

where x_k denotes a vector of variables representing the k-dimension of socioeconomic characteristics (for example, religion, ethnicity/caste, gender, location and so on), where, $x = (x_1, \dots, x_m)$. The complete specification has been described in empirical application section but the important point is the choice of specification, which ensures that the functions end up being linear in parameters, so that, $f_k(x_k) = x_k\beta_k$.

Estimates of the parameters,$\{\beta_k\}$ obtained from the above logistic regression are denoted by $\{\hat{\beta}_k\}$ and are used to obtain the predicted probability of falling below poverty line for each individual. That is, for each individual, *i*

$$\hat{p}_i = \frac{Exp(\hat{\beta}_o + \sum_{k=1}^{m} x_{ki}\hat{\beta}_k)}{1 + Exp(\hat{\beta}_o + \sum_{k=1}^{m} x_{ki}\hat{\beta}_k)} \quad (4)$$

is obtained. Using these predicted probabilities, the average prevalence of poverty in the sample and the *D-index* of poverty can be computed as follows:

$$\bar{p} = \sum_1^n w_i \, \hat{p}_i \qquad (5)$$

(Note that $\bar{p}$ is nothing but HCR)

and

$$\widehat{D} = \frac{1}{2\bar{p}} \sum_{i=1}^{n} w_i \, |\hat{p}_i - \bar{p}| \qquad (6)$$

where n is the total population and $w_i = \frac{1}{n}$ or some sampling weights.

Since, $\lim_{n\to\infty}(\bar{p}) = P(I = 1)$ and, under the assumptions that the regression has been correctly specified and its coefficients consistently estimated, also

$\lim_{n\to\infty}(\sum_{i=1}^{n} w_i \, |\hat{p}_i - \bar{p}|) = E|P(I = 1|x) - P(I = 1)|$

Therefore, $\lim_{n\to\infty}(\widehat{D}) = D$. In other words $\widehat{D}$ is a consistent estimator of *D*.[4]

The *D-index* obtained from the above procedure has the following properties.[5]

Consider a situation where there are *g* groups. Let p_j be the proportion of individuals in group *j* who are below poverty line and $\propto_j$ be the proportion of individuals in this group. Then the dissimilarity index will be given by,

$D = \frac{1}{2\bar{p}} \sum_{j=1}^{g} \propto_j |p_j - \bar{p}|$ where $\bar{p} = \sum_{j=1}^{g} \propto_j p_j$

Property 1: $D \geq 0$

Since, $|p_j - \bar{p}| \geq 0$, therefore $\sum_{j=1}^{g} \propto_j |p_j - \bar{p}| \geq 0$ and hence, $D \geq 0$

Also, when $p_j = \bar{p}$ for all $j = 1,\ldots,g$ then $D = 0$ which is the case of perfect equality as far as between-group disparity of poverty is concerned.

[4] In a strict sense *D-index* is not defined when $\bar{p} = 0$. However if $\bar{p}$ is zero, then the dissimilarity index doesn't make any sense. Since there is no poverty, there is no sense in defining the inter-group disparity in poverty.

[5] The proofs are direct, intuitive and similar to Barros et al. (2008). However, the detailed proofs can be provided on request.

Property 2: $D \leq (1 - \bar{p})$

Intuitively, the disparity between-groups will become highest when all the poor are in one particular subgroup (and everybody poor in this subgroup) in that case,

$p_j = 0$ for all $j = 1,\ldots,g\text{-}1$ and $p_g = 1$ then $D = 1 - \propto_g = 1 - \bar{p}$.

Therefore, $D \leq (1 - \bar{p})$ and, $D \uparrow 1$ (the case of perfect inequality)$as \ \propto_g \downarrow 0$.

Property 3: *D* is insensitive to balanced increase (decrease) in poverty

By balanced increase (decrease) in poverty, it is meant that the prevalence of poverty in each subgroup has increased (decreased) by say γ percent, that is $p_j^* = (1 + \gamma)p_j$ and therefore the prevalence of poverty in the whole population will also increase (decrease) by the same percentage, thus, $\bar{p}^* = (1 + \gamma)\bar{p}$. Where p_j^* is the new proportion of individuals in group *j* falling below poverty line and $\bar{p}^*$ is the new proportion of individuals in the whole population falling below poverty line. Clearly the proportion of population in any subgroup ($\propto_j$) has not changed.

The new *D-index* of poverty will be given by,

$$D^* = \frac{1}{2\bar{p}^*}\sum_{j=1}^{g} \propto_j \left|p_j^* - \bar{p}^*\right| = \frac{1}{2(1+\gamma)\bar{p}}\sum_{j=1}^{g} \propto_j \left|(1 + \gamma)p_j - (1 + \gamma)\bar{p}\right| = D$$

Therefore, the *D-index* of poverty is insensitive to balanced increase (decrease) in poverty.

It should be noted that the *D-index* of poverty should not be compared to the commonly used scalar measures of inequality like, Relative Mean Deviation, Coefficient of Variation, Gini Coefficient etc. and therefore should not be evaluated on the properties which these scalar inequality measures satisfy. However, the *D-index* of poverty does possess few properties which are analogous to some of the standard axioms commonly associated with scalar inequality measures. These properties are not defined in the strict sense in which they are defined for the commonly used inequality measures but in a manner similar to them.

Proposition 1: Anonymity or symmetry

Inequality of poverty index (*D-index* of poverty) remains unchanged when individuals switch places in the income order. Assumption here is that an individual cannot change his/her socioeconomic characteristic/circumstances like religion, caste/ethnicity, gender etc. Since, individuals' cannot change their subgroups, if they switch places in the income order in their own

subgroup, neither the proportion of poor in a subgroup changes nor the proportion of individuals in a subgroup, therefore the *D-index* of poverty will remain unchanged.

Proposition 2: Population Replication

Population replication holds if increasing (or decreasing) the population size across all income levels in all subgroups has no effect on the measured level of inequality. If the entire population is replicated (or cloned for example two times or k times) without any change in either the proportion of population in any subgroup or the proportion of poor in any subgroup, clearly the *D-index* of poverty will not change.

Proposition 3: Transfer sensitivity

Transfers here are defined in a different sense. It is like transferring a poor individual from one subgroup to another or more elaborately, transferring of an instance of poverty, that is transfer is made in such a way that an individual becomes non-poor in one subgroup and at his/her place another individual becomes poor in another subgroup. If an instance of poverty is transferred from a worse-off group to a better-off group, clearly the *D-index* will decrease (as the prevalence of poverty in both the subgroups will become closer to the average prevalence of poverty) which is desirable, on the other hand if an instance of poverty is transferred from a better-off group to a worse-off group the *D-index* increases (as the deviation of the prevalence of poverty of both the subgroups from the average prevalence of poverty will increase) which is again desirable in the *D-index*. Therefore the *D-index* of poverty possesses the property of transfer sensitivity in the sense defined above.

3. Empirical Application

The discussion on the inequality of poverty index (*D-index* of poverty) will not be complete if a suitable empirical application is not demonstrated. Therefore this section provides estimation of inequality of poverty for India. The estimation is not only an application of the proposed index but also provides new insights about the condition of poverty in India, however readers here should note that the main purpose of this section is to demonstrate the technical soundness and usefulness of the proposed inequality of poverty index and therefore the discussion on the results has been limited to minimum required.

India is one of the most diverse countries in terms of a large number of socioeconomic groups and therefore the analysis offers important insights to readers in general and policymakers in particular about the extent and nature of between-group disparity in poverty in India. The estimation

has been carried out for India as a whole and separately for its five geographical regions. India is comprised of 29 states and seven Union Territories. The different states of India are at different levels of socioeconomic development; most of the western and southern states of India are economically and demographically advanced than the central and eastern states of India (Bose, 1991; Bhat & Zavier, 1999; Dev & Ravi, 2007; Himanshu, 2007; Planning Commission, 2007; Pathak & Singh, 2009). So, any meaningful analysis should take into account the vast regional diversity present in India. To take care of this regional diversity, present analysis was carried out for India as a whole and separately for its five major geographic regions namely North, East, Central, West, and South. Northern region comprises of states of Jammu & Kashmir, Himachal Pradesh, Delhi, Uttaranchal, Punjab, Haryana, Rajasthan and Chandigarh (Union territory). The Eastern region includes the states of Bihar, Jharkhand, West Bengal, Orissa and the North-eastern states of Assam, Arunachal Pradesh, Meghalaya, Manipur, Tripura, Nagaland and Sikkim. The states of Uttar Pradesh, Madhya Pradesh and Chattisgarh come under the central region. The Western region includes states of Maharashtra, Goa, Gujarat and Union Territories of Daman & Diu and Dadra & Nagar Haveli. Finally, the Southern region comprises of states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Pondicherry (Union territory).

The data has been taken from India Human Development Survey (IHDS), 2004-05, conducted by National Council of Applied Economic Research (NCAER), New Delhi, India, in collaboration with University of Maryland. This survey is a micro unit recorded, nationally representative survey based on a stratified, multistage sampling procedure. The survey is spread over all the states and union territories of India except Andaman & Nicobar Islands and covers 26,734 households (143,374 individuals) and 14,820 households (72,380 individuals) in rural and urban areas respectively. The survey contains substantial information on a person's family background and other details like sex, religion, region of residence, caste etc. Besides, the survey also reports the actual earnings (along with consumption expenditure) from different sources for the households as well as the individuals, which is very important as it removes the sole dependency on consumption expenditure as an indicator of income. The survey has gained wide acceptability among researchers (Sen & Noon 2007; Adams 2008; Maitra & Sharma 2009; Singh 2010) working in the field of economics, demography and sociology.

The basic model used for the estimation is the separable logistic model described in equation (3). The dependent variable used in the analysis is whether an individual falls below poverty line or not ($I_i = 1$ if an individual *i* falls below poverty line and $I_i = 0$ otherwise) [6].

The independent variables (socioeconomic characteristics/ circumstances) used in the analysis are caste of the household head (categorized into scheduled castes/ tribes, other backward castes, and general; scheduled castes/tribes as reference category), religion (categorized into Hindu, Muslims, Others; Hindu as reference category), sex of the child (male and female; female as reference category) and place of residence (rural-urban; rural as reference category). All the independent variables were converted into dummy variables for inclusion into the logistic regression model.

The socioeconomic characteristics/circumstances have been identified based on their importance and relevance in the Indian society. Caste and religion have been chosen because, historically the Indian society is severely divided into different caste (or religion) groups/categories with several groups enjoying privileges more than other groups just because of their superior caste or religion (Dreze & Sen, 1995, Bayly, 1999; Sharma, 1999; Government of India, 2006; Shah et al., 2006; Desai & Kulkarni, 2008). It therefore becomes important from the point of view of both academic interest as well as policy implication, to capture the effect of caste (religion) on inequality in the distribution of poverty across different subgroups.

Place of residence, that is, rural or urban always has a differential impact in a developing country like India, as far as poverty is concerned. It has always been and will always remain an area of interest for researchers to analyze the difference in poverty levels in the two regions. Given the large rural urban divide in India, the region of residence automatically qualifies as an important group defining variable (Sundaram & Tendulkar, 2003b; Dev & Ravi, 2007; Himanshu, 2007; Planning Commission, 2007). Finally, Gender is also a variable of interest because females have traditionally lagged behind males in India, whether it is earning, sharing of resources or other related aspects (Meenakshi, Ray & Gupta, 2000). The percentage distribution of population by their socioeconomic characteristics is presented in Table 1. [INSERT TABLE 1 HERE]

Using the coefficients estimates obtained from the logistic regression (equation 3), for each individual in the sample, his/her predicted probability ($\hat{p}_i$) of falling below poverty line has been

[6] For each and every individual the survey itself reports whether the individual is poor or not (that is below poverty line or not). The poverty lines used in the survey are based on the guidelines of Planning Commission of Government of India and are based on the amount required in different regions of India to support the minimum calorie requirement set by Government of India. Since the survey is a standard and reliable survey, this study has used the survey's reporting on poverty of the individuals.

computed using equation (4). The computation of the average poverty $(\bar{p})$ has been done from equation (5) and finally the inequality of poverty index (*D-index* of poverty) has been obtained from equation (6). The process has been carried out separately for India and its five geographical regions. The results have been discussed along with concluding remarks in the following section.

4. Results, Discussion and Conclusion

The study has started with the motivation that different socioeconomic groups may have different prevalence of poverty and it is important to measure the between-group disparity in poverty along with the average prevalence of poverty in order to have a complete picture. Table 2 clearly brings out the importance of this fact for India. [INSERT TABLE 2 HERE]

The prevalence of poverty is far greater in the 'Scheduled Castes/Tribes (SC/STs)' category (in fact more than twice except for the eastern region) compared to the 'General' category. In India SC/STs are the lowest in the caste hierarchy and have suffered from severe exclusion from social activities and governmental services (Beteille, 1969; Mendelsohn & Vicziany, 1998; Bayly, 1999; Shah et al., 2006). Individuals belonging to the General category are the highest in the social hierarchy and have historically been considered superior to their counterparts belonging to other caste categories. The category 'Other Backward Castes (OBCs)' lie in between the SC/STs and the General category. They are considered socially superior to SC/STs but inferior to General category. The same is reflected in their economic status also. The prevalence of poverty in OBCs can be seen to be less than SC/STs but more than General caste category. It can also be seen that the condition of 'Muslims' is poorer than the 'Hindus' as far as prevalence of poverty is concerned. It is in line with the Government of India's report on the socioeconomic status of 'Muslims' in India (Govt. of India, 2006).

There is little difference in prevalence of poverty among males and females with the prevalence more in the case of females than males. The rural-urban divide can also be seen from Table 2. For India as a whole, the prevalence of poverty is more in rural areas but region wise trend is not singular, with prevalence of poverty more in rural areas than urban areas for some regions and less for others. When there is large difference in average poverty across different socioeconomic groups, it is expected that there will be large between-group disparity in poverty also. This observation is justified by the results.

Since, the inequality of poverty distribution has been obtained using the predicted probabilities from the logistic regression, it will be important to note that the regression results are as per

expectations. The regression results in terms of the odds in favor of falling below poverty line have been presented in Table 3. [INSERT TABLE 3 HERE]

As expected the probability of an individual belonging to 'SC/ST' category falling below poverty line is higher than the individuals of both, the 'OBC' category and 'General' categories. The odds ratio (or the coefficients)[7] of caste dummies are highly significant (at 1% level of significance for India as a whole as well as for its five geographical regions). In a similar manner, the odds of Muslims being poor is, much higher than their Hindu counterparts. The odds ratios (and the coefficients) once again are highly significant, even at 1% level of significance.

Though region of residence is not significant when India as a whole is considered, when geographical regions are analyzed independently, it comes out to be highly significant (at 1% level of significance). The results however are mixed. For the regions of North, West and South the chances of an urban individual falling in poverty is higher than the individuals of rural areas but for the regions of East and Central the odds in favor of falling below poverty line is higher for the individuals of rural areas than the individuals of urban areas. The trend is in line with the report of Government of India (Planning Commission, 2007). As far as gender is considered, males are clearly in a better position than the females. Their odds of being poor, is lesser than the females and this story is true for India as a whole as well as for its different geographical regions. The finding is consistent with the previous studies on related subject (Meenakshi, Ray & Gupta, 2000).

Since, the main focus of this study is on the proposed *D-index* of poverty, its usefulness and policy implications, no further discussion has been provided on the regression results or the reasons behind it. Table 4 presents the main findings of the analysis, that is, the estimates of the *D-index* of poverty along with the average prevalence of poverty, for India and its five geographical regions. [INSERT TABLE 4 HERE]

The prevalence of poverty in India (25% (HCR), 2004-05) is in line with the estimates of government of India as well as finding of other researchers (Planning Commission, 2007). The interesting observation is regarding the inequality associated with the distribution of poverty across different subgroups. Approximately, 17% of the poor population need to be transferred from the worse-off groups (groups with more prevalence of poverty than the average prevalence of poverty in

[7] For estimating the D-index of poverty, estimates of coefficients have been used to obtain the predicted probabilities of falling below poverty line, however for a more meaningful and direct interpretation, estimates of odds ratio have been presented in Table 3.

India) to the better-off groups (groups with less prevalence of poverty than the average prevalence of poverty in India) to achieve equal distribution of poverty across different subgroups.

A region wise picture of average prevalence of poverty and between-group disparity in poverty is even more interesting. The large variation in the between-group disparity in poverty across different geographical regions justifies the approach of dividing India into five geographical regions for the purpose of analysis. The Indian economy has grown steadily at a healthy rate and the per capita income has doubled during the last fifteen years or so, but recent studies (Pal & Gosh, 2007; Sen & Himanshu, 2005; Ghosh & Chandrasekhar, 2003; Ahluwalia, 2002) have shown that, despite such an impressive economic growth, the economic inequalities and regional disparities have enlarged in India. A similar kind of disparity can be seen in the present study also. One will beyond doubt declare that if the only concern is prevalence of poverty then the regions of central (HCR, 39.2%) and east (HCR, 26.5%) have performed badly than the other regions. This is indeed the case as these regions include some of the poorest states of India namely Uttar Pradesh, Madhya Pradesh, Bihar and Orissa. But a look at the *D-index* of poverty will tell another story. The same regions which have the highest prevalence of poverty are also the regions with the least between-group disparity in poverty. The inequality in poverty in these regions (central, 14.5% and east, 16%) is lower than the national average (16.8%) and much lesser than the regions which have the lowest levels of prevalence of Poverty.

The lowest levels of prevalence of poverty can be observed in the regions of South (HCR, 15.2%) and North (17.5%). These are the regions which include some of the richest states like Punjab and Haryana of North India and the economically and demographically advanced states of South India. Though the regions of south and north have the lowest levels of prevalence of poverty, they also have the highest between-group disparity in poverty. The *D-index* of poverty for south (23.5%) and north (22.8%) are well above the national average and much higher than the regions of central and east.

Though the *D-index* of poverty is a useful tool in itself as it informs the policymakers about the extent of inequality in poverty in the society and the kind of redistribution needed to remove this inequality, it becomes even more important in situations like above. When different regions of a country have different prevalence of poverty and prevalence of poverty varying across different socioeconomic groups in a region and across the regions, the regions cannot be compared with each other just on the basis of average poverty alone. Regions of south and north cannot be simply declared superior to the regions of central and east on the basis of average poverty. If at one end the prevalence of poverty is low in south and north, then at the other end the between-group disparity in

poverty is also very high. Therefore the need is of an indicator which can take into account both the average poverty as well as the between-group disparity into account and can rank societies in a sense of complete ordering. Such an index which can be pursued as a future research, may combine the average poverty ($\bar{p}$) and the *D-index* of poverty in a suitable way so as to capture the above two effects.

To summarize and conclude, the paper has developed a new index (*D-index* of poverty) which captures the inequality within the distribution of poverty across different subgroups in a simple and meaningful manner. The *D-index* of poverty is a distribution-sensitive measure, is insensitive to size of the population as well as to balanced increase (decrease) in the prevalence of poverty. The index also has the properties of anonymity (symmetry), population replication and transfer sensitivity in its own sense.

In addition to comparing different situations (for example, one nation at two time points, two nations at one point of time and so on) on the principle of between-group disparity in poverty, it can also be used to determine the major contributors (for example, caste, religion or location etc.) to the inequality of a given poverty distribution across different subgroups, the relative effect on poverty of a specific socioeconomic characteristic/circumstance as compared with other ones, and the relative importance of a specific characteristic over time. These can be done by simple methods, for example computing the *D-index* for only one characteristic keeping the others as fixed and doing this for different time periods and so on. Such an analysis can help in devising effective policies to counter the effect of identified characteristics/circumstances contributing to the inequality of poverty across different subgroups.

Recently there has been a lot of debate on the concept of inclusive growth, especially with reference to developing countries like India. The proposed *D-index* of poverty can also be used to gauge out whether the growth over a time period in a nation has been inclusive or not. If a country achieves growth along with a decrease in the *D-index*, then the growth can be said to be inclusive. This is because, at one hand there is growth for the society as a whole and at the other hand the between-group disparity in poverty has also got reduced which means that the worse-off groups have grown (economically) faster than the better-off groups.

As final words it can be said that, the *D-index* of poverty can capture the between-group disparity in poverty in a society in a meaningful manner, has sound intuition, satisfies some desirable properties and is especially useful when it comes to potential policy implications.

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Table 1. Percentage distribution of socioeconomic characteristics of individuals, India (IHDS, 2004-05)

Region Characteristics	North	East	Central	West	South	India
Caste						
SC/ST	29.7	33.4	28.5	26.5	26.8	29.3
OBC	29.9	37.5	47.9	34.9	52.1	41.5
General	40.4	29.1	23.7	38.6	21.1	29.2
Religion						
Hindu	75.1	76.3	84.9	86.5	83.8	81.2
Muslim	14.5	17.1	14.1	7.2	9.5	12.9
Others	10.4	6.6	1.0	6.3	6.7	5.9
Gender						
Female	48.3	49.1	49.4	49.2	50.0	49.3
Male	51.7	50.9	50.6	50.8	50.0	50.7
Place of Residence						
Rural	70.5	82.3	79.2	60.3	66.8	73.2
Urban	29.5	17.7	20.8	39.7	33.2	26.8

Table 2. Crosstab of prevalence of poverty ($\bar{p}$) with the socioeconomic variable of individuals, India (IHDS, 2004-05)

Region Characteristics	North	East	Central	West	South	India
Caste						
SC/ST	37.4	34.1	57.7	34.4	20.9	35.6
OBC	26.0	24.2	37.6	20.5	13.9	24.2
General	18.3	20.7	19.9	15.7	11.2	15.6
Religion						
Hindu	19.3	24.5	39.4	20.8	13.8	24.4
Muslim	17.4	32.0	37.8	38.0	24.3	30.4
Others	4.0	35.5	39.4	24.9	19.3	21.7
Gender						
Female	18.1	27.1	39.9	23.3	15.6	25.7
Male	16.9	25.9	38.4	21.4	14.8	24.4
Place of Residence						
Rural	17.9	28.8	40.4	20.2	11.8	25.8
Urban	16.3	15.5	34.4	25.6	22.0	23.0

Table 3. Logistic regression estimates (probability of falling below poverty line), IHDS, 2004-05

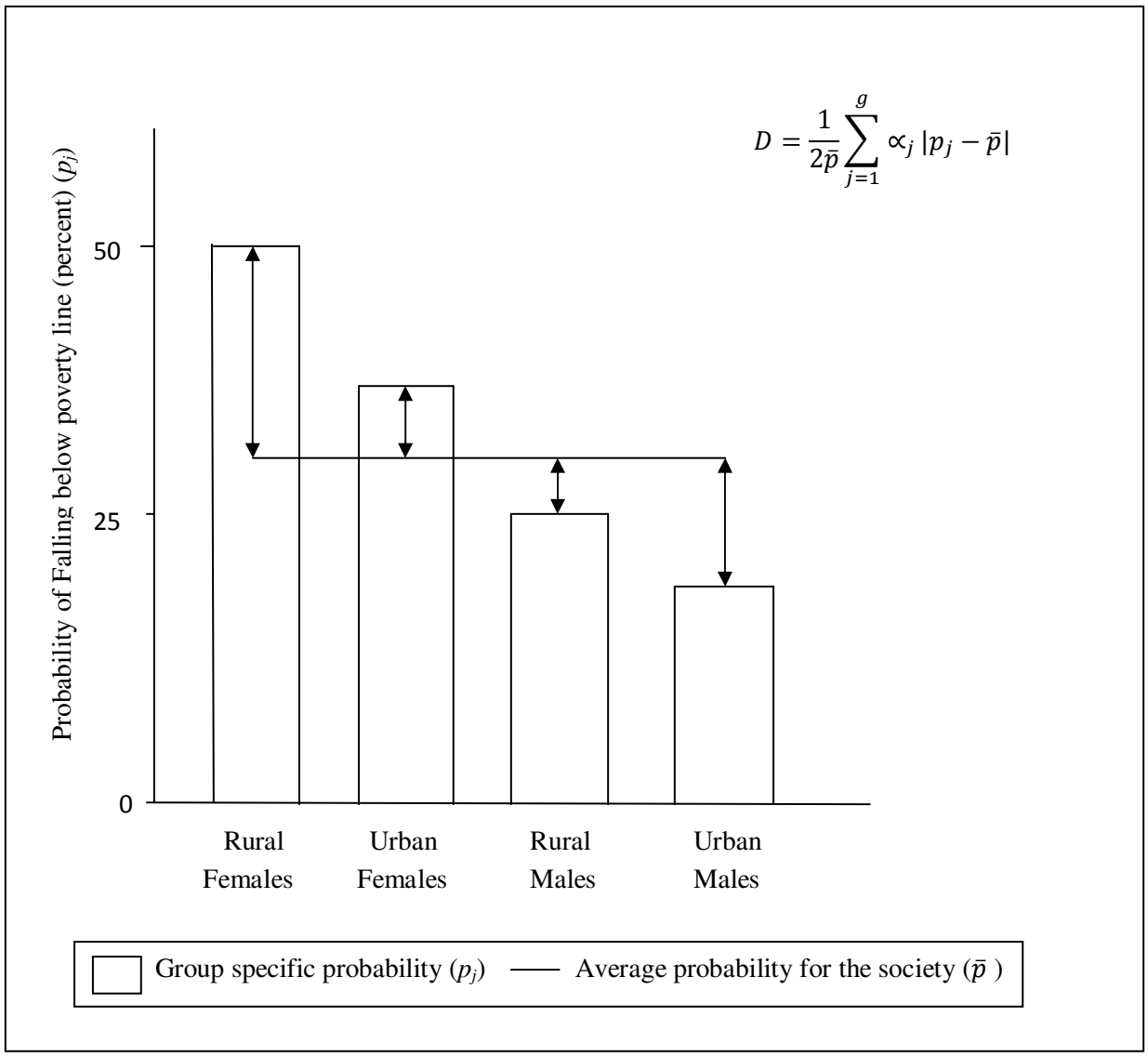
Odds Ratio[1]	North	East	Central	West	South	India
Caste (SC/ST: reference)						
OBC	0.67***	0.57***	0.46***	0.36***	0.45***	0.51***
	(0.021)	(0.016)	(0.011)	(0.014)	(0.013)	(0.006)
General	0.20***	0.32***	0.17***	0.25***	0.23***	0.23***
	(0.007)	(0.011)	(0.005)	(0.010)	(0.010)	(0.004)
Religion (Hindu:						
reference)	1.83***	2.42***	1.75***	2.61***	2.42***	2.29***
Muslim	(0.069)	(0.082)	(0.054)	(0.135)	(0.089)	(0.036)
	0.29***	0.70***	1.41***	0.91	1.20***	0.62***
Others	(0.019)	(0.027)	(0.128)	(0.056)	(0.067)	(0.014)
Gender (Female:	0.93***	0.93***	0.95**	0.91***	0.96	0.94***
reference)	(0.024)	(0.013)	(0.020)	(0.028)	(0.024)	(0.010)
Male						
	1.32***	0.52***	0.90***	1.41***	2.22***	0.99
Location (Rural: reference)	(0.037)	(0.020)	(0.023)	(0.045)	(0.057)	(0.012)
Urban						

1. For estimating the D-index of poverty, estimates of coefficients have been used, but for a more meaningful interpretation, estimates of odds ratio have been presented here.
2. Figures in parenthesis are standard errors.
3. ***Significant at 1% level of significance; **Significant at 5% level of significance; *Significant at 10% level of significance

Table 4. Average prevalence of poverty and the inequality of poverty (*D-index* of Poverty), India, IHDS, 2004-05

Regions	Prevalence of Poverty ($\bar{p}$) (%)	*D-Index of Poverty* (%)
North	17.5	22.8
East	26.5	16.0
Central	39.2	14.5
West	22.3	20.7
South	15.2	23.5
India	25.0	16.8

Figure 1: Illustration of *D*-Index of Poverty



Source: Author's own illustration (motivated from Barros et al. 2008), not based on any estimates.