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Rethinking Poverty Estimation in India: Literature Insights and a New Index Formulation

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Abstract
Background: *Poverty estimation comprises two separate tasks: determining the poverty line and constructing poverty indices. Fixation of poverty is required to distinguish between the poor and non-poor. In contrast, the construction of poverty indices is/are required to assess the poverty situation of a group of individuals. The construction of poverty indices is well discussed in the literature of development economics.*
Methods: *In contrast, this study investigates the issue of poverty line estimation by reviewing existing research on poverty estimation. This research work considers that multi-dimensional poverty estimation is superior to one-dimensional poverty estimates. Furthermore, this study examines several existing multidimensional poverty indices that fail to satisfy the required axioms of a good poverty measure. This study proposes an index of multidimensional poverty that satisfies the majority of the axioms of a good poverty measure, including transfer, transfer sensitivity, dimensional transfer sensitivity, and deprivation transfer sensitivity.*
Conclusion: *This study proposes an index of multidimensional poverty that satisfies the majority of the axioms of a good poverty measure, including transfer, transfer sensitivity, dimensional transfer sensitivity, and deprivation transfer sensitivity.*
Keywords*: Poverty Estimation, poverty debate, Multidimensional Poverty, India*

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I. Introduction

Poverty estimation comprises two separate tasks: determining the poverty line and constructing poverty indices. Fixation of poverty is required to distinguish between the poor and the non-poor. In contrast, constructing poverty indices is necessary to assess the poverty situation of a group of individuals. Now, regarding the question of fixing the poverty line, two types of issues arise: one is the choice of dimension or indicator, and the other is the choice of the cut-off. Before addressing the issues of choosing dimensions and cut-off, it is essential to shift our focus to the matter of basic needs. Poverty means a lack or deprivation of something. Now, the question arises: what is the lack of? Based on this, a debate is ongoing worldwide. Some suggest that basic needs should be ensured, and that individuals deprived of these needs should be considered poor. The concept of basic needs is not well-defined; it varies both across societies and over time. Several commodities, considered extravagant in some societies, may be seen as basic needs in other societies at a given time. Similarly, some commodities or services that are regarded as basic needs today were considered luxuries in the past. For example, electricity was not viewed as a basic need in rural India during the 1930s, but it is now. Likewise, having a smartphone is no longer considered a basic need in India, but it may be viewed as an important element of basic needs in developed nations. Thus, the benchmark of poverty, defined as the deprivation of basic needs, can change over time and across different societies. As the elements of basic needs differ significantly over time and between societies, a narrower definition of poverty can be proposed as the deprivation of human needs necessary to sustain a minimum level of decency in life (Mcnamara, 1973). This concept is defined as absolute poverty. McNamara defined absolute poverty as a condition of deprivation that falls below any rational definition of human decency. He further noted that the deprivation of minimum nutrition, literacy, sanitation, and a healthy life can be referred to as absolute poverty (McNamara, 1973). Thus, absolute poverty can be defined as the deprivation of the minimum basic needs necessary to sustain human life. Most developing nations, including India, utilise absolute poverty as their official poverty estimate. It is a fact that a person unable to afford these minimum basic needs—comprising food, health, education, shelter, and clothing—should be considered poor. In this context, Sen (1983) distinguished between characteristics (which include calories, proteins, vitamins) and commodities (which include wheat, rice, housing, education, etc.). The concept of basic needs should be specified in terms of a hybrid vector that encompasses both characteristics and commodities—e.g., amount of calories, proteins, fats, housing, education level, etc. (Sen, 1983). Once the vector of basic needs has been constructed, two alternatives should be followed to identify the poor. First, it is necessary to examine the consumption basket of individuals, and those whose consumption basket fails to satisfy their basic needs should be identified as poor. Conversely, the second

alternative involves a technique that first calculates the minimum income or expenditure necessary to meet the specified minimum needs of society and then identifies individuals whose income or expenditure falls below this threshold. The first alternative can be considered a direct way to identify the poor, while the second is an indirect method known as the income method or expenditure method of poverty estimation. It is noteworthy that the first alternative, the direct way to measure poverty, requires several measuring rods or dimensions included in basic needs to identify the poor, whereas the second alternative essentially converts minimum basic needs into monetary terms by translating several dimensions into a single dimension. Thus, regarding the aforementioned two alternatives, the former reflects the concept of multi-dimensional poverty, while the latter pertains to single-dimensional poverty. This discussion pertains to absolute poverty. Unlike absolute poverty, there exists another concept known as relative poverty. This concept of poverty is often associated with distribution. Indeed, poverty can be identified as a situation of deprivation concerning the basic needs of society. As mentioned earlier, since basic needs vary over different societies and time periods, the poverty line should adjust accordingly. This concept of poverty is referred to as relative poverty. To address the changing nature of basic needs, a given proportion (say 70%) of the median of the specified indicators is used as the threshold for relative poverty. Poverty estimates in India primarily adhere to the single-dimensional absolute poverty measurement. Here, the Monthly Per-Capita Consumption Expenditure (MPCE) of households has been considered the measurement standard for poverty. However, in recent times, efforts have been made to adopt a multidimensional measure of poverty, utilising multiple indicators to assess poverty.

Against this backdrop, this study investigates poverty line estimation by reviewing existing research on both one-dimensional and multidimensional poverty estimation. Additionally, it highlights the limitations of current estimations. The study proposes an index of multidimensional poverty that meets most of the axioms of a good poverty measure, including transfer, transfer sensitivity, dimensional transfer sensitivity, and deprivation transfer sensitivity. This work is structured as follows: Section 1 introduces the work; Section 2 examines the existing debates on poverty in India; Section 3 presents the concept of multidimensional poverty estimation; Section 4 proposes an index of multidimensional poverty that meets most axioms of a good poverty measure; and Section 5 summarizes and concludes the work.

II. Poverty line debate in India

It is also a fact that, in most cases, a one-dimensional concept of poverty has been used to estimate poverty in India. The Planning Commission of India provided official estimates of poverty from 1973-74 to 2011-12, using MPCE as the sole indicator for this calculation. Additionally, several individual researchers have estimated poverty by utilising the MPCE of households. These estimates can be referred to as unofficial estimates. By examining various poverty estimates, both official and unofficial, it becomes clear that poverty estimation, particularly in rural India, varies significantly. More specifically, the trends estimated by different economists differ noticeably. For instance, Utsa Patnaik (2007) has shown an increasing trend of poverty, whereas different estimates from the Planning Commission, Deaton, and Dreze indicate a decreasing trend of poverty. (Deaton & Dreze, 2002; Patnaik, 2007; Planning Commission, 2009). Utilising the same datasets, they not only differentiate the estimation of poverty but also reveal various types of trends found.

Before embarking on the debate about poverty estimation, this study would like to draw your attention to history, which begins with Jawaharlal Nehru and the version of the National Planning Committee. It stated that a development policy objective should be to ensure the basic minimum needs of people, setting goals for nutrition at 2400 to 2800 calories for adults, 30 yards of clothing per capita per annum, and 100 sq. ft. of shelter per capita. (Suryanarayana, 2013). After the first two five-year plans, the government established a working group that determined a national minimum, which included minimum requirements for energy, clothing, and shelter. They calculated the spending necessary to meet these minimum needs at the prices of 1961-62, resulting in a figure of Rs 20 per capita per month for rural India (Suryanarayana, 2013). Dandekar and Rath (1971) recommended a calorie norm of 2250 as the minimum amount necessary for a healthy life for both rural and urban India. Those who are unable to afford this amount would be considered poor (Dandekar, 1981; Rath & Dandekar, 1971).

The primary debate regarding poverty in modern India began here, as Dandekar and Rath initiated one of the first efforts to define an income and consumer expenditure standard for poverty, referencing a set average daily per capita calorie intake standard of 2,250 kcals for both rural and urban areas (Suryanarayana, 2013). In 1979, the Planning Commission established a task force chaired by Dr. Y. K. Alagh, which projected the population for 1982 using census data. This data segmented the population by age, sex, and activity into sixteen groups, with calorie needs ranging from 300 for children under one year to 3,600 for adults engaged in heavy labour. By calculating a weighted average of these needs, they determined a minimum standard of 2,435 (approximately 2,400) and 2,095 (approximately 2,100) for rural and urban areas, respectively. They asserted that those unable to meet this calorie threshold should be considered poor. Utilising a 2,400 calorie standard for rural areas, this equated to Rs 49 per month per capita, while it amounted to Rs 56.6 per month per capita for urban locales at 1973-74 prices (Planning Commission, 1979). It is well understood that calories are necessary but not

sufficient. Therefore, the poverty line should be defined by an average level of expenditure per capita per day, which also addresses non-food consumption needs based on observed consumer behaviour while fulfilling the minimum calorie requirements. However, methodologies such as integrating estimates of mean consumption from the National Accounts Statistics (NAS) and distribution parameters from the NSSO (National Sample Survey Organisation), as well as employing an implicit private consumption deflator from the NAS to adjust poverty lines for price changes, were scrutinised. To address these concerns, the Planning Commission formed an expert group in 1989 to evaluate the methodologies for poverty estimation. The expert group recommended that the minimum standards suggested by the Task Force on Minimum Needs and Effective Consumption Demand for both rural and urban areas remain unchanged; thus, the minimum standard of 2,400 calories for rural areas would continue to serve as the foundation for poverty estimation (Planning Commission, 1993). Furthermore, it was concluded that applying the national poverty line to the state level is illogical. Therefore, to ensure that poverty estimates are comparable across states, the committee recommended state-specific poverty lines. For this purpose, the standard national-level poverty line basket is valued at state-specific prices from 1973-74, utilising Fisher's cost of living indices to capture inter-state price differentials for the all-India rural and urban sectors, respectively (Planning Commission, 1993). Additionally, to update the poverty line over time at both the national and state levels, the Consumer Price Index of Agricultural Labourers (CPI-AL) and the Consumer Price Index for Industrial Workers (CPI-IW) were suggested for rural and urban areas, respectively (Planning Commission, 1993).

This is the conjecture from which one sort of debate has been started, i.e. to update the poverty line. Following the nutrition norm, the poverty line can be updated in the following two ways.

I. Direct way: Here, the minimum norm is 2400 calories for rural areas. The NSSO Consumption Expenditure Survey (CES) provides the distribution of persons and average expenditure by monthly per capita expenditure groups. It also presents the calorie intake per capita per day by expenditure groups, although these latter tabulations have been released with a considerable time lag in the past. This extensive sample data is published within a five- to six-year time gap. Thus, the functional form of equation 1 is available to us. Now, by simply using the minimum norm of nutrition, one can work out the poverty line using equation 2. Then, by plotting an ogive where one axis represents MPCE and the other represents the cumulative percentage of the population, and placing the poverty line MPCE on that ogive, we get the corresponding population percentage that is classified as poor.

$$NUTR_{cal} = f(MPCE) \quad \text{.....1}$$

$$OPL_{n} = k\,[f_{n}, NUTR^{*}_{cal}] \quad \text{.....2}$$

II. Indirect way: Here, the poverty line of the current year is updated by multiplying the consumer price index by the base year poverty line.

$$OPL_{n} = OPL_{0} \,.\, P_{n}/P_{0}$$

The Planning Commission followed the 'Indirect way' to update the poverty line. In contrast, researchers like Patnaik (2007) preferred the first technique, i.e., the 'Direct way', for this purpose. Consequently, these estimates vary significantly. The 'Direct way' of poverty estimation revealed a rising trend in HCR, except for the large sample year of 1977-78; whereas the calorie deprivation associated with the indirect poverty line has increased over the years, and the 'Indirect way' shows a decreasing trend. The official poverty line set by the Planning Commission fails to capture the actual cost required to meet the nutritional norm, i.e., 2400 calories for rural areas. Furthermore, Patnaik (2007) questioned whether the norm of 2400 was never applied by the Planning Commission, not even in 1973-74. Rath (2003) argued that calorie data were never published in 1973-74, and the estimation was based on a nine-month NSS sample. Moreover, Nayyar (1991) demonstrated that the percentage of people unable to access 2400 calories in rural India was 72% in 1970-71 (Nayyar, 1991). Thus, it is quite strange to find that 56.4% of the rural population was below the poverty line, especially given the rapid food price inflation during the period from 1970-71 to 1973-74. Accordingly, she recommended that the poverty estimate and poverty line should have been 72% and Rs 56 for the year 1973-74.

The Planning Commission (2009) further recommended, under the chairmanship of Suresh Tendulkar, that after establishing the poverty line, one should apply the MRP of NSS to obtain poverty estimates (Planning Commission, 2009). The methodology assumes urban poverty as a given and applies the urban poverty line commodity to construct the rural poverty line. It states that the urban poverty estimate is less controversial than the rural one. However, this methodology is not very influential because, to apply the urban commodity basket to the rural one, it is necessary to confirm that the urban poverty line is accurate. In this case, the urban poverty line is also somewhat controversial. Regardless of the methodology, the poverty line estimated for rural areas by this committee is quite effective because its cut-off not only satisfies the nutritional needs recommended by FAO/ WHO but also considers education and health. Again, facing several controversies, the Planning Commission

established a committee chaired by Rangarajan to estimate poverty. The prescribed poverty line of the committee allows for the ICMR norm for nutritional intake and all other requirements necessary to lead a decent human life.

This debate would have ended here with the conclusion that the Planning Commission committed a great mistake in updating the poverty estimate, unless some questions arise.

- What dimension are we following?
- How far is the index number used by the Planning Commission viable?
- Should the minimum norm of calories be fixed over the period?

Regarding the first question, i.e., dimensions of poverty can include income/consumption, education, food, and nutrition, etc. Now it depends on the researcher's focus on which dimension he/she is considering. If income is the chosen dimension, then the cut-off should be income; if the dimension is nutrition or calories, then the cut-off should be calories, and the same applies to others, such as education, health, etc. If the poverty estimation of India focuses solely on calories, then the official estimates of poverty are indeed significantly underestimated. However, the Planning Commission (1993) employed an income/expenditure dimension, where nutrition was a key component. Thus, the substantial differences in trends of poverty estimation between the official estimate and the direct estimate by Patnaik (2007) were primarily due to the choice of different dimensions. Over the period, the percentage of consumption expenditure on food is decreasing, while that of non-food is increasing. Moreover, Studies showed that the percentage of food expenditure fell from 80.4% in 1973-74 to 71.6% of total MPCE (Nayyar, 1991; Patnaik, 2007). In contrast, non-food expenditure rose from 19.6% to 28.4% in the same period. Among the non-food components of non-food expenditure, fuel and light, as well as miscellaneous goods and services, which include health, have shown an increasing trend. They argued that the rising spending on fuel and light is due to shortages of natural resources. Furthermore, it can be reasoned that people are consuming more superior food items, which are more costly in terms of calorie content. These are the reasons that have caused the curve to shift downward over time. This is why, even with the same real income, people's ability to afford calories is declining. Consequently, there is an increasing divergence between the poverty cut-off in terms of expenditure and calories.

Alternatively, the divergence between the official estimates of the Planning Commission and the Arjun Sengupta Committee report is not due to the choice of dimension. In fact, Sengupta suggests Rs20 per day per person as the poverty line and found that 77% of people are living below this line using the NSS extensive sample consumption expenditure survey of 2004-05. However, there is no methodological backup behind this poverty line. The distributions are not properly normal but log-normal, meaning there could be a significant jump in the neighbourhood mean. This is why a slight change in the poverty line can lead to a significant change in the HCR. Here, it becomes clear that the divergences arise mainly from the choices of different dimensions. Even Dandekar and Rath (1971) attempted to relate income to calories, but they chose to derive an income norm based on the calorie-income relationship. Until now, we have been focusing on the single-dimensional measurement of poverty, but in reality, poverty is a multi-dimensional deprivation. The most essential elements of human life are longevity, knowledge, and a decent standard of living (UNDP). Consequently, deprivation of these elements should be considered poverty. In the UNDP (1998) report, instead of using income as a poverty indicator, they focus on the most basic dimensions of deprivation, such as a short life span, lack of basic education, and lack of access to resources, whether public or private, to calculate the Human Poverty Index (UNDP, 1998). The HPI is derived separately for developing countries (HPI-1) and a group of selected high-income OECD countries (HPI-2) to reflect better socio-economic differences and the widely varying measures of deprivation in the two groups.

Looking at the question regarding the index numbers used to update the poverty line, it is quite logical that when one is using income dimension of poverty then it needs a proper deflator to update the poverty line. And it is the case that after the recommendation of Expert Committee (1993) we are using the reweighted version of CPIAL to update the poverty line for rural areas. Until 1995, CPIAL was based on prices regularly collected from a sample of 422 villages, and in November 1995, it was revised with the weights using expenditure patterns that date back to 1060-61, which was an unusually long period for any primary price index anywhere in the world (Deaton & Tarozzi, 2005). Moreover, he argued that urban to rural price differentials that are implicit in the official lines are quite implausible. Further, Deaton and Tarozzi (2005) argued that neither the Laspeyres nor the Paasche is particularly suitable for making comparisons between Indian states. By taking the example of Kerala and Uttar Pradesh and comparing between them he stated "consumption patterns different greatly across states even to the extent that a staple in one state may not be consumed at all in another. In consequence, prices for the staple in the "wrong" state are either not observed at all, or at best will be poorly measured". Moreover, Deaton (2003) argued that, when updating the line, one should use a price index that is not just relative to the period but also to the space. For example, to update the poverty line of any state for the year 2011, one uses the price index not just of 2011-12 relative to 1973-74 or any other base year, but needs to measure the prices of other parts of India (say Delhi = 100). To estimate poverty for 1987-88, 1993-94 and 1999-00 Deaton (2003) start with the All-India poverty line of 1987-88 and to get the poverty line for specific state he multiply the state specific rural price index number, which was calculated by using Tornquvist price index number, relative to All India. And to update

the poverty line, let's say for 1993-94, he used the all-India poverty line of 1987-88, multiplied by the Tornquvist price index for All India. And to get the state-specific poverty line for 1993-94, he used the same method as in 1987-88, as stated above. And Deaton found the rural poverty estimate for 1987-88 as the same as the official one for all India, but for the state-specific, he got a different result for the same round. In subsequent rounds, the All-India poverty line also diverged from the official poverty line estimate, and so did the HCR. And as a result, the associated headcount ratios show a more rapid decline in poverty rates, by one percentage point a year from 1987-88 to 1993-94, and by 1.9 percentage points a year from 1993-94 to 1999-2000.

Looking at the third question regarding the calorie intake it was the case that Task Force on Projections of Minimum Needs and Effective Consumption Demand which projected population of 1982 by using census data where population, based on their age, sex and activity divided into sixteen with the calorie intake varies from 300 for child below one year to 3600 the adult engaged with heavy work and taking weight average of these they have reached a average norm of 2435 approx of 2400 and 2095 approx of 2100 for rural and urban respectively. According to the 1993 Expert Committee's recommendation, we also found that the minimum norm of 2,400 calories for rural areas will continue to serve as the basis for poverty estimation. Over here, different sorts of points one can raise

- As stated earlier, the Task Force on Projections of Minimum Needs and Effective Consumption Demand, which projected the population of 1982 by using census data, used the population to determine the nutrition norms. Now, comparing rural areas over time, it is the case that work effort on average is declining mainly because of the use of modern tools in agriculture, such as tractors and harvesters, which should affect the calorie requirement.
- It was the case when the minimum norms had been calculated; it had taken into account that 90% of the people should be calorie sufficient. So there exist a large number of people who have calorie excess. And it that 90% there exist some people for whom less consumption is better.
- FAO and WHO recommended that countries like India should have a minimum calorie norm of 1800 calories for both rural and urban.
- Suryanarayana (2013) argued that in rural India, calories consumed by the poor (rural labour) are underestimated by NSSO. In fact, NSS questions are how much they spend on food in the last week or month, and based on this, they estimate the calorie consumption. But it is the case that most of the rural labourers take their lunch and breakfast in the employer's house, and that expenditure is accounted for on the employer's account. Thus the lower expenditure class consumption of calories is underestimated, and that of higher expenditure classes is overestimated. These were very significant when, in the 1960s, a part of the wage was given in kind.

III. Concept of Multidimensional Poverty

The drawbacks of any income method of poverty estimation, such as the aforementioned two, are as follows. Firstly, the income method of poverty estimation relies on the inherent assumption of uniform consumption behaviour. However, in reality, household consumption behaviour varies significantly across regions and societies. Thus, it is challenging to determine any income level at which households can satisfy their minimum basic needs. Secondly, the prices faced by households differ markedly across regions. Although state-level poverty lines are drawn in India, they cannot capture the variation in prices at regional or more disaggregated levels. Thirdly, there are goods and services, such as education and health, whose prices vary for consumers. For example, households incur nominal expenses when visiting public health centres or sending their children to public schools compared to those who utilise private services in those contexts. Therefore, the income method involves some arbitrariness. In contrast to the income method, the direct method is much more appealing, as it is not based on any assumptions related to the uniformity of consumer behaviour among households (Sen, 1983).

Over the years, various initiatives have been implemented to utilise the direct method of poverty estimation. Direct methods of poverty estimation require the specification of a commodity bundle of basic needs. This method considers multiple dimensions to capture poverty. In that sense, Capability Poverty Measures (CPM) can be considered a foundational stone for direct poverty measures. It takes into account the proportion of the population experiencing deprivation in capabilities. Capabilities comprise three dimensions: living a healthy and nourished life, the capability for safe and healthy reproduction, and literacy and knowledge (Sen, 1990; UNDP, 1996). Soon after, the Human Poverty Index (HPI) was formulated by Sen and Anand (1997) based on three dimensions: long and healthy life, knowledge, and a decent standard of living (Sen & Anand, 1997). Later, social exclusion was included as an additional dimension to measure the HPI for OECD countries (HDR 1998). Mehta (2003) assessed the poverty situation at the district level, considering several macro-level parameters—literacy rate, infant mortality, agricultural productivity, and infrastructure development (Mehta, 2003). In this analysis, the district has been considered the primary unit. With a different set of indicators, the Planning Commission attempted to measure the HPI across three dimensions: health, education, and standard of living (Mehta, 2003). All these multidimensional poverty measures operate at the macro level. Researchers have identified several

shortcomings related to the HPI, including the selection of dimensions and corresponding indicators, the weights assigned to these dimensions and indicators, aggregation issues, and multicollinearity (Alkire et al., 2013). Furthermore, these measures are not decomposable over population groups and are not efficiently applicable at the household level. Later, Mack and Lansley (1985), using 26 dimensions, recognised those as poor who are deprived in at least three out of those dimensions (Mack & Lansley, 1985). Although not in the same manner, the Government of India has initiated an effort to identify the poor under the BPL Census, considering multidimensional deprivation (Dreze & Khera, 2010). This approach involved a score-based ranking for each household, indicating their quality of life. Thirteen socio-economic indicators were selected, including size of landholding, type of house, food availability, clothing availability, sanitation, literacy, means of livelihood, and indebtedness, reflecting the quality of life of the rural population to gauge the living standards of rural families. Individuals were questioned regarding these indicators, with scores varying from 0 to 4, and the maximum possible score was 52. The cut-off for the BPL category was determined by the number specified by Planning Commission estimates of poverty in the respective state. This proposal for identifying the poor has faced significant criticism regarding the scoring pattern and the implementing authority (Dreze & Khera, 2010; Planning Commission, 2009). Alternatively, Alkire and Santos (2011) adopted ten indicators covering three dimensions: health, education, and living standards. In their estimation of multidimensional poverty, they identified those as poor who were deprived in at least thirty percent of the indicators (Alkire & Santos, 2011)

Identification of poor under direct measure of poverty requires three specific tasks need to be completed – Choices of dimension and sets of indicators under each dimension with their respective weights, Selection of deprivation cut-offs for each indicator (Z_j), and fixation of the poverty line across the indicators (C). Fixation of the poverty line across the indicators (C) involves the use of different criteria, including the union criterion, intersection criterion, and dual criterion. Union criterion can be present as

$$P(Q_{ij}, Z_j) = 1 \; iff \; C \geq 1 \; \forall \; i = 1,2, \dots, n \; \& \; j = 1,2, \dots, d$$

In the above expression Q_{ij} stands for ith household's achievements on jth dimension, Z_j stands for poverty line of jth dimension, and C is the number of deprivations faced by a household. This criterion of identification is intuitive and effective when the set of indicators, in a multidimensional framework, is essential and limited in number. However, when a large number of dimensions are used, most households would be recognised as poor under this method of identification. Remarkably, this will not be particularly helpful for policymakers in the eradication of poverty. Contrary to this approach, *the intersection criterion of identification recognised those households as poor* who are deprived in all dimensions.

$$P(Q_{ij}, Z_j) = 1 \; iff \; C = d \; \forall \; i = 1,2, \dots, n \; \& \; j = 1,2, \dots, d$$

This method would be accurate when each selected single dimension is enough to prevent poverty. Otherwise, inevitably, many of those who are actually poor would be missed as poor under this method of identification. Between these two extreme – *union* and *intersection* method of criterion, several researchers identified those households as poor who are deprived in k number of dimensions, where $1 < k < d$ (Alkire and Foster, 2011; Alkire and Santos, 2011; Mack and Lansey, 1985).

$$P(Q_{ij}, Z_j) = 1 \; iff \; C = k \; where \; 1 < k < d$$

The union criterion of identification is commonly referred to as the union method of identification. In contrast to this *union method of criterion*, Alkire and Foster (2011), Alkire and Santos (2010), Mack and Lansey (1985), and several others follow the dual criterion in multidimensional poverty measurement.

Following the above-mentioned literature, it can be summarised that the bundle of human needs significantly varies over time and space. However, the minimum requirements to live a healthy life can be roughly confined to some basic needs: health, nutrition, education, and living standards. Authors seem to suggest that researchers mix up health with nutrition. This research work highlights significant shortcomings in the existing research. Firstly, the majority of researchers[1] took nutritional indicators under the health dimension. Nutrition is necessary for good health. Nevertheless, adequate nutrition is not sufficient for good health. The availability of public health clinics, physicians, and adequate nutrition should be considered indicators of good health. Thus, health cannot be considered as a household-level dimension. It can be considered, if possible, as a district-level dimension. Secondly, the nutritional requirements of calories, protein, and fat are not uniform for all members of society. It is differentiated by age, sex, work effort, residence, and other factors. Keeping other factors constant, the varying physical effort requirements of these nutrients vary. Because heavy workers are poorer relative to moderate and sedentary working people, a uniform cut-off level of nutrients underestimates the deprivation of heavy workers and overestimates the deprivation of moderate and sedentary workers. Further, the above-mentioned estimates lack methodological criteria for choosing weights against the indicator. They assign average weight to each dimension – health, education and living standard, considering all dimensions are equally likely. In reality, the importance of these dimensions may differ. Pasha (2015) employed principal component analysis

and multiple correspondence analysis to assign weights to the chosen dimension for multidimensional poverty estimates (Pasha, 2015). It has been found that the estimated weights significantly vary from the uniform weight criterion. Against this backdrop, authors tried to develop a non-income measure of poverty in this section, considering some of the above-mentioned drawbacks of the existing poverty estimates. Using NSSO-CES data, it has been found that poverty disparity between social groups in rural India is increasing significantly over time. In this section, we calculate incidence, depth, and disparity of poverty under the non-income framework to assess the situation of poverty disparities between social groups over time in rural India. Income poverty reveals that poverty disparities between social groups are increasing over time. Therefore, we hypothesise that poverty disparities between social groups are increasing over time, as measured by a non-income measure of poverty.

IV. Construction of Multidimensional Poverty

The multidimensional method of poverty estimation is one type of direct method for estimating poverty. A bundle of indicators to satisfy the basic needs of households would be specified. Like the income method, this measure of poverty also requires two tasks to be completed – identification of the poor and aggregation of poverty. The former investigates who is poor and the latter envisages the amount of poverty.

Identification of poor

As discussed earlier in this study, during the discussion of income poverty, the poverty line serves to distinguish between the poor and the non-poor. Thus, identifying the poor becomes straightforward by simply drawing a poverty line. Unlike income poverty, defining a set of basic needs is essential in this approach to determine whether a household is considered poor or not. Under this approach, a household is deemed poor if it cannot fulfil these needs. Defining the set of basic needs is quite challenging. Generally, it is characterised as a hybrid vector comprising various aspects, including nutrition (calories, protein, fat), education, health, housing conditions, electricity availability, and more. Therefore, selecting the indicators for the set of basic needs and their respective cut-offs is a key task in identification. Assigning weights to respective indicators is also necessary to estimate poverty under this direct approach. In the non-income measure of poverty, our goal is to build a composite index of well-being. Most literature on the direct approach to poverty measures has utilised the equal weight criterion (Alkire & Foster, 2011; Alkire & Santos, 2011; Mack & Lansley, 1985). Generally, weights are assigned to respective indicators based on the Marginal Rate of Substitution (MRS) between them, as the MRS expresses the trade-off between the indicators. Consequently, the selection of weights for each indicator is crucial for accurate poverty estimation. Apart from choices of dimensions along with their respective weights, to draw both - deprivation cut-offs for dimensions and a poverty line across the dimensions. Hence, identification of the poor under the non-income framework requires three specific tasks to be completed – Choices of dimension and with their respective weights, Selection of deprivation cut-offs for each dimension (Z_j), and fixation of the poverty line across the dimensions (C).

Aggregation of poverty

Under the identification criterion, a household has been identified as deprived or not in any indicator of poverty. Let us assume, Q_{ij} stands for i[th] household's achievements on j[th] indicator, Z_j and W_j stands for poverty line and weight assigned for j[th] indicator. W_j varies from zero to 1. And sum of W_j is equals to 1. The poverty index has been constructed as follows.

$$M_{\alpha,\beta} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{d}\sum_{j=1}^{d} W_j \left\{\frac{Z_j - Q_{ij}}{Z_j}\right\}^{\alpha}\right]^{\beta} \; if \; Z_j > Q_{ij}$$
$$= 0 \; otherwise$$

Here, the power α, deprivation aversion parameter, has been used to measure the sensitivity of deprivation gap and the power β, dimensional aversion parameter, has been used to measure the sensitivity of dimensional gap. For practice the value of these $\alpha \; and \; \beta$ could be taken as 2 or more than that. The above-mentioned index of poverty may be treated as multidimensional criterion of FGT index.

Definition: 1

When, $\alpha = 0 \; and \; \beta = 0$, above-mentioned index of poverty became Head Count Index of Poverty. It measures the proportion of poor to total population. It satisfies monotonicity od deprivation. But not monotonicity of indicators. Poverty would have been unchanged when a poor person deprived a new indicator.

Definition: 2

When, $\alpha = 0 \; and \; \beta = 1$, multidimensional index of poverty became Adjusted Head Count Index of Poverty.

$$M_{\alpha=0,\beta=1} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{d}\sum_{j=1}^{d} W_j\right] \; if \; Z_j > Q_{ij}$$

$= 0\ otherwise$

Along with the head count, this index of poverty can catch the change in poverty when a poor become deprived in new dimension. Thus, this index of poverty satisfies both the monotonicity in deprivation and monotonicity in dimension. Unlike this, if $\alpha = 0\ and\ \beta = 1$, it will become the simple head count ratio of poverty, which satisfies only the monotonicity of deprivation. Under the simple head count ratio, poverty would have been unchanged if a poor person were deprived of a new dimension. Thus, it can be said that the adjusted head count ratio of poverty is superior to the simple head count of poverty. But it is also noteworthy that the adjusted head count ratio does not satisfy the axioms of transfer and transfer sensitivity.

Definition: 3

When, $\alpha = 1\ and\ \beta = 1$ multidimensional index of poverty became Multidimensional Poverty Gap Index.

$$M_{\alpha=1,\beta=1} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{d}\sum_{j=1}^{d} W_j\left\{\frac{Z_j - Q_{ij}}{Z_j}\right\}\right]\ if\ Z_j > Q_{ij}$$

$$= 0\ otherwise$$

This measure of poverty satisfies the transfer axiom of poverty deprivation. In this context it is superior to the adjusted head count index of poverty since it measures the extent of poverty. This index actually able to tell the amount of minimum transfer required for the Government to the poor to eliminate poverty. But Multidimensional Poverty Gap Index does not satisfy the transfer sensitivity axiom. Thus, it will be unaffected if there prevail some transfer from poorer person/ household to less poor household under the circumstances that both are remain poor.

Definition: 4

When, $\alpha = 2\ and\ \beta = 1$ the poverty index will be reduced to

$$M_{\alpha=2,\beta=1} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{d}\sum_{j=1}^{d} W_j\left\{\frac{Z_j - Q_{ij}}{Z_j}\right\}^2\right]\ if\ Z_j > Q_{ij}$$

$$= 0\ otherwise$$

It is actually a weighted sum of the deprivation gap, where the weights are the magnitude of the deprivation gap itself. Thus, it not only measures the multidimensional poverty gap but also puts more importance on those who are more deprived. Thus, unlike the multidimensional poverty gap, it satisfies the transfer sensitivity in deprivation axiom also. But unfortunately, this measure of poverty does not satisfy the transfer sensitivity of dimension i.e., it does not satisfy the CPM.

Definition: 5

When, $\alpha = 2\ and\ \beta = 2$, then the reduced form of the multidimensional poverty index should be called the multidimensional squared poverty gap index.

$$M_{\alpha=2,\beta=2} = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{d}\sum_{j=1}^{d} W_j\left\{\frac{Z_j - Q_{ij}}{Z_j}\right\}^2\right]^2\ if\ Z_j > Q_{ij}$$

$$= 0\ otherwise$$

This measure of multidimensional poverty satisfies all the desired axioms mentioned earlier, including the axiom of CIM. This measure actually satisfies both dimensional transfer sensitivity and deprivation transfer sensitivity. Furthermore, this poverty index can be disaggregated by population sub-groups, and the contribution of each sub-group to the composite poverty measure can be calculated.

The indices mentioned in Definitions *3, 4, and 5* would be useful when all the indicators are quantitative. In this research analysis, Definition 2 has been employed to aggregate poverty, utilising specific attributes as indicators of poverty.

V. Summary and Conclusion

Poverty estimation varies significantly in India. Furthermore, the trend in the incidence of poverty varies significantly among researchers, even when using the same datasets. This divergence in poverty estimation appears because they used different methodologies to estimate poverty. This study investigates those methodologies carefully. This study argues that single-dimensional poverty cannot fully capture the actual deprivation of basic needs among the population. Specifically, in countries like India, several problems exist, including market imperfections, asymmetric information, limited market access, and other violations of the assumptions inherent in the use of monetary metric poverty measures. Thus, instead of using the income/ expenditure method, multidimensional poverty approach would be more effective. This study proposes a multidimensional poverty index that satisfies all the desired axioms, including the axioms of transfer, transfer sensitivity, transfer sensitivity in deprivation, transfer sensitivity of dimensions, and the CPM. This measure

actually satisfies both dimensional transfer sensitivity and deprivation transfer sensitivity. Furthermore, this poverty index can be disaggregated by population sub-groups, and the contribution of each sub-group to the composite poverty measure can be calculated.

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