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Conceptualising a New Multidimensional Poverty Index for India

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ABSTRACT While India has successfully lifted millions out of poverty over the past few decades, the issue remains among the foremost challenges confronting the country. One of the first crucial steps to solving the problem of poverty is to measure its extent. Although there is some agreement on the multidimensional nature of poverty and the inability of unidimensional measures to capture its true magnitude, a national or global consensus on a single poverty index remains elusive. This working paper attempts to fill the gap in the current discourse on the multidimensional nature of poverty, based on the lauded Capability Approach of Nobel laureate Amartya Sen. It offers a multidimensional poverty index that espouses Sen's approach while highlighting the flaws in the existing multidimensional approaches.

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1. INTRODUCTION

India has lost its unenviable position of being home to the world's largest number of poor people, a figure determined by the International Poverty Line (IPL) of US$1.90 per day. About 70.6 million Indians live below this line, implying that about three percent of the Indian population is now below the international poverty standards.[1] In stark contrast, the national standard of the Rangarajan Committee methodology pegs the number of poor at 363 million.[2] An analysis of the reasons for such a massive difference in the poverty figures in the two studies will help highlight those forms of deprivation that are beyond the notion of extreme international poverty but are considered in the Rangarajan poverty ratio as necessary to be tackled by policy.

This variance in poverty measurement suggests a lack of consensus on a common methodology of poverty estimation. One might argue that poverty is an ever-evolving phenomenon and so it is difficult to determine a methodology that remains invariant over time. But it is the philosophy that underlies the methodology that needs to be sound and well-articulated. Today, there is a broad consensus on the need for a multidimensional index instead of a unidimensional one that is based on a single homogenous entity such as income or utility. The Capability Approach, as espoused by Nobel laureate Amartya Sen, has been pivotal in bringing about this shift.

Yet, there are several nuances in the discussions on Sen's Capability Approach that are missing in the efforts to develop multidimensional poverty indices. This paper seeks to highlight these nuances and capitalise on them to build a new multidimensional poverty index. These nuances have nothing to do with the axiomatic approach adhered to by other multidimensional indices, yet the new index is expected to satisfy most of these axioms. The axiomatic framework will need to be modified slightly to be applicable to the context of the newly developed poverty index.

The objective of this paper is to propose a new multidimensional poverty index that is an improvement over other major attempts at measuring poverty through a multidimensional framework, both in the identification of the poor and the subsequent aggregation that is required to arrive at the index. The paper addresses many of the limitations that previous poverty measures have encountered. The outcome is expected to be a refined version of a poverty index that reflects ground realities and has the calibre to underpin an effective anti-poverty policy strategy.

2. THE CAPABILITY APPROACH: THEORETICAL FOUNDATIONS FOR THE NEW MULTIDIMENSIONAL POVERTY INDEX

Sen's Capability Approach forged a line of reasoning that has been significantly influential in establishing the contemporary perception of poverty. Instead of viewing poverty through narrow metrics such as GDP growth and industrialisation, Sen posited that poverty be seen as an *'unfreedom'* that individuals deprived of a good life that they value and have reason to value experience. Development takes centre stage, but poverty is one of the many antitheses to development. Thus, tackling poverty amounts to enhancing development. Development is both the means and the end. The erstwhile metrics of economic growth and industrialisation rely upon mechanisms of development to transmit economic increments to the various sections in society. These mechanisms are goals of development. Therefore, development begets development. Sen, for instance, identifies basic conditions such as good health and education, economic opportunities, political liberties, and social power as the mechanisms.

Sen distinguishes between two forms of freedoms. The first represents the constituent components of development, which refer to the value attached to the freedom because of their intrinsic importance. These freedoms include basic conditions such as good health and education, sanitation and clean drinking water. The second form refers to the instrumental role of freedoms in development. These include political freedoms, social opportunities, economic facilities, transparency guarantees and protective security. These freedoms are *instrumental* in achieving other important freedoms. Sen accorded utmost priority to the free agency of individuals. He may be interpreted as saying that free and sustainable agency gets eroded if substantive freedoms are eroded. Substantive freedoms are to be construed as those in which deprivations may be regarded as urgent moral and political priorities.[3]

There are two concepts fundamental to understanding Sen's Capability Approach: *functionings* and *capabilities*.

Functionings: These allude to the states of being and doing, and refer to the actual achievements of an individual, for instance, being well-educated, having a roof over one's head and being decently clothed. Functionings can range from simple elementary states to relatively complex achievements. Apart from some fundamental functionings, there is no reason to expect people who live across different spatial and temporal dimensions to value the same functionings. The consensus on the importance of certain functionings is only reflective of their universality and their urgency.[4]

Capabilities: The set of capabilities includes functionings or freedoms to which one has *effective* access. This implies that if one has access to a functioning, then they can achieve that functioning, unless they have *chosen* not to. The capability set, therefore, is one that includes all possible combinations of the relevant functionings or actual achievements. According to Sen, the measurement of progress must be articulated in terms of the improvement in the freedoms of people.[5]

Capability Approach vs other approaches to poverty

The Subsistence or Minimum Needs Approach

In 1901, Joseph Rowntree defined poverty as the minimum level of income deemed essential to acquire necessities such as food, clothing, shelter and fuel to sustain physical efficiency. According to Rowntree, "Nothing must be bought but that which is absolutely necessary for the maintenance of physical health, and what is bought must be of the plainest and most economical description."[6]

This view of poverty was relevant at the time it was conceived but has since become obsolete. Although it is a necessary approach to understanding poverty, it has several limitations, even in the context for which it was developed. The Subsistence Approach requires poverty to be defined exclusively in terms of income, but this is a clear drawback that allows arbitrariness to creep in. For instance, income cannot purchase the longevity of life.

Furthermore, the focus on subsistence income may perhaps preclude the ability to combat poverty. This conception of income does not include health and education as necessities of life even though they are needed to fight poverty. Besides, how is physical efficiency defined? Does it include the ability to earn more income so that the poor can escape the poverty trap? Earning a minimum income may keep them alive, but they will likely be miserable. The poor must be empowered to earn the means to a better standard of living. By focusing on the plainest and most economical description, the poor may be deprived of this ability.

The Basic Needs Approach

The International Labour Office formally adopted the Basic Needs Approach at the World Employment Conference in Geneva in 1976, defining basic needs as:

"Firstly, they include certain minimum requirements of a family for private consumption: adequate food, shelter and clothing, as well as certain household furniture and equipment. Second, they include essential services provided by and for the community at large, such as safe

drinking water, sanitation, public transport and health, education and cultural facilities. The concept of basic needs should be placed within the context of a nation's overall economic and social development. In no circumstances should it be taken to mean merely the minimum necessary for subsistence; it should be placed within a context of national independence, the dignity of individuals and peoples and their freedom to chart their destiny without hindrance."[7]

The Basic Needs Approach extends the Subsistence Approach to include certain necessities made available at the community level, but shifts the focus from determining a minimum income level to the consumption level required to maintain physical efficiency, thereby defining the poverty line.[8] This exercise is computationally difficult while conceiving of a consumption poverty line for factors such as sanitation and public transport. For the sake of argument, it is assumed that one has managed to determine the consumption poverty line. Does that mean someone who consumes less of sanitation—whatever that may mean—is poor? Open defecation has been widespread in rural India. There could very well be instances where even the well-off can build their own toilets, but don't due to social conventions.[9]

Similarly, people may consume less of public transport simply because they have private vehicles. Even if individuals have consumed enough to remain above the income poverty line, have they done so by taking recourse to some form of debt? These nuances are not accounted for by the Basic Needs Approach.

Furthermore, aiming for physical efficiency cannot be equated with striving for development. Development is more aspirational than just physical efficiency. It demands a good quality of life for all beyond mere survival.

The Relative Deprivation Approach

This approach, championed by Peter Townsend, requires poverty to be seen in reference to the standards and norms of life in a society. The poverty line is, thus, the minimum income level needed to adhere to these standards and rules in a satisfactory manner. Such standards refer to the broad spectrum of roles, relationships and responsibilities that constitute the functioning mandated by being a member of society.[10] The Relative Deprivation Approach goes beyond the Basic Needs Approach by viewing the aspiration of well-being as the ability to function satisfactorily as a member of society rather than just mere physical efficiency. Such functioning calls for several requirements, such as rights, liberties, economic opportunities, mental peace and happiness. Although it recognises the importance of these requirements for the well-being of a person, this approach intends to translate this significance in terms of income. The multidimensional nature of well-being does not get due priority, while the intrinsic importance of the above requirements is disregarded.

The Capability Approach does well what the Subsistence, Basic Needs and Relative Deprivation approaches set out to do, but goes much further. The importance of the Capability Approach lies in it being universally relevant for all space-time configurations. Development as "the enlargement of the capabilities required to live life which individuals have value for and have reason to value"[11] is a view that was relevant during Rowntree and Townsend's existence, is important today and will continue to remain so in the future as well. What will change over various space-time configurations is the content of what one values and has reason to value. For instance, the internet is of extreme importance today but did not even exist during Rowntree's time.

Measurement of poverty under the Capability Approach

Capabilities vs functionings

According to Sen's *evaluative reason*, the measurement of progress must be articulated in terms of improvement in the freedoms of people. He says, "The evaluative focus of this "capability approach" can be either on the *realised* functionings (what a person is able to do) or on the *capability s*et of alternatives she has (her real opportunities). The two give different types of information—the former about the things that a person does and the latter about the things a person is substantively free to do."[12]

However, later discussions are heavily focused on the valuation of functioning vectors. The Stiglitz, Sen and Fitoussi Commission report overrules this emphasis in favour of considering the full range of opportunities available to individuals. According to them, "The limits of focusing on achievements for assessing [quality of life] become obvious when considering cases where a low observed functioning (e.g. low-calorie intake) reflects a choice (as in the case of fasting) or where a high level of functioning reflects the choices of a benevolent dictator."[13]

Since choice plays a role, measuring deprivation will have to be in terms of capabilities. For instance, one can afford to buy a vehicle but chooses not to and instead uses public transport to commute. Here, the capability should be considered. In certain cases, functionings supersede capabilities. One's choice to not exercise their capability may not be socially acceptable. For instance, one may choose not to build a toilet in their home even though it is socially desirable to do so. Here, the functioning must be considered. The measurement of poverty needs to be amenable to this fungibility of what to measure.

What is finally chosen to value in the index being developed are those capabilities that count as substantive freedoms that are valued by all individuals, and those that individuals at large have a reason to value.

Valuation of capabilities: A social choice exercise

The social evaluation of well-being or deprivation demands reasoned consensus and follows from 'public debate and discussion' and 'democratic understanding and acceptance.' Personal opinions (reflecting what one values) are synthesised to generate a consensus (reflecting what one has reasons to value).[14] An important example by Sen that is often cited is: if there are four contradicting opinions about the relative weight to be assigned to capability ***x*** vis-à-vis capability **y**, of ½, ⅓, ¼ and $^1/_5$, there exists an implicit agreement that the relative weight of capability ***x*** should not exceed ½, nor fall below $^1/_5$.[15] It follows naturally from the Capability Approach that individuals must enjoy the freedom to participate in the social evaluation of well-being.

Resources—and the ability to convert them into functionings—matter

Measures that take into account the command over resources but not the ability of individuals to convert them into functionings suffer from a handicap.[16] For instance, a billionaire detected with an incurable disease cannot access a cure despite his wealth because none exists, and he will eventually die. Several factors determine the ability to convert owned or available resources into functionings. They are:

Personal heterogeneities

The differences in the physical characteristics of individuals, attributable to factors such as age, gender and disability, play a decisive role in how the command over a set of resources translates into a good quality of life.[17]

Environmental diversities

Climatic conditions and geographical characteristics that influence people's heating and clothing needs, the proclivity to outbreaks of infectious diseases and the level of pollution determine the differential abilities to lead the same quality of life from the same level of resources.[18]

Variations in social climate

Social realities such as public health and education facilities, community relationships and crime rates are crucial in determining how one's resources can be used to achieve valued functionings.[19]

Differences in relational perspectives

The customs and traditions prevalent in society also influence the transformation of resources into actual achievements. According to Sen, for instance, "...to be able to "appear in public without shame" may require higher standards of clothing and other visible consumption in a more prosperous society than in a poorer one."[20]

Distribution within the family

Incomes earned by one or more members of a family are utilised to satisfy the needs and wants of the earners and non-earners in the family. The distributional rules applied in the family with respect to factors such as gender and age influence the level of actual achievements of all members of the family. For instance, in many parts of India, women can have their meals only after everyone else in the family is done eating, and often end up eating the least as a result.[21]

Pluralistic poverty measures

A poverty measure must be pluralistic in nature. According to Sen, arguing for technical convenience by hammering all that matters for the well-being of individuals into a homogenous entity like income or utility is discounting humankind's ability to reason.

Furthermore, doing so denies important rights and freedoms the intrinsic value associated with them. The deprivation of these rights and freedoms need to be accounted for in a manner separate from entities like utility and income.[22]

Poverty measurement must take into account interconnections between capabilities

While measuring poverty, one must be sensitive to the constitutive and the instrumental roles of freedoms. The instrumental roles of freedom emphasise the interconnections between various freedoms. Sen only talks about the complementarity of freedoms. As he points out, the provision of public education and health, besides being valuable in themselves, contribute to economic development. Economic growth, on the other hand, enables the provision of social insurance.[23]

Sen does not discuss substitutabilities. This paper presents an alternative way of looking at substitutes and complements. When two capabilities have functionings in common such that both are not required to acquire these functionings, they are referred to as substitutes. For instance, income and education can be viewed as substitutes. Education generates employment opportunities, which in turn generates income. More education can compensate for less

income. Same is the case with less education and more income. Housing and electricity, on the other hand, are complements. Unless you have a house, having an electricity connection is impossible and pointless. Health and education can be conceived as complements as well. Health is crucial for being able to participate in education.

However, at urgent levels of deprivation, income and education are also complements. Low income will prevent you from accessing education. At higher levels of education, the substitutability between income and education becomes relevant. This is compatible with the conventional notion of substitutes. When you have more of one attribute, the reduction in poverty is lower when another attribute, which is a substitute for the first, is increased. When two capabilities have common functionings, the more one has of one capability, the less the substitute can do to compensate for functionings that are lacking. When two capabilities are needed for a functioning to become available, the value of a capability that one may have more of increases when the quantity of the complement is increased.[24] Following Sen, the focus in the proposed poverty index is on complements, given the constraints of relatively higher levels of deprivation.

3. HOW DO EXISTING MULTIDIMENSIONAL POVERTY INDICES FARE?

Existing multidimensional poverty indices broadly resonate with Sen's philosophy of moving beyond income and focusing on deprivations in multiple attributes/freedoms. However, they do not pay attention to the desiderata for poverty indices implicit in Sen's discussions.

Several attempts have been made to develop multidimensional poverty indices. General attempts to appraise these measures have been made based on their obedience to certain axioms deemed essential to the soundness of such indices. These axioms include symmetry, focus, population invariance, scale invariance and subgroup additivity. These indices will be assessed from the prism of the desiderata outlined in the previous section of the paper, which also underlines the development of the new index.[25]

The poverty measures that follow are in no way social choice exercises. An important merit of a social choice exercise is that the need to determine a poverty line becomes redundant. Furthermore, weights in the measures below are generally assigned in an arbitrary manner. Categorical variables cannot be included in the measurement of poverty through these indices.

The instrumental role of freedoms crucial to the process of poverty alleviation is ignored by the poverty indices mentioned below.

A measure of poverty must be fungible in terms of what is being measured, the functioning

or the capability. The measures, as they stand, assume that the attribute is quantitative in nature, can be calculated and that a threshold can be determined as well. What is always evaluated are functionings, and there is no room for assessing capabilities. There may be many ways in which one can construe a quantitative characterisation of the dimension. But this precludes the fungibility we desire. Consider, for instance, the case of health. To begin with, we want to measure the capability of being healthy, or, in other words, access to good health. At the individual level, a quantitative measure will be the annual expenditure on health. But what if an individual has not fallen ill frequently? He will not spend as much on healthcare. Here, the fungibility concept is violated.

There could be several functionings associated with a single capability, in this case, access to good health. The typical response to a threat to good health is to visit a health facility. This can be seen as the functioning most representative of the capability of being healthy. It is thus prudent to measure the derived capability of having access to good healthcare facilities. Here, social choice can be evoked to assess whether individuals have access to affordable and good healthcare facilities. The subjectivity associated with notions of affordability and quality does not affect the results. Assuming most people find, depending upon their reasoning and judgment, health facilities to be affordable and good, we can rule out deprivation in terms of access to health. The indices mentioned below do not allow for such assessments.

It is important to define some notations at the onset. Let x_{ik} represent the k^{th} attribute/dimension of the i^{th} individual, $i = 1,2, \ldots N;\ k = 1,2, \ldots k$. Let x_{ik} be the typical element of the row vector x_i, which is the (1xk) vector representing the set of attributes of the i^{th} individual. The vector $\boldsymbol{x}_i$ is the i^{th} row of the matrix $\mathbf{X}$, which is the (N x K) matrix representing the distribution of K dimensions of N persons. Let $\mathbf{z} = z_1, z_2, \ldots z_k, \ldots z_K$ be the vector of poverty lines in terms of $\boldsymbol{x}_i$.[26]

1. Chakravarty, Mukherjee and Ranade index[27]

This index is proposed as an extension of the Foster Greer Thorbecke (FGT) class of unidimensional poverty measures. It is defined as:

$$P(\mathbf{X}; \mathbf{z}) = N^{-1} \sum_{i=1}^{N} \sum_{k=1}^{K} w_k \, g_{ik}^{\alpha}$$

Where

$$g_{ik}^{\alpha} = \max\left(0, 1 - z_k^{-1} x_{ik}\right)$$

2. Alkire-Foster index[28]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\sum_{i=1}^{N}\sum_{k=1}^{K} w_k\, g_{ik}^{\alpha}\, I(d_i \geq \zeta)$$

Where

$$d_i = \sum_k g_{ik}^{0}$$

ζ is the cross-dimensional "dual" cut-off, the minimal number of dimensions required for an individual to be multidimensionally poor.

Focusing on the number of dimensions rather than the type may not be an appropriate approach towards measuring poverty. Furthermore, there is no normative requirement that constrains the value of ζ. Assume the value of $\zeta = 3$. Now take into consideration a woman who comes from a wealthy family, and who is well to do in all parameters except education due to social pressures. This index will not consider her poor. Similarly, consider an individual belonging to the middle-income class of society, who does well in all other parameters but suffers from a terminal illness such as cancer. The individual cannot finance his medical expenses without incurring debt. Even this individual will not be treated as multidimensionally poor. In this case, there is a great likelihood that the debt may result in the individual becoming impoverished in future terms of other dimensions as well. This impact of a single deprivation is worth capturing in the index.

3. The Multidimensional Poverty index[29]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\sum_{i=1}^{N}\; K^{-1}\sum_{k=1}^{K} d_i \;\; I(d_i \geq \zeta)$$

This index is weaker in comparison to the Alkire-Foster index. It does not consider the severity of the individual deprivations in computation. As a result, for instance, a major deficit in basic nutrition is given the same importance as educational deprivation, while the former is more urgent than the latter.

4. Chakravarty, Deutsch and Silber index[30]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\sum_{i=1}^{N}\sum_{i\epsilon S_k}\sum_{k=1}^{K} w_k \left[ln\left(\frac{Z_k}{\min\, x_k, z_k}\right)\right]$$

It represents the multidimensional version of the Watts index. It aggregates the deprivation of certain attributes experienced by individuals who are poor in those attributes. The logarithmic nature of the index ensures that the poorer person is given greater importance in the index.

The Chakravarty, Mukherjee and Ranade index; the Alkire-Foster index; the Multidimensional Poverty index; and the Chakravarty, Deutsch and Silber index do not take into account the cumulative impact of multiple deprivations. They do not give greater importance to the greater impoverishment arising out of multiple deprivations.[31]

5. Multiplicative FGT index[32]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\sum_{i=1}^{N}\prod_{k=1}^{K} g_{ik}^{\alpha^k}$$

and

6. Tsui Index[33]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\Sigma_{i=1}^{N}\Pi_{k=1}^{K}\left[\left(\frac{Z_k}{\min\ x_k,z_k}\right)^{\delta_k} - 1\right], \delta^k \geq 0$$

The Multiplicative FGT index and Tsui index are of the Cobb-Douglas form of functions. As such, the elasticity of substitution is constant at one. Although these measures are sensitive to multiple deprivations, they suffer from two major drawbacks. From the perspective of the desiderata outlined in section two of this paper, these indices miss taking into consideration the constitutive importance of certain capabilities to the process of development. By assuming a constant elasticity of substitution, they forfeit crucial information about the substitutability or complementarity between capabilities.

7. Datt index[34]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\Sigma_{i=1}^{N} K^{-1}\left(\Sigma_{k=1}^{K} g_{ik}^{\alpha}\right)^{\beta}, \beta \geq 1$$

and

8. Bourguignon and Chakravarty Index[35]

$$P(\mathbf{X};\mathbf{z}) = N^{-1}\Sigma_{i=1}^{N}\ \left(\Sigma_{k=1}^{K} w_k g_{ik}^{\alpha}\right)^{\frac{\gamma}{\alpha}}\qquad, \frac{\gamma}{\alpha} \geq 1$$

Above, $\beta = \frac{\gamma}{\alpha}$. If $\beta, \gamma > 1$, then the previous indices are more averse to the greater incidence of multiple deprivations. α is the parameter of substitution. Depending upon the elasticity of substitution, α lies between one and minus infinity. When $\alpha = 0$, the previous indices assume the Cobb-Douglas functional form. The value of this parameter is held constant, and the degree of substitution between pairs of attributes or capabilities is treated as constant.

This forfeits crucial information about the true degree of substitution between capabilities.

The functional form of the Bourguignon and Chakravarty index has been derived by inferring the shape of iso-poverty contours that adhere to a set of axioms and determining the functional forms corresponding to that shape. These axioms include the Focus Axiom, Monotonicity Axiom, Continuity Axiom and the Multidimensional Transfer Principle.

When the parameters of substitution and inequality aversion are set right, the Datt index and the Bourguignon and Chakravarty index have the ability to unearth rather approximately the substitutability and complementarity between attributes. However, none of the authors have provided any guidance on how to go about determining these parameters in an empirical manner, making the choice arbitrary and the poverty measurement exercise susceptible to errors.[36]

4. THE NEW MULTIDIMENSIONAL POVERTY INDEX

The proposed measure is a multidimensional poverty index motivated by the Deprivation Index conceived by Meghnad Desai and Anup Shah in their 1998 paper 'An Econometric Approach to the Measurement of Poverty'[37], and applied by Bernard Delhausse, Axel Luttgens and Sergio Perelman in their paper 'Comparing measures of poverty and relative deprivation: An example for Belgium.'[38] This index is underlined by the desiderata outlined for poverty measures in the previous section.

Methodology

Step 1: Poverty evaluation as a social choice exercise

The first step involves identifying the various dimensions of poverty and deprivation that are to be incorporated in the index. This paper takes into consideration food (nutrition), clothing, housing, electricity, water supply, sanitation, education, health, clean energy, and mobile and internet access as these are urgent capabilities that are universally valued and that people have reason to value. The measurement of poverty begins with the administration of a survey to individuals to self-evaluate their ownership of capabilities. It is reasonable to expect people to capture their abilities to convert resources into functionings in their evaluation. The questions will either be related to capabilities or functionings, depending on what is better to measure poverty. For instance, for food, clothing, shelter and sanitation, the questions are framed in terms of functionings. The question on food demonstrates how quantitative variables can also be accounted for in the poverty measurement exercise. As such, the intended poverty measure is fungible.

Using the responses generated by the survey, a binary indicator function can be computed.

Measuring capabilities must use the binary approach since one either has capabilities or not. Functionings can allow for more cardinalisation of responses, but at the cost of accompanied arbitrariness. This will further require the determining of thresholds that distinguish the poor from the non-poor. There can be several numerical schemes used for such cardinalisation, which can give rise to conflicting results. This is precisely the drawback of having arbitrary poverty lines. While cardinal quantitative variables can be modelled as binary responses, the opposite is not feasible. The biggest merit of using binary responses is to rule out the use of poverty lines, as illustrated below.

Let H be the number of households being investigated for the poverty index. Therefore, the index is being developed for a sample of households and not the entire population in the country. So, what is obtained is a reliable estimate of poverty. Let I_{nk} be the indicator function associated with the k^{th} dimension and the h^{th} household.

$$I_{hk} = \begin{cases} 0 \; if \; the \; h\text{th} \; household \; is \; not \; deprived \; on \; the \; kth \; dimension \\ 1 \quad\quad if \; the \; h\text{th} \; household \; is \; deprived \; on \; the \; kth \; dimension \end{cases} \qquad k=1,2,\ldots K;$$

$h=1,2,\ldots H$

Computing the indicator function for the various dimensions of poverty:

For food

The question asked is,

Does every member of the household consume the minimum stipulated nutrients: calories, fat and protein?

Yes is coded as **0** and ***No*** is coded as **1**

This evaluation is objective and involves measuring the consumption of nutrients, which are then compared to the benchmarks set by the Indian Council of Medical Research.

For clothing

The question asked is,

Do you own the minimum clothing required to cover and keep yourself comfortable across all = seasons?

Yes is coded as **0** and ***No*** is coded as **1**

This question does not enquire if one owns all the clothing they *desire*. Rather, the question relates to whether the *basic need* of clothing is fulfilled.

For housing

The question asked is,

Do you live in a non-serviceable katcha house, an obsolescent house, a congested house, or are homeless?

No is coded as **0** and ***Yes*** is coded as **1**

For sanitation

The question asked is,

Do you have an independent toilet unit within your residence?

Yes is coded as **0** and ***No*** is coded as **1**

For water supply

The question asked is,

Do you have access to piped water supply to your residence?

Yes is coded as **0** and ***No*** is coded as **1**

For education

The question asked is,

Do you have affordable and easy access to primary, secondary and higher secondary education? Do you need to take recourse to any form of debt?

Yes is coded as **0** and ***No*** is coded as **1**

For health

The question asked is,

Do you have access to affordable and quality health services without requiring to take any form of debt?

Yes is coded as **0** and ***No*** is coded as **1**

Burden of debt

The question asked is,

Do you have to take any form of debt to meet the basic needs such as food, clothing, shelter and education?

No is coded as **0** and ***Yes*** is coded as **1**

For clean energy

The question asked is,

Do you have access to clean energy such as LPG or electricity?

Yes is coded as **0** and ***No*** is coded as **1**

For connectivity

The questions asked are,

Does any member of the household own a mobile phone?

Yes is coded as **0** and ***No*** is coded as **1**

Does the household have any access to internet?

Yes is coded as **0** and ***No*** is coded as **1**

Step 2: Calculation of weights

The weights assigned to the indicator function are obtained from simultaneous equations probit regressions in which the indicator function is the response variable. The weights are calculated in this manner for two reasons. The responses of the social choice exercise, it can be argued, are being synthesised using a sound methodological framework that is well- established in econometric literature. The input identifies what is valued, and the methodology is an algorithm that has reason to be valued. The weights assigned also use the information on the influence of the probability of deprivation in a particular capability on the probability of being poor in terms of some other capability. Therefore, a simultaneous equations model (SEM) can capture the instrumental role of freedoms on enabling other freedoms.

There are substantial reasons to believe that there are other exogenous factors that have an impact on whether a household is poor or not. For instance, the factors considered as explanatory variables in this paper's SEM probit regression include the following: 1) whether rural or urban, 2) the state the household belongs to, 3) religion and 4) social groups such as Scheduled Caste and Scheduled Tribes. Other explanatory factors could also be included, keeping in mind the complete structure of the index. Let z_i, $= 1,2 \ldots .m$ denote the explanatory variables. The SEM probit regression method follows as below:

I_h represent endogenous dummy variables, the indicator functions defined for the h^{th} household.[39] It is assumed that these variables are obtained from latent endogenous variables I_h^*. Further, the variable I_h^* is unobserved, but the event $I_h^* > 0$ is observed in terms of the dummy I_h

$$I_h = \begin{cases} 1 & if \ I_h^* > 0 \\ 0 & otherwise \end{cases}$$

Assume that I_h^* is defined by the following relationship:

$$I_h^* = \gamma z_h + u_h$$

It follows that

$$Prob\ (I_h = 1) = Prob\ (\gamma z_h + u_h)$$

Assuming that u follows the standard normal distribution, the following probit model is obtained:

$$Prob\ (I_h = 1) = \Phi\ (\gamma z_h)$$

In the above expression, Φ *(.)* is the standardised normal cumulative distribution function.

Generalising the above reasoning, one can obtain a bivariate structural model:

$$I_{h1}^{*} = \beta_1 I_{h2}^{*} + \gamma_1 z_{h1} + \zeta_{h1}$$

$$I_{h2}^{*} = \beta_2 I_{h1}^{*} + \gamma_2 z_{h2} + \zeta_{h2}$$

The β_s denote the direct effects among the latent variables I_{h1}^{*} and I_{h2}^{*}corresponding to the dummies I_{h1} and I_{h2} respectively. The complementarity or substitutability between attributes/ capabilities is captured by the β_s. The γ*s* represents the direct effects of the exogenous variables on the endogenous ones. The error terms ζ_{h1} and ζ_{h2} are assumed to be bivariate normally distributed with variance-covariance matrix ψ.

The reduced form of the above system of equations is:

$$I_{h1}^{*} = \pi_{11} z_{h1} + \pi_{12} z_{h2} + v_{h1}$$

$$I_{h2}^{*} = \pi_{21} z_{h1} + \pi_{22} z_{h2} + v_{h2}$$

Where

$$\pi_{11} = \frac{\gamma_1}{1-\beta_1\beta_2} \quad , \quad \pi_{12} = \frac{\beta_1\gamma_2}{1-\beta_1\beta_2} \quad , \quad \pi_{21} = \frac{\beta_2\gamma_1}{1-\beta_1\beta_2} , \quad \pi_{22} = \frac{\gamma_2}{1-\beta_1\beta_2}$$

If the joint distribution of the error terms v_1 and v_2 is bivariate normal distribution, we get the following:

$$\mathrm{E}(v_1) = \mathrm{E}(v_2) = 0$$

$$\mathrm{E}(v_1^{2}) = \mathrm{E}(v_2^{2}) = 1$$

$\mathrm{E}(v_1 v_2) = \rho$, where ρ is the correlation coefficient between the error terms v_1 and v_2.

The π_s are estimated using the probit regressions. The probabilities of the joint occurrence of the two events can now be expressed as:

1. Prob ($I_{h1} = 1$ and $I_{h2} = 1$) = $\mu(I_{h1}^{*}, I_{h2}^{*}, \rho)$

2. Prob ($I_{h1} = 0$ and $I_{h2} = 0$) = $\mu(-I_{h1}^{*}, -I_{h2}^{*}, \rho)$

3. Prob $(I_{h1} = 1 \text{ and } I_{h2} = 0) = \mu(I_{h1}^*, -I_{h2}^*, -\rho)$

4. Prob $(I_{h1} = 0 \text{ and } I_{h2} = 1) = \mu(-I_{h1}^*, I_{h2}^*, -\rho)$

$\mu(.)$ is the standardised bivariate normal distribution. The correlation coefficient ρ can be estimated using the maximum likelihood method.

The marginal probability Prob $(I_{h1} = 1)$ can be obtained by aggregating expressions 1) and 4). Similarly, other marginal probabilities can be obtained by aggregating the appropriate expressions.

The marginal probabilities and joint probabilities both take into account the complementarity or substitutability between capabilities or attributes.

This reasoning can be extended in a straight forward manner in the case of more than two endogenous dummy variables.

Step 3: Aggregation into a household-level index of deprivation

Let Prob $(I_{hk} = 1)$ be denoted by P_{hk} and Prob $(I_{hk} = 1 \text{ and } I_{hj} = 1)$ be denoted by P_{hkj}. Computing the household-level index of deprivation requires aggregating the marginal probabilities of deprivation as well as the joint probabilities of deprivation. In this discussion, the marginal probabilities represent the constitutive role or the intrinsic value of capabilities. The joint probabilities are added to emphasise the need for poverty indices to be sensitive to multiple deprivations.

Finally, the multidimensional poverty index can be constructed. Let MP_h denote this index for household h.

$$MP_h = \frac{\sum_{k=1}^{K} \frac{P_{hk}}{\max_h P_{hk}} . I_{hk}}{K} + \frac{\sum_{\substack{k,j=1 \\ k \neq j}}^{K} \frac{P_{hkj}}{\max_h P_{hkj}} . I_{hk} . I_{hj}}{K_{C_2}}$$

The indicator function is a measure of absolute poverty with respect to a certain dimension. It answers the question of if a particular household is poor as per the dimension under consideration. The next question to be investigated is whether all poor households are equally susceptible or vulnerable to a certain form of poverty. The weight $\frac{P_{hk}}{\max_h P_{hk}}$ provides this information.

When $I_{hk} = 0$ the term $\frac{P_{hk}}{\max_h P_{hk}} . I_{nk}$ equals zero. The value of the ratio does not matter because there is no deprivation.

When $I_{hk}(I_{hj})= 1$, the larger the value P_{hk}, the greater the susceptibility or vulnerability of a household to poverty in relation to dimension k. This implies a value for the ratio $\frac{P_{hk}}{\max_h P_{hk}}$ closer to one. The range of the values assumed by the index $\frac{P_{hk}}{\max_h P_{hk}}$ is (0,1]. In the same way, the range of the index is (0,1].

Therefore the range of the values assumed by

$$MP_h = \frac{\sum_{k=1}^{K} \frac{P_{hk}}{\max_h P_{hk}} . I_{hk}}{K} + \frac{\sum_{k,j=1, k\neq j}^{K} \frac{P_{hkj}}{\max_h P_{hkj}} . I_{hk} . I_{hj}}{K_{C_2}}$$

is [0,1]. A non-poor household has $MP_h = 0$, while a maximally deprived household, which is not only poor on all dimensions but experiences the highest level of vulnerability with respect to these dimensions, has $MP_h = 1$. The closer the index value of a household is to one, the poorer it is. This index can be interpreted as a measure of the intensity of poverty experienced by the household in question.

The headcount ratio can now be obtained by adding the number of households whose index value is greater than zero and divide this sum by the number of total households under consideration. This ratio reflects the absolute poverty in the country.

Let $\widehat{MP_h}$ denote the national average of the index and is to be computed using the following formula:

$$\widehat{MP_h} = \frac{\sum_{h\in\{h:MP_h>0\}} MP_h}{\sum_{h\in\{h:MP_h>0\}} h}$$

The above expression measures, on average, the vulnerability to poverty of poor households. Both the headcount ratio and the $\widehat{MP_h}$ can be used for comparative purposes over time and across regions.

Proofs of the newly constructed poverty index satisfying important axioms are included in the appendix.

CONCLUSION

Given the current lack of necessary data, the exercise of computing the multidimensional poverty index articulated in this paper will be undertaken as part of a future research project, with the results being compared with existing indices. Questions about different dimensions of poverty must be framed in a certain manner to compute the index. Data on these questions is unavailable. Data on the questions on electricity, clean energy, mobile and internet access

can be obtained from the National Sample Survey Office's 2011-12 Household Consumption Survey.[40]

This paper has attempted to operationalise the insights implicit in Sen's Capability Approach to develop a new multidimensional poverty index. Some of the key features of this index are: it rules out the need for a poverty line, the determination of which generally does not follow a globally accepted set of guidelines; it is sensitive to the plurality associated with the notion of poverty and the need to capture the cumulative effects of several forms of deprivation; the instrumental role of freedoms in combatting poverty has been captured in the computation of weights used in building the index; it takes into account the constitutive role of freedoms; it does away with the problem of arbitrariness in a significant way; and, quantitative and categorical variables can both be accommodated in the computation of the index.

Statistical methods have many sceptics given the possibility of manipulation of evidence in the absence of any agreed-upon singular method to arrive at the evidence in some cases. Poverty measurement is one such instance. There is a need for the academic and policymaking community to arrive at a consensus on the way to measure poverty such that poverty estimates converge and there is no conflict in the estimation exercise. This is crucial for anti-poverty measures to be unambiguous and, as far as possible, have some agreement around it. It is also important to be able to accurately compare poverty trends across time and space. There is a need to devise an index that rules out all forms of arbitrariness and utilises reasoned evaluative techniques to arrive at results, a requirement the new multidimensional poverty index proposed in this paper aims to satisfy. ORF

ENDNOTES

1 Joanna Slater, "India is no longer home to the largest number of poor people in the world. Nigeria is.," *The Washington Post*, July 11, 2018, https://www.washingtonpost.com/news/worldviews/wp/2018/07/10/india-is-no-longer-home-to-the-largest-number-of-poor-people-in-the-world-nigeria-is/

2 Planning Commission. *The Rangarajan Committee Report Of The Expert Group To Review The Methodology For Measurement Of Poverty* (June 2014), http://webcache.googleusercontent.com/search?q=cache:http://planningcommission.nic.in/reports/genrep/pov_rep0707.pdf

3 Amartya Sen, *Development as Freedom* (New York: Random House, 1999),

4 Ibid, Sabina Alkire, "The Capability Approach and Well-Being Measurement for Public Policy," *OPHI Working Paper* No. 94, March 2015; Joseph E. Stiglitz, Amartya Sen and Jean-Paul Fitoussi, *Report by the Commission on the Measurement of Economic Performance and Social Progress,* https://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+Commission+report

5 Ibid.

6 Peter Townsend, "Poverty," in *The Social Science Encyclopedia*, ed. Adam Kuper and Jessica Kuper (London: Routledge, 1996),Concepts of Poverty, https://shodhganga.inflibnet.ac.in/bitstream/10603/59660/6/06_chapter%202.pdf

7 Peter Townsend, op.cit; Peter Townsend, "Basic Needs," in *The Social Science Encyclopedia*, ed. Adam Kuper and Jessica Kuper (London: Routledge, 1996)

8 Peter Townsend, "Poverty," in *The Social Science Encyclopedia*, ed. Adam Kuper and Jessica Kuper (London: Routledge, 1996)

9 Anuradha Himatsingka, "Swachh Bharat Mission: Getting people to use toilets is next big challenge," *The Economic Times,* February 17, 2018, https://economictimes.indiatimes.com/news/politics-and-nation/swachh-bharat-mission-getting-people-to-use-toilets-is-next-big-challenge/articleshow/62955975.cms?from=mdr

10 Ibid.

11 Amartya Sen, op.cit.

12 Ibid.

13 Joseph E. Stiglitz, Amartya Sen and Jean-Paul Fitoussi, op.cit.

14 Amartya Sen, op.cit.

15 "Sen's Capability Approach," *Internet Encyclopaedia of Philosophy,* https://www.iep.utm.edu/sen-cap/#SH3c

16 Amartya Sen, op.cit.

17 Ibid.

18 Ibid.

19 Ibid.

20 Ibid.

21 Ibid., Sharmistha Chakraborty, "India Suffers Because Women Eat The Last And The Least," *Outlook Poshan*, July 10, 2019, https://poshan.outlookindia.com/story/poshan-news-the-game-changer/333941

22 Ibid.

23 Ibid.

24 François Bourguignon and Satya R. Chakravarty, "The measurement of multidimensional poverty," *Journal of Economic Inequality* **1:** 25–49, 2003; Jean-Yves Duclos and Luca Tiberti, "Multidimensional Poverty Indices: A Critical Assessment," in *The Oxford Handbook of Well-Being and Public Policy*, ed. Matthew D. Adler and Marc Fleurbaey (Oxford Handbooks online, 2016)

25 Ibid.

26 Jean-Yves Duclos and Luca Tiberti, op.cit.

27 Ibid.

28 Ibid.

29 Ibid.

30 Ibid.

31 Ibid.

32 Ibid.

33 Ibid.

34 Ibid.

35 François Bourguignon and Satya R. Chakravarty, op.cit.

36 Ibid.

37 Meghnad Desai and Anup Shah, "An Econometric Approach to the Measurement of Poverty," *Oxford Economic Papers* 40 (1988), 505-522

38 Bernard Delhausse, Axel Luttgens, and Sergio Perelman, "Comparing measures of poverty and relative deprivation," *Journal of Population Economics* (1993) 6:83-102, Springer-Verlag 1993

39 The discussion on the computation of probabilities is drawn completely from Leo J. van Wissen and Thomas F. Golob, "Simultaneous-Equation Systems Involving Binary Choice Variables," *Geographical Analysis,* Vol. 22, No. 3 (July 1990)

40 National Sample Survey Office. *Household Consumption of Various Goods and Services in India 2011-12*, (June 2014), http://mospi.nic.in/sites/default/files/publication_reports/Report_no558_rou68_30june14.pdf

APPENDIX

Axiom 1 -*Symmetry***:**

Permutations of the rows of **X** should not affect

Proof: In the case of $\widehat{MP_h}$ what form will the matrix, which is (N x K) matrix representing the distribution of K dimensions of N persons, take?

The matrix will record the responses of the survey in the digits zero and one. The elements of the matrix will be zero and one. Each row represents a household/individual. As long as the elements of each row are held constant so that the row is held constant, the computation of $\widehat{MP_h}$ takes place in a way that the permutation of the rows of **X** will not affect $\widehat{MP_h}$. Permutation of rows will affect the index at the second stage of taking an average of the individual/ household level deprivation term Mp_h. However, due to the law of commutation, the average Mp_h does not get affected by the permutation. If the columns of the matrix are permuted and the position of elements within the row are changed, then the index $\widehat{MP_h}$ will definitely get affected via the change in Mp_h .

Axiom 2- *Population size invariance:*

If the N rows of **X** are replicated and added to **X**, poverty should remain unchanged.

Proof: If the replication exercise as mentioned in axiom 2 is undertaken n times, both the numerator and the denominator of the poverty index $\widehat{MP_h}$ are multiplied by n.

We have,

$$\widehat{MP_h} = \frac{\Sigma_{h\epsilon\{h:MP_h>0\}} MPh}{\Sigma_{h\epsilon\{h:MP_h>0\}} h}$$

This implies that axiom 2 is satisfied by the poverty index $\widehat{MP_h}$.

Axiom 3- *Scale invariance*:

The poverty index $\widehat{MP_h}$ should remain invariant under scale transformations of attributes and thresholds.

Proof: This axiom is not applicable in the case of our poverty index because of the scale-free nature of variables involved in computing the index.

The monotonicity and the continuity axioms are also not applicable to the multidimensional poverty index under consideration.

Axiom 4-*Strong focus axiom*:

If **Y** is obtained from **X** by changing some non-poor attainment quantities so that the set of poor persons as well as their attribute levels below the relevant threshold remain the same, then the poverty levels $\widehat{MP_h}$ associated with **X** and **Y** must be equal.

Proof: Given the antecedent of the conditional statement in the strong focus axiom, in the case of the proposed poverty index, matrices **X** and **Y** will be equal. Hence the poverty levels $\widehat{MP_h}$ associated with **X** and **Y** will be equal, thus satisfying the strong focus axiom.

Axiom 5- *Weak focus axiom*:

The poverty index is independent of the attribute levels of the non-poor persons only.

Proof: In our conception, a person is non-poor if he is not deprived on any of the dimensions considered. In that case, the household/individual level of deprivation MP_h=0. Only when MP_h>0, is it considered in the final computation of $\widehat{MP_h}$. Hence the numerator is the sum of MP_h for all poor households and the denominator is equal to the number of all poor households. Hence, the poverty index $\widehat{MP_h}$ is independent of the attribute levels of the non-poor persons only.

Axiom 6- *Subgroup additivity:*

Total poverty should be a population-weighted average of population subgroup poverty.

Proof:

Let there be m subgroups and the associated subgroup poverty indices $\widehat{MP_{h1}}$, $\widehat{MP_{h2}}$,..... $\widehat{MP_h}_m$. Let these m subgroups be mutually exclusive and exhaustive. Let n_1, n_2, ⋯ n_m be the total number of households in the m subgroups respectively. Therefore,

$n_1 + n_2 + \cdots n_m = N$ is the total number of households. Let the $h_1 + h_2 + \cdots h_m$ be the number of poor households in the m subgroups respectively. Let $h_1 + h_2 + \cdots h_N$ is the total number of poor households. Let *i, j, …s* represent the different m subgroups.

Therefore,

$$\widehat{MP_{h1}} = \frac{\Sigma h_1 \, MP_i}{h_1},$$
$$\widehat{MP_{h2}} = \frac{\Sigma h_2 \, MP_j}{h_2},$$
$$\vdots$$
$$\widehat{MP_{hm}} = \frac{\Sigma h_m \, MP_s}{h_m}.$$

Given that the subgroups are mutually exclusive and exhaustive,

$$\sum_{h_1} MP_i + \sum_{h_2} MP_j + \cdots \sum_{h_m} MP_s = \sum_{h_N} MP_h = \sum_{h \in \{h : MP_h > 0\}} MP_h$$

From above,

$$h_1 . \widehat{MP} + h_2 . \widehat{MP_{h2}} + \ldots h_m . \widehat{MP_{hm}} = h_N . \widehat{MP_{hN}} = \sum_{h \in \{h : MP_h > 0\}} . \widehat{MP_h}$$

$$\frac{h_1 . \widehat{MP_{h1}} + h_2 . \widehat{MP_{h2}} + \ldots h_m . \widehat{MP_{hm}}}{h1 + h2 + \ldots h_m} = \frac{h_N . \widehat{MP_{hN}}}{h_N} = \frac{\Sigma_{h \in \{h : MP_h > 0\}} h . \widehat{MP_h}}{\Sigma_{\{h : MP_h > 0\}} h} = \widehat{MP_h}$$

This proves that the axiom of subgroup additivity is satisfied by the new poverty index.

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