

Fuzzy Set Approach to Measure Multidimensional Poverty

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Fuzzy

Meanings:

- not clear
- vague



Vagueness in the Measurement of Poverty

The concept of poverty can be described as being **vague and complex**.

Vagueness refers to the lack of clear-cut boundaries in concepts such as ‘poverty’.

Poverty is perceived to be vague in at least three ways:

- ✓ horizontal
- ✓ vertical
- ✓ temporal.



Vagueness in the Measurement of Poverty

Horizontal Vagueness

One or more relevant indicators of poverty need to be identified and selected to judge about who is to be considered poor.

This is the most controversial part of poverty measurement because any selection remains somewhat arbitrary; vagueness exists independent of whether a single or many poverty dimensions are selected.

Qizilbash (2003, 2006) refers to this kind of vagueness as ‘**horizontal vagueness**’

Fuzzy set theory and fuzzy set theoretic poverty approaches in general do not address the problem of horizontal vagueness.



Vagueness in the Measurement of Poverty

Vertical vagueness

It refers to the assumption that no clear or sharp threshold exists that allows differentiating between the poor and non-poor and since cases can exist which neither classify as being either poor or non-poor (Bantilan et al., 1992; Qizilbash, 2003, 2006).



Vagueness in the Measurement of Poverty

Temporal vagueness

Poverty concepts also contain ‘temporal vagueness’. In their chronic poverty framework Clark and Hulme (2010) introduce the time dimension to poverty by arguing that apart from the multidimensionality (breadth/horizontal vagueness) and severity (depth/vertical vagueness) the duration people live in poverty need to be taken into account.

This adds another dimension of vagueness in the sense that whether a persons is either only poor or non-poor over time or poor and non-poor in a given time period (see also Qizilbash, 2006).



The Fuzzy Approach is useful because:

- Indicators are qualitative or may be categorical
- No arbitrary weight is required for the indicators
- It avoids the specification of the critical threshold
- The DOD of each individual on a given indicators depends on its place in the distribution of the attribute.
- It measures the degree of deprivation of a particular indicators, over all deprivation, and MPI
- It also helpful to decompose MPI and find out the contribution of particular attribute/group



The fuzzy set approach

In fact, the fuzzy approach of multidimensional poverty is based on the theory of fuzzy subsets for the construction of an index including the different dimensions (attributes) of poverty.

In this approach, the poverty of a person is identified by its *degree of belonging* to the fuzzy sets, and this respectively to each of the attributes of poverty.



The fuzzy set approach

Assume $i \in [1, n]$ respondent, $j \in [1, M]$ indicators of relating with food security.

Consider $X_j = \{ X_{j/j=1,2,3,\dots,M} \}$ vectors of indicators respectively of food insecurity. The variable X_j^i is the values taken by indicators j for the i -th respondent.

For the formulation of Membership Function in respect of degree of effective achievement for each indicator, let us assume that μ_j^i provides the degrees of effective achievement of the i -th respondent relative to the indicator j .



The fuzzy set approach

When ranking values of j by increasing order (i.e., higher the value of a given indicator, higher is the degree of effective achievement), function μ_j^i is defined as follows:

$$\mu_j^{(i)} = \begin{cases} 1 & \text{If, } X_j^{\max} \leq X_j^i \\ X_j^i - X_j^{\min} / X_j^{\max} - X_j^{\min} & \text{If, } X_j^{\min} \leq X_j^i \leq X_j^{\max} \\ 0 & \text{If, } X_j^i \leq X_j^{\min} \end{cases}$$

Where, X_j^{\min} and X_j^{\max} are the lower and upper bound of the system.



The fuzzy set approach

- It is to be noted that the functions are increasingly linearly between zero and one according to the degree of effective achievement.
- If it is closer to one, it is an indication of high degree of achievements and if it is closer to zero, it is an indication of low degree of achievement.
- The lower degree of achievement means higher level of multidimensional poverty. In order to obtain the composite index of multidimensional poverty for each respondent, different degrees of effective achievement obtained for each respondent and indicator need to be summarized.



The fuzzy set approach

Following Cerioli and Zani (1990), composite index is defined by taking the weighted arithmetic mean of the membership functions, obtained from the respective indicators. Mathematically, it is represented as:



The fuzzy set approach

$$\mu_{fs}(i) = \sum_{j=1}^M w_j \mu_j(i) \dots\dots\dots (2)$$

Where w_j is the weight attributed to the respective indicators (j).

Where weight must be positive and its' sum must be equal to one. That is

$$w_j \geq 0 \text{ and } \sum_{j=1}^M w_j = 1 \dots\dots\dots (3)$$

The weights of each indicator are calculated by the following way;

$$w_j = \log(1/\bar{\mu}_j) / \sum_{j=1}^M \log(1/\bar{\mu}_j) \dots\dots\dots (4)$$

$$\text{Where, } \bar{\mu}_j = 1/N \sum_{i=1}^N \mu_j(i) \dots\dots\dots (5)$$



The fuzzy set approach

- The *weight is inverse functions* of the mean effective achievement level relative to the indicator j .
- Since Poverty does not vary in a linear way, the logarithmic curve function has been used into the weighting system. In this way a more important weight has been given to the indicators those are more widespread among the respondents.
- The value of MPI lies between zero and one. Where one indicates high level of Multidimensional, zero indicates low level of Poverty.



Thanks

