

# Statistical Analysis of Poverty in Oyo-State: A $Q^2$ -Approach

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## Abstract

*The limited scope of uni-dimensional money-metric approach of analyzing poverty based on either expenditure or income has made approaches that allow poverty to be studied at several dimensions a necessity. It is in the light of this, that this study was aimed at analyzing poverty in Oyo State using a  $Q^2$ -approach. This approach combined both quantitative and qualitative aspects of poverty. The quantitative aspect was based on the per capita expenditure head count index while the qualitative aspect was based on fuzzy set poverty index derived from the following pre- selected indicators: major source of water for drinking and cooking, type of fuel used for cooking, toilet facilities, electricity supply and information and communication technology (ICT). Estimates of both quantitative and qualitative poverty indices were obtained from the National Survey of households' data having a total of 508 households. The per capita head count and fuzzy set poverty indices showed that 196 and 316 households were respectively poor. These estimates implied that approximately 39% and 62% percent of households were poor. The qualitative estimate further indicated that more than 50% of the households lacked access to the pre-selected deprivation indicators with lack of access to quality water ranking highest. The  $Q^2$  Approach has therefore provided better insight into the nature of poverty in Oyo State. It has also identified provision of quality water as being paramount to any government-designed poverty intervention policy.*

**Keywords:** Money-metric approach, Poverty,  $Q^2$ -approach, Multi-dimensional approach, Head count index, Fuzzy set poverty index

## 1.0 Introduction

Poverty is a worldwide phenomenon which impacts continents, nations and individuals differently. It afflicts individuals in various depths and levels, at varied times and stages of existence. There is no country that is completely without it [1: p.148]. Poverty might suggest a condition of deficiency as stated by [2: p3] as "lacking an adequate amount of food to consume, a very high level of infant mortality, a reduced lifespan, reduced educational choices, unhealthy water, inadequate medical care, unwholesome accommodation and a decreased effective

involvement in the making of definite decisions"

Central Bank of Nigeria (1999) as cited in [1: p148-149 and 3: p.34] considered poverty as a "state where a person struggles to provide satisfactorily for his or her essential requirements of food, clothing and shelter; is not able to fulfil societal and financial commitments; and consequently, has minimal opportunity to utilize his or her capabilities". There is no common consensus on the meaning of poverty. This may not be unconnected to its multidimensional nature [4-5].

Based on its multi-dimensional meaning, poverty generally is perceived using different factors.

[6] argued that while the general wellbeing of people in a given society is critical to their existence, the monetary definition of poverty significantly limits their opportunities and choices. The general approach of explaining the incidence and factors that cause poverty can be divided into quantitative and qualitative methods. These two approaches are termed as the Q<sup>2</sup> method in this present study. In line with the argument by [6], a multidimensional (Q<sup>2</sup>) method will be used in this study to analyze the incidence of poverty in Oyo-State with the objective of determining the major causes of poverty in the state. This should guide policy interventions on poverty by government. This line of thought is supported by [7]. They noted that understanding of poverty can be significantly enriched by integrating both qualitative and quantitative information.

## 2.0 Methodology

The qualitative approach begins with the selection of non quantitative indicators of poverty. For the present study, the selected indicators are major source of water for drinking and cooking; type of fuel used for cooking; toilet facilities; electricity supply; and information and communication technology (ICT-radio, television, telephone (mobile), personal computer and internet service). The analytical framework for this approach is based on Fuzzy Set Principle as introduced by [8]. Using this type of method, it is unnecessary to define an arbitrary poverty line as is the case under the quantitative money-metric approach. The rest of this section is drawn primarily from [4] and [9].

### 2.0.1 The Concept of Fuzzy Set

“Fuzzy sets” as noted by [9] may be thought of “as extensions of traditional set theory.

Suppose we have a set Y of elements  $y \in$

any fuzzy subset B of Y is:

$$B = \{y, f_B(y)\}$$

where

$f_B(y): Y \rightarrow [0,1]$  is termed the “membership function” of the fuzzy set B [9]. This function indicates how y belongs to B.

Thus,

$$f_B(x) = \begin{cases} 0 & \text{if } y \notin B \\ 1 & \text{if } y \in B \end{cases}$$

where  $0 < f_B(y) < 1$ ,

It follows then that y partly belongs to B and the membership of B is directly proportional to the ratio of the distance of  $f_B(y)$  to 1 [9-10]. The “degree of membership” according to [9] and [11] of fuzzy set B is considered as:

$$\mu_B(Y_j(a_i)) = Y_{ij}; 0 \leq Y_{ij} \leq 1 \quad (1)$$

The implication of the above definition is that:

$Y_{ij} = 1$  for any household where an attribute is lacking,

$Y_{ij} = 0$  for any household where an attribute is available, and

$0 \leq Y_{ij} \leq 1$  for any household possessing an attribute relatively within the interval (0, 1).

### 2.0.2 Elements of Fuzzy Set Approach

#### 2.0.2a Notion of Membership Functions

There are a number of definitions for the membership function in existence. [11] provided the initial definition. They said that “there ought to be a minimum significant level below which a household must be considered extremely poor and a

maximum critical level above which a household should not be thought of as being extremely poor. If the deficiency of a household falls between these ranges, the membership function is a linear function comprising the two significant levels''. This has been subsequently modified by [10] by them deriving explicitly deficiency indices of the distribution function of the measured attributes. They termed this method the 'Totally Fuzzy and Relative (TFR)' method.

The modalities associated with the choice of method for the determination of the membership function is determined by the recognition and indication of the range of variables which could be assigned this type of indicator and the type of variable. The variables could be categorical or dichotomous, which might take on discrete or continuous values. Costa (2002) as cited in [12] considered the "degree of membership" to the fuzzy set P as shown in equation (2)

$$y_{ij} = \mu_p(y_j(a_i)) \quad (2)$$

According to [8] as cited in [13] "given a population A of n households,  $A = \{a_1, a_2, \dots, a_n\}$ ,  $\mu_p$  means membership of the subset of poor households P which includes any household  $a_i$  having some degree of poverty". Thus  $y_{ij} = 1$  for any given household that does not possess an attribute and  $y_{ij} = 0$  if the attribute under consideration is present in the household. Hence the deprivation index of the  $a_i^{th}$  household  $\mu_p(a_i^{th})$  can be defined as the weighted average of  $y_{ij}$  as in equation (2):

$$\mu_p(a_i) = \frac{\sum_{j=1}^m y_{ij} w_j}{\sum_{j=1}^m w_j}, (i = 1, 2, 3, \dots, n) \quad (3)$$

where  $w_j$  is the weight attached to the  $j^{th}$  attribute, which stands for the intensity of deprivation of attribute  $Y_j$ .

However there are certainly situations where it is unclear whether or not a given household is poor or not. This is especially true when one uses a multidimensional method to measure poverty, since according to certain criteria one might clearly define the given household as being poor, while, based on various other factors, one should not regard such a household as being poor.

### 2.0.2b Weights of attributes

The significance of an indicator in the determination of the level of poverty is highly dependent on its dominance in finding the standard of living of a given community. This means that the "weight  $w_j$  has an indirect association with the level of deprivation" [9]. To reduce the subjectivity that comes with the estimation of the weights, [9] recommended a logarithmic function, which was defined as:

$$w_j = -\ln \left\{ \left( \frac{1}{n} \right) \sum_{j=1}^k \mu(Y_{ij}) \right\} \quad (4)$$

where

$\frac{1}{n} \sum_{j=1}^k \mu(Y_{ij})$  represents the ratio of the poor obtained via the fuzzy method.

### 2.0.2c Aggregate Poverty Index

Ceroli and Zani (1990) as cited in [9] noted that "aggregate index of poverty can be obtained for the population under consideration by finding the average of the individual poverty ratios" by using equation (5)

$$P = \frac{1}{n} \sum_{i=1}^k \mu_p(a_i) \quad (5)$$

The quantitative poverty measurement begins with the determination of the poverty line (poverty line =  $z = (2/3) * \text{mean per capita household expenditure}$ ). This is the expenditure level that separates the poor from the rest of the population. Once the poverty line has been set, the three dimensions of poverty, namely incidence, depth and severity of

poverty may be calculated using the Foster Greer Thorbecke (FGT) index defined as

$$\frac{1}{N} \sum_1^N \left( \frac{z-y}{z} \right)^\alpha I(y \leq z) \quad (6)$$

(6) becomes the head count index, poverty gap index and square poverty gap index when  $\alpha = 0, 1$  and  $2$  respectively. Each of these indices measures a particular dimension of poverty.  $Z$  in (5) is the poverty line;  $y$  is per capita household expenditure and  $\alpha$  is the aversion of the index to poverty. The quantitative approach is easier to follow but has been criticised for being restrictive. That is, it is one-dimensional focusing only on income or expenditure as selected proxy for poverty.

### 3.0 Numerical Illustration and Discussion of Results

The 2004 National Living Standard Survey (NLSS) dataset [14] will be used for validating the methods presented in this paper. The detailed description of the data has been presented in [5] where the data were used to validate estimators derived for Foster Greer Thorbecke (FGT) poverty indices from first principles. The intention here however is to validate the  $Q^2$  approach to poverty analysis based on a total of 508 households in Oyo State with detailed information. These were eventually selected from the gross total of 19,518 households considered in the survey.

The membership function for the households in Oyo State was obtained by following the approach adopted in [9]. Table 4.1 shows that the level of deprivation of households in Oyo State for the nine attributes chosen as indicators of poverty in the state. Lack of personal computer had the highest membership score of 94% while lack of toilet had the lowest score of 88.98%.

**Table 4.1: Membership function for the attributes**

Attributes	Membership Function
Lack of electricity for cooking( $\alpha_1$ )	0.9213
Lack of toilet( $\alpha_2$ )	0.8898
Lack of tap water( $\alpha_3$ )	0.9882
Lack of electricity for lighting( $\alpha_4$ )	0.9331
Lack of radio( $\alpha_5$ )	0.8910
Lack of television( $\alpha_6$ )	0.9035
Lack of telephone( $\alpha_7$ )	0.9173
Lack of personal computer( $\alpha_8$ )	0.9429
Lack of internet service( $\alpha_9$ )	0.9094

The weights for each indicator using (4) are shown in Table 4.2. Lack of toilet had the highest value of 0.1168 while lack of tap water had the lowest value of 0.0119.

**Table 4.2: Weights for the Selected Indicators (Attributes)**

Attribute	Weight
Lack of electricity for cooking	0.0820
Lack of toilet	0.1168
Lack of tap water	0.0119
Lack of electricity for lighting	0.06927
Lack of radio	0.1058
Lack of television	0.1014
Lack of telephone	0.0863
Lack of personal computer	0.0588
Lack of internet service	0.0949

The multidimensional (qualitative) poverty ratio (head count index) of the population was obtained as 0.6226 (Table 4.3) while the quantitative head count index was obtained as 0.3858 (Table 4.3).

The higher value of the multidimensional head count index implies that a larger proportion of the households in Oyo State do not have the benefits of accessing essential amenities.

**Table 4.3: Head Count Index**

Qualitative Head Count Index	Quantitative Head Count Index
0.6226	0.3858

#### 4.0 Conclusion

This study has shown once again that poverty is not just the result of insufficient

expenditure as traditionally believed. Rather, it is the result of a combination of social, economic and political factors. The fuzzy set identified lack of access to good water as the leading deprivation indicator for the existence of poverty and equally gave a higher value for the head count index. This implies that more than 50% of the households in Oyo State do not have access to basic services. Therefore in designing poverty interventions, the government of Oyo State should pay more attention to provision of quality water

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## APPENDIX

### Appendix 1: Attributes Selected for Qualitative Poverty Measurement

Attributes	Categories
Type of fuel for cooking	Electricity, gas, kerosene, wood, and coal.
Toilet Facilities	Toilet on water, flush to sewer, flush to septic tank, pail or bucket, covered pit latrine, uncovered pit latrine and V.I.P latrine.
Electricity supply	PHCN (NEPA) only, rural electrification, private gen alone, PHCN (NEPA)/generator and rural electrification/generator.
Major source of water for drinking and cooking	Pipe borne water treated, pipe borne water untreated, borehole/hand pump, well/spring protected, well/spring unprotected, rain water, streams/pond/river and tanker/truck/vendor
Radio	Own, access and None
Television	Own, access and None
Telephone Mobile	Own, access and None
Personal Computer	Own, access and None
Internet Service	Own, access and None