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THE ANALYSIS OF POVERTY DYNAMICS IN ALGERIA : A MULTIDIMENSIONNAL APPROACH

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Abstract

The study of poverty is often oversimplified and, its manifestation, perceived as dichotomous. This conventional analysis is merely based upon the splitting of the population into two groups: poor and non-poor according to some hypothetical poverty line. This is called the one-dimensional approach of poverty. In addition there is no consensus regarding the poverty threshold, as Cerioli and Zani (1990) point out that a strict division of the population into poor and non-poor is unrealistic. To avoid this shortcoming, recent studies are increasingly using multidimensional analysis which will constitutes the first objective of this study that is concerned primarily with the application of this new methodology to the west part of Algeria with the emphasizing of two types of approaches: The Logit-Probit and the fuzzy set. The second objective is to comprehend the phenomenon of poverty within a systemic and dynamic approach. Our results show that the fuzzy set approach is more pertinent than the others in capturing different graded attributes of poverty. Therefore, the study reveals that income is not the sole indicator of well-being and should be supplemented by other attributes, mainly, housing, level of comfort and social capital. Moreover, the main finding highlights that rural areas are the most hit by deprivation and poverty. This analysis serves as a basis for a better targeting as far as policy options for poverty reduction are concerned.

Keywords : Poverty measurement- Logit Probit- Fuzzy sets - Multidimensional approach -Attributes- Algeria

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1 Introduction: Theoretical framework

The capability approach developed by Sen in his seminal work (1985, 1987) has considerably contributed to furthering our understanding of the standard model by incorporating in human welfare, quality of life, development and poverty.

Sen (1981) has already highlighted the inexactitude and vagueness of concepts such as poverty and well-being. Many attempts have been made to deal with these shortcomings. We shall summarize them through a general five-framework approach that comprises the traditional unidimensional, the non-axiomatic aggregate welfare, the multidimensional approach based on data aggregation, the multi-dimensional axiomatic and the fuzzy set approach to poverty.

a) *The traditional unidimensional approach* is called the monetary approach to poverty. This approach based on the revenue suffers from many drawbacks that are well documented.

In fact, the adoption of such approach has been subject to severe criticism by many authors; among them, townsend (1979), Ravaillon (1996), Tsui (2002), Asselin (2002), Mozaffar & Clark (2005).

b) *The non-axiomatic aggregate welfare* is based on empirical dimensions that capture the welfare indicators that are first aggregated at the individual level, then, second, across individuals, Bibi (2005).

This methodology pursued by Adams and Page (2001) for instance, considers the aggregation of monetary and non-monetary indicators of poverty such as education, life expectancy and health. Sen's capability approach (1980, 1981) offers a theoretical basis for poverty analysis, putting emphasis on three fundamental concepts: commodity, functioning and capability. Poverty is thus defined as a default of capabilities to transform commodities into functionings Many indicators based on Sen's composite poverty index, Arnaud and Sen (1997), such as the HDI, the HPI_1(for developing countries), the HPI_2 (for developed countries) and the GDI (Gender-related Development Index) take into consideration specific welfare indicators.. This broader concept of well-being is incorporated into the construction of several human development indices.

The Sen's composite poverty index is as follows:

$$HPI = (w_1 HPI_1^{\theta} + w_2 HPI_2^{\theta} + w_3 HPI_3^{\theta})$$

$$w_1 + w_2 + w_3 = 1 \text{ and } \theta \geqslant 1$$

This Index suffers, however, from arbitrariness as far as the characterization of W_i and is concerned. This approach has been adopted by Tsui (2002), Bourguignon & Chakravarty (1998, 2002), Asselin (2002) etc..

c) *The multidimensional approach based on data aggregation*

As one dimension cannot on its own capture all facets of poverty, many researchers (Bourguignon & Chakravarty (1998, 2002a and b, 2003) argue in favour of a multidimensional approach, as a consensus on how to construct an appropriate poverty measure is extremely hard if not impossible to be found (Bibi 2005). This approach assumes that the individual different dimensions can be aggregated into a single welfare index. Following this reasoning (Smeeding and Saunders 1993), individuals are classified as poor if their welfare index is below an estimated poverty line that embraces the different facets of poverty. There are several types of models. Among them, Klassen (2000) additive model, and Pradhan

& Ravaillon (2000) subjective probit model. We shall present in the second section the application of a logit-probit model to a region of Algeria (Benhabib et *al* 2006).

d) *The multidimensional axiomatic approach*

The concept of poverty is subject to heated debates on the perception of the level of objectivity and/or subjectivity assigned to its quantification. Its complexity and multidimensionality can better be grasped through a normative view built on a axiomatic approach. Bibi (2005) has dwelt on the presentation of the principal axioms and the measures they yield.

Beginning from a general equation :

$P(x, z) = F[\pi(x_i, z)]$

Where is the degree of aggregation at the individual level; F & π are based on some axioms that stipulate how poverty indicators can be assessed.

Bibi (2005) enumerated the following axioms: continuity, symmetry, population principle, scale invariance, focus, monotonicity, subgroup consistency, subgroup decomposability, transfer, non-decreasing poverty and non-increasing poverty.

The conclusion is that although specific data on poverty is becoming more available, there still remain some obstacles so as to measure poverty adequately (eg, aggregation, continuity and compensation).

e) *The fuzzy set approach to poverty*

This multidimensional approach based on the fuzzy set was initiated by Zadeh in 1965 and introduced by Cerioli and Zani (1990) then extended by Cheli and Lemi (1994), Dagum et *al* (1991), Dagum (2002). This theory stipulates that there is no clear cut between the poor and the non-poor due to fuzziness and vagueness on both the aggregate boundaries and within each indicator. So an individual considered poor is identified according to its degree of membership to fuzzy sub-sets with regard to each poverty attribute, Costa (2003). Poverty should be regarded as a matter of grades and intensity rather than a dichotomous attribute that considers only two extremes, i-e the existence or lack of an attribute, Betti et al (2005).

- The main aim of this paper is threefold :

Firstly, we shall apply the fuzzy set approach to Algeria and more specifically to the region of Tlemcen in order to assess the degrees of deprivation and the aggregate number of individuals deemed poor.

Secondly, we will try to know how this approach compares with the Logit-probit analysis. And finally, insights for policy implications will be provided as far as poverty reduction is concerned .

Thus, this paper is organised as follows :

The second section present the results of a multidimensional analysis based on a Logit-Probit model, then in the third section, an application of the fuzzy set theory is made on a reduced four step methodological programme that was first applied by Dagum (2002) on the basis of nine steps. As we consider that the first and the last steps are inevitable in any approach, we shall concentrate on the core steps inherent to fuzzy set analysis. We shall conclude this paper with some policy recommendations.

2 A Multidimensional Analysis based on a Logit-Probit Model

In this approach we present a probability analysis in which different characteristics of households are retained in a regression form (Equation (1)). These characteristics include the composition of the household, the residence, education status of the head of the household, the health status, etc.

$$y_i = x_i\beta + u_i \tag{1}$$

Where:

y_i: denotes the dichotomic qualitative variable

x_i: denotes the characteristics vector of household i as binary variable (0 or 1).

β: denotes parameters vector

u_i: denotes the residuals (errors)

The binary variable (poor or non-poor) expression is defined as follows:

$$\begin{array}{l} 0 \text{ si } y_i \geqslant z \\ 1 \text{ si } y_i \leqslant z \end{array} \tag{2}$$

The model described above is a subjacent model, then the probability decision rule becomes then:

$$\begin{array}{l} prob(\ y_i = 0) = prob(x_i\beta + u_i \succ Z) = 1 - prob(u_i \succ Z - x_i\beta) \\ prob(\ y_i = 1) = prob(x_i\beta + u_i \leqslant Z) = 1 - prob(u_i \leqslant Z - x_i\beta) \end{array} \tag{3}$$

For the purpose of this study we use total spending to classify households into poor and non-poor .To estimate the probability and the model parameters, the statistical distribution for u_i must be specified, and the two statistical laws usually used are: the Logistic law and the Gauss law

(normal distribution); these two distributions give then a binary qualitative model known as Logit and Probit.

Let F(.) be the distribution function stemming from the statistic distribution of the error term ui , the model becomes than:

$$\begin{array}{c} prob(\ y_i = 0) = prob(u_i \succ x_i\beta) = 1 - F(-x_i\beta) \\ prob(\ y_i = 1) = prob(u_i \leqslant -x_i\beta) = F(-x_i\beta) \end{array} \tag{4}$$

2.0.1 The Probit Model

The specifications of this model are conceived to analyse quantitative data reflecting a choice between two alternative solutions being poor or non-poor. The model measures the relation between the characteristics of the household, and their level of poverty. The specifications help to define a probability to monitor poverty among households. We assume that the error u_i is a normal law variable with mean 0 and variance σ^2

The density and the distribution functions related to a normal variable $N(0,1)$ are respectively:

$$\phi(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2} \text{ and } \phi(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} e^{-t^2/2dt} \tag{5}$$

To use these two expressions including ui with variance σ^2 , we should reduce the probability: $y_i = 1$ by dividing them into their per standard deviations

$$prob(\ y_i = 1) = prob(u_i \succ -x_i\beta) = prob(u_i \prec x_i\beta) = prob(\frac{u_i}{\delta} \prec \frac{-x_i\beta}{\delta}) = \phi(\frac{-x_i\beta}{\delta}) \tag{6}$$

To estimate the parameters of the Probit model , we should maximise the maximum likelihood parameters then assuming that observations are independent and similarly distributed, the likelihood of the model can be expressed as the probabilities related to the outcome of y_i

L and N_1 and N_0 be the sum of the observations in which $(y_i = 1)$ and $(y_i = 0)$, then

$$L(y, x, \beta) = \Pi_{N_1}[\phi(x_i\beta)]\Pi_{N0N_1}[1 - \phi(x_i\beta)] \tag{7}$$

and assuming all the number of observations, we have:

$$L(y, x, \beta) = \Pi_{i=1}^{N}[\phi(x_i\beta)]^{y_i}[1 - \phi(x_i\beta)]^{1-y_i} \tag{8}$$

2.0.2 The Logit model

In the Logit regression model, the anticipated values of the dependent variable should never be equal or less than zero and conversely equal or more than one, whatever the values of the independent variables.

This characteristics can be denoted as:

$$\lambda(x_i\beta) = \frac{\exp(x_i\beta)}{1 + (x_i\beta)} \tag{9}$$

These expressions can be more easily computed than the normal law function

Thus:

$$1 - \lambda(x_i\beta) = \lambda(-x_i\beta) = \frac{\exp(-x_i\beta)}{1 + \exp(x_i\beta)} = \frac{1}{1 + \exp(x_i\beta)} \tag{10}$$

we note that the probability related to the logistical law can be inverted

If we assume P_i the probability that $y_i = 1$, then we have the following expression:

$$log(\frac{P_i}{1-P_i}) = (x_i\beta) \tag{11}$$

The estimation is given by:

$$L(y,x,\beta) = \Pi_{i=1}^{N}[\frac{1}{1+\exp(x_i\beta)}]^{1-y_i}[\frac{\exp(-x_i\beta)}{1+\exp(x_i\beta)}]^{y_i} \tag{12}$$

then

$$logL = \sum_{i=1}^{N}\left[(1-y_i)\log[(1+\exp(x_i\beta))^{-1}\right] + y_i(x_i\beta) - y_iLog(1+\exp(x_i\beta) \tag{13}$$

2.0.3 Testing the model

The maximization of the likelihood function requires the estimating of χ^2 with $\chi^2 = 2\left[Log(L_0) - Log(L_1)\right]$

If the level p associated to χ^2 is significant, than the model offers better adjustment than the nul model and that the regression parameters are statistically significant

2.1 The study of the region of Tlemcen

2.1.1 Sample characteristics

The sample consists of 500 households living in the wilaya of Tlemcen. A stratified survey is used to measure poverty in both urban and rural areas. As for the choice of the households, a simple random sampling method for each stratum is applied.

In a stratified survey, the mean $\bar{X}$ of the population is given:

$$\bar{X} = \sum_{h=1}^{k}\frac{N_h}{N}X_h \tag{14}$$

Where:

$\bar{X}$: estimated mean of the population

N_h: number of the hth stratum

N: number of the population

h: number of strata $1 \ldots\ldots, ..k$

The wilaya of Tlemcen consists of 53 communes ;10 communes are situated in urban areas, and 43 in rural areas. The number of households in the two strata is estimated at 159105 in 2002 .

<Insert Table 1> (see appendix (1))

The choice of the representative sample of 500 households covering the whole wilaya of Tlemcen was made sequentially as follows:

1- The first step concerns the choice of the stratum area (urban and rural) 98252 in urban area corresponding to a sample of 309 , and in rural area 60853 out of 159105 giving 191 rural households.

The sample is distributed proportionally to the total number of households in each stratum .

N_1 =(98252/159105).500=308.76309 households

N_2 =(60853/159105).500=191.23191 households

2- The second step consists of sorting out the households and the related communes with random sampling method. At this stage, we sorted out the commune number out of 10 for urban and out of 43 for rural areas, and the corresponding number of households within each stratum. The results are as follows:

309 households in the urban stratum were sorted out from 9 communes out of 10, and the like for rural area (19 from 43).

3- The third step is to compute the number of households according to the weight of each commune. The results are presented in

<Insert Table 2>

2.2 Description of Variables and Comments of Results

2.2.1 Description of variables

The independent variables used in the model are classified into two categories: the first category includes the characteristics of the household while the second presents the characteristics of the household head

<Insert Table 3, Table 4 and Table 5>

For the interpretation of the results, the following codes are used :

- **POV 0** : Household non- poor.
- **POV 1** : Household poor.
- **ZONE 1** : Urban area.
- **ZONE 2** : Rural area.

2.2.2 Results

The results of the survey are described below (Maliki S.B, 2002): Households are classified using the upper poverty line. Our study find that 23.8% in the sample are deemed poor (119 households).

1 – *Revenue Source*

The upper poverty line is estimated at 18191 DA per capita per year while the lower poverty line is estimated at 14827 DA on the basis of O.N.S (Office National des Statistiques).From the survey field, it appears that half of those surveyed are wage earners, salary earners, or working on a day basis. This can be partly explained by the loss of purchasing power and the precarity of the available jobs.

We also note also that 10.12% of the respondents get revenues out of the eleven categories mentioned in the table and this should give us an indication of the extent of the informal /parallel/underground sector in which they are engaged. The 12th type named "others" which includes street sellers, petty domestic services, porters and others informal activities, seems to be in better situation than other types as far as revenue generation is concerned . We may infer that this is an unexpected outcome in that it contributes more than other types to alleviating poverty.

2 – *Savings*

The results show that monetary income is a determinant factor in our classification, and only 36.89 % of the respondents are able to save.

3- *Days in Difficulty*

Most of the households (74.37 %) have more than 10 difficulty days ' in a month, and it should be noted that some of the non-poor have also the same difficulty ; those in urban area experience more difficulties than those in rural areas (176 households in 295, that is 59.66 %) .

4- *Contribution to Income for Household Member*

The study reveals that the contribution of the father amounts to 63.4 % . However , the share of other members augmented gradually, since 26.4 % of the households benefited from the collective contribution , which is largely due to the decreasing purchasing power of their income.

5- *Gender of the household head*

Our study found that in 16.8 % of the households headed by a female , 31.7% are deemed poor ; that means that in ten households in which the head is a female, three are poor. 5.5 % of the total sample are poor female, i-e one out of three is poor, while 83.2% of households heads are male representing 18.6% of the household sample, that is one out of five is poor. This means that the poverty situation is more acute for women.

6- *Education Level of the household head*

Our investigation shows the importance of education in the study of poverty since 65.5 % of the poor households are headed by individuals who have not passed the primary level of education. In the sample , 25.6 % of the households heads have no education; half of them are in rural areas . Paradoxically, the study shows that some heads have followed university education (8 households in 500 households) . This point to the evidence that nationally 4% of university degree holders are unemployed.

7- *Type of Housing*

12 % of the surveyed households live in precarious dwellings while 43.2 % live in individual houses or villas as bivariate histogramme indicates. 30.25% of poor households live in precarious dwelling (36 households of 119), and 31 % live in landlord houses. The proportion of the poor households living in precarious urban dwelling is nearly the same of that living in rural areas (3.8 % and 3.4 %) .Thus the type of housing cannot in its own inform on poverty level. So whatever the type of housing and whatever the area (urban or rural), we cannot know precisely the status of the household.

8- *Food Budget*

Whatever the household status: poor or not-poor, the results show paradoxically that the majority of the households spend less than 30% of their budgets on red, white meat, and fish. This means that

the income is not the main factor in determining protein intake within the household, even though Algerians are basically cereal consumers.

9- *Results of the Model*

The model is very significant at a global level since the probability related to the test of χ^2 is extremely low in both urban and rural areas. The odds ratio gives us the indication of the probability of the household becoming poor (see table 6 in appendix 1).

In this case, the odds ratio that are less than one imply that the values of independent variables are associated with the fall in the probability of the household becoming poor. Generaly, the values of the odds ratio that are more than one imply that the variable increases the probability; The results obtained show some similarity between the two models. The estimated signs of the coefficient point to the following:

- In both urban and rural areas, the probability of becoming (being) poor increases with the number of persons within the household.

- In rural area, schooling of children increases poverty.

- Living in precarious dwelling increases poverty in rural area.

- In urban area the poor lives in different types of housing.

- A household, living in rural area is more likely to be poor even though it has piped water.

- In rural area , a household headed by a female has a strong probability of becoming poor than a household headed by a male (0.944 against 0.246) .

- The sample reveals that households whose heads work in industry, agriculture, craftmanship in rural area have strong probabilities of becoming poor. The households whose heads work in craftsmanship in urban area have low probabilities of becoming poor.

- A secondary and higher education level of the household head in rural area decreases the probability of falling into poverty. Whereas in urban areas, the education level of the household head does not necessarily help to distinguish between the poor and the non-poor.

- As far as health is concerned, the health status of the household head is not a determinant factor in classifying the poor and the non poor.

- As far as social links are concerned, (within families and between families), the logistic regression shows that these links do not necessarily decrease the probability of falling into poverty ; however these links are not always a basis for solidarity and cooperation. In urban area, contacts with families and friends are very helpful in lowering the probability of being poor.

This approach has provided us with very interesting results that need to be strengthened, and to that end we shall apply the fuzzy set analysis

3 The Fuzzy set Approach

This section draws on work done by Dagum and Costa (2004) and the paper of Mussard and Pi Alperin (2005) in which they briefly introduce one-dimensional indices for measuring deprivation in each attribute for the entire surveyed population. Furthermore, this decomposition allows assessing each attribute contribution as far as the aggregate poverty level is concerned.

To apply this method we must specify:

(1) The economic units,D a household subset belonging to an economic space A (region or country): $A = (a_1 + a_i....a_n)$ and

(2) Each $a_i \in D$ presents a degree of deprivation in at least one of k socio-economic attributes included in X:

$X = (X_1, ...X_j, ...X_k)$ $\qquad\qquad$ $j = 1, ...k$

Let xij denote the membership degreeμD of the i-th household ($i = 1, \ldots n$) with respect to j-th attribute to the sub-set D :

$x_{ij} = \mu_D(X_j(a))$

Where: $0 \preceq x \preceq 1$ Especially:

$x_{ij} = 0$, if the $i-$ th houshold possesses the j th attribute;

$x_{ij} = 1$, if the $i-$ th houshold does not possesses the j th attribute;

$0 \prec x_{ij} \prec 1$, if the $i-$ th houshold possesses the j th attribute with an intensity comprised between (0.1)

We can obtain various types of fuzzy sets according to the type of membership function. Based on the classification made by Zadeh (1965) a number of types can be chosen (the triangular, L function, Gamma function, trapezoid [1]etc...). The aim of fuzzy analysis is to express the notions of increase, decrease and approximation. Each notion requires a specific type. In our case, that of approximation, the appropriate type is the extended trapezoid type . This type offers many advantages such as simplicity, usefulness, and « *allows greater expressiveness through increased complexity* » (Galindo, Urrutia and Piattini, 2005)

Cerioli et Zani (1990) define the degree of membership of the i-th household to the fuzzy sub-set D as a weighted arithmetic mean of x_{ij}

$$\mu D(a_i) = \frac{\sum_{j=1}^{k} xijwj}{\sum_{j=1}^{k} wj} \tag{15}$$

(15)

This equation measure the poverty index of the i-th household, where$w_j$represents the weight attributed to the j-th attribute. Accordingly, one can note that:

Where: $0 \leq \mu D(a_i) \leq 1$

$\mu D(a_i) = 0$, if the a_i possesses all k attribute;

$\mu D(a_i) = 1$, if the a_i does not possesses any k attributes;

$0 \prec \mu D(a_i) \prec 1$, if the a_i partially or totally deprived of some attributes but not fully deprived of all of them.

Now, the main concern is how to choose the appropriate method to determine the weights w_j . In fact, the choice of an appropriate weight is one of the most fundamental steps in the computation in fuzzy

[1]According to Chiappero Martinetti, (2000), The membership function depends on the context to which it refers and on the type of the indicator to be specified

indices. Among the various methods proposed in the literature, that focus mainly on the multivariate analysis[2] , our choice has fallen on the PCA (Principal Component Analysis).

The weights determine the respective value of the different attribute (i.e) intensity with which a chosen variable contributes to explaining poverty. Therefore, each attribute may be assigned different weights. It should be noted that the weighting system based on PCA corresponds to a state of relative poverty, which means that much importance should be accorded to data. With such specification, much weight is assigned to poverty indicators in terms of information content. It should be admitted that one cannot escape from arbitrariness and redundancy problem, as pointed out by Brandolini & D'Alessio (1998), Perez-Mayo (2003) and Kuklys (2003) in that it is difficult to determine a set of non equivocal indicators due to arbitration between information redundancy between items and the risk of omitting relevant variables.

The membership degree of the i-th household to the fuzzy sub-set D $\mu D(a_i)$ can be defined as a weighted average of :

$$\mu D = \frac{\sum_{i=1}^{n} \mu D(a_i) h(a_i)}{\sum_{i=1}^{n} h(a_i)} \tag{16}$$

(16)

It should be noted that the fuzzy set theory allows the computation of both the multidimensional poverty index ot the i-th household and the one-dimensional poverty index for each

attribute as denoted by :

$$\mu D(Xj) = \frac{\sum_{i=1}^{n} x_{ij} h(a_i)}{\sum_{i=1}^{n} h(a_i)} \tag{17}$$

The aggregated fuzzy set index can also be defined as a weighted average of one-dimensional poverty indices for each attribute as shown by :

$$\mu D = \frac{\sum_{i=1}^{n} \mu D(X_i) w_j}{\sum_{i=1}^{n} w_j} \tag{18}$$

3.1 Poverty fuzzy set decomposition

A robust method can also be used to evaluate poverty structure by way of decomposing the multidimensional fuzzy poverty index into sub population groups and attributes. In what follows, we present decomposition methods introduced by Dagum et Costa (2004) and Mussard et Pi Alperin (2005).

[2] Among others, Sahn and stifel 2000 use factor analysis, Filmer & Prichett 1998 use a PCA and Ayadi 2005 use an MCA

3.1.1 Group and sub group decompositions

Let us divide the total economic surface into m groups, R_m, of size n_m $(m = 1 \dots r)$. The poverty intensity of the i-th household of R_m is given by :

$$\mu D(a_i^m) = \frac{\sum_{i=1}^{k} x_{ij}^m w}{\sum_{j=1}^{k} w_j} \tag{19}$$

Where x_{ij}^m represents the degree of membership of the i-th household $(i = 1 \dots n)$ of R_m to the D sub-set with respect to the j-th attribute $(j = 1 \dots k)$.

Thus, the Multidimensional poverty index related to sub-set R_m is :

$$\mu_D^m = \frac{\sum_{i=1}^{n_m} \mu_D(a_i^m) h(a_i^m)}{\sum_{i=1}^{n^m} a_i^m} \tag{20}$$

The equation (20) allows computing the aggregated fuzzy poverty index which is defined as a weighted average of the poverty level within each group and can be denoted as follows:

$$\mu_D = \frac{\sum_{m=1}^{r} \sum_{i=1}^{n^m} \mu_D(a_i^m) h(a_i^m)}{\sum_{i=1}^{n^m} h a_i} \tag{21}$$

The equation (21) can be used to assess the contribution of m-th group to the total poverty index:

$$C_{\mu_D}^m = \frac{\sum_{m=1}^{r} \mu_D(a_i^m) h(a_i^m)}{\sum_{i=1}^{n^m} h a_i} \tag{22}$$

3.2 Decomposition by attribute

The decomposition by attribute introduced by Dagum and Costa (2004) allows to calculate the contribution of the j-th attribute to the aggregate poverty index.

The absolute contribution of the j-th attribute to the index can be obtained using the following equation (Dagum and Costa (2004)):

$$C_{\mu_D}^j = \frac{\mu_D(X_i) w_j}{\sum_{i=1}^{k} wj} \tag{23}$$

Using the above equation (22), we can compute the contribution of the j-th attribute to the m-th group by introducing the one-dimensional poverty index of the j-th for the m-th group :

$$\mu_D(X_j^m) = \frac{\sum_{i=1}^{n^m} x_{ij}^m h(a_i^m)}{\sum_{i=1}^{n^m} h(a_i^m)} \tag{24}$$

Thus, the contribution of the j-th attribute to the m-th group is :

$$C_{\mu_D^m}^j = \frac{\mu_D(X_i^m) w_j}{\sum_{i=1}^{k} wj} \tag{25}$$

3.3 Multidimensional Decomposition

The Multidimensional decomposition of the fuzzy poverty index introduced in 1998 by Chakravarty, Mukherjee and Ranade (1998) satisfies the axiom of decomposability by both attribute and sub-group.

Applying equation (24), it is possible de define the fuzzy poverty index as a weighted function of the one-dimensional poverty index of j-*th* attribute in the m-th group:

$$\mu_D = \frac{\sum_{m=1}^{r} \sum_{i=1}^{k} \mu_D(x_j^m) w_j}{\sum_{i=1}^{k} wj} \tag{26}$$

The contribution du j-th attribute to the m-th group is therefore:

$$C^{jm} \mu_D^m = \frac{\mu_D(X_j^m) w_j}{\sum_{i=1}^{k} wj} \tag{27}$$

3.4 Empirical evidence

In this study, we use data compiled from the above mentioned field survey carried out by a team of our Laboratory MECAS on a five hundred representative household of the region of Tlemcen.

The use of the Principal Component Analysis (PCA) enables us to select the following socio-economic attributes that help explain the degrees of deprivation

3.4.1 The socio-economic attributes

Thus, the selected variables are :

- Type of Housing (X1)
- Present occupancy Status of the household (X2)
- Comfort level (X3)
- Education level (X4)
- Present employment status (X5)
- Equipments (X6)

- Type of Health service (X7)
- Solidarity (family, community etc) (X8)
- Income (X9)

The next step is to construct a membership function for each attribute. Membership is a set to « *graded membership* » in a set. However, anyone who endeavors to apply fuzzy set approach must answer the following questions: What does graded membership mean?, How is-it to be measured ? Bilgik and Turksen (1999). Answering the first question requires choosing between different views of fuzziness[3] .

In our case, we have chosen the Likelihood view[4] that subscribes to the philosophical point of view that « *meaning is essentially objective and it is a convention among the users of a language* » Thomas (1979,1995). The answer to the second question leads us to adopt an appropriate elicitation method[5] . For the purpose of consistency and coherence, we opted for the pooling method, in the belief that fuzziness arises from interpersonal disagreements. The question "*do you agree that (a) is* F ? is asked to different experts. The answers are polled and an average is taken to construct the membership function. In our case, a pool of one hundred experts in fields related to selected attributes was asked to assign a membership degree to a set of attributes. The results are shown in **appendix (2)**.

Results of the fuzzy set method are presented thereafter.

3.4.2 The attribute Decomposition

The implementation of the attribute decomposition based on Dagum and Costa (2004) helped us compute the multidimensional poverty index for the wilaya of Tlemcen. The index is $\mu_D = 0.2649$,i-e 26.49% of households is structurally poor.

To sort out the main causes of poverty, estimation the one-dimensional fuzzy set indices was undertaken. The results show that among the selected attributes, four contribute strongly to deprivation state of poor households; They are respectively, Income, education level, equipments and the type of housing. Furthermore, an analysis of the contribution of each attribute to the multidimensional index shows that home related dimensions contribute far more to explaining poverty in the region of Tlemcen. Indeed, dimensions such as Type of Housing, Confort Level and Equipment count for 35% (see table 7).

[3] According to Bilgik & Turksen (1999), there exists five views of fuzziness : Likelihood view, Random set view, similarity view, view from utility theory and view from measurement theory.

[4] Assuming the vague predicate that « John (x) is tall (T) » is given a number in the unit interval $\mu_t(x) = 0.7$, this means that in the Likelyhood view that 70% of a given population (expert) considers that john is tall.

[5] According to Bilgik & Turksen(1999), therre are eight elicitation methods : polling, Direct Ratin g, Reverse rating, Interval Estimation, Membership Exemplification, Pairwise Comparison, Fuzzy clustering Methods, and Neural-Fuzzy Techniques.

Table[7] One-dimensional Poverty Index of Poverty, Absolute and Relative Contributions

Attributes	Membership Functions	Absolute Cont	Relative Cont
Type of Housing (X1)	0.3024	0.0315	11.8936
Present occupancy Status X2)	0.1922	0.0277	10.4668
Confort level (X3)	0.2506	0.0302	11.3916
Education level (X4)	0.4328	0.0312	11.7847
Present employment status (X5)	0.2492	0.0301	11.3656
Equipements (X6)	0.3232	0.0317	11.9783
Type of Health service (X7)	0.2120	0.0285	10.7433
Solidarity (family,com) (X8)	0.1660	0.0259	9.7934
Income (X9)	0.5660	0.0280	10.5826
Multidimensional membership function	26.49%	0.2649	100

These results help identify some causes of poverty. However, the search for deepness and precision of the analysis calls for decomposition methods.

3.4.3 The multidimensional Decomposition

On the basis of available data, the study is confined to a decomposition by area : the urban and rural. A computation of multidimensional poverty index of each area is made along with its absolute and relative contributions. Table (8) shows that rural areas contribute to explaining 52% of poverty in the region of Tlemcen.

Table[8] Decomposition by Region, Absolute Relative Contributions

Region	Membership Functions	Absolute Contributions	Relative Contribution
Urban	0.2295	0.1274	48.09
Rural	**0.3180**	0.1375	**51.91**
Multidimensional M.F	**0.2649**	**0.2649**	**100**

Table 9 shows the decomposition by attribute and area. Results reveal that despite a high degree of solidarity and occupational status, rural area suffers most from poverty We may note furthermore that two attributes, Type of housing with 54.35 % and Income 71.50 % alone contribute largely to the explanation of deprivation in rural areas.

Table[9] Decomposition by Attribute and area

	X1	X2	X3	X4	X5	X6	X7	X8	X9
Urban	0.1417	0.2473	0.1783	0.4097	0.1033	0.3103	0.1900	0.2333	0.4667
Rural	0.5435	0.1095	0.3590	0.4675	0.4680	0.3103	0.2450	0.0650	0.7150

Table (10) presents Absolute and Relative Contributions within Decomposition by attributes and areas

Table[10] Absolute and Relative Contributions within Decomposition by attributes and areas

		X1	X2	X3	X4	X5	X6	X7	X8	X9
Urban	Absolue	0.0148	0.0357	0.0215	0.0296	0.0125	0.0305	0.0255	0.0365	0.0231
Urban	Relative	6.4326	15.5442	9.3549	12.876	5.4379	13.273	11.113	15.886	10.072
Rural	Absolue	0.0566	0.0158	0.0432	0.0337	0.0565	0.0336	0.0329	0.0102	0.0354
Rural	Relative	17.806	4.9672	13.594	10.604	17.780	10.574	10.342	3.1943	11.136

Results show that rural area is the most hit by poverty. The decomposition by attribute and area exhibits that the type of housing, confort level and present employment status contribute to deprivation in rural area, whereas present occupational status and solidarity are main contributors to deprivation in urban area. We should note that the other dimensions contribute equally to explaining poverty in both areas. In addition, albeit its high contribution to deprivation, Income is not the sole dimension that explains poverty phenomenon. In fact, its contribution is less important than the others, mainly, the Type of Housing, employment status and the level of education.

4 Conclusion and policy recommendations

Despite numerous criticisms about the validity of the fuzzy set theory such as the absence of the core dimension and the assumption that there is some precise truth about the degree to which vague statute is true (Qizilbash: 2003), and the imprecision to capture vagueness (Qizilbash, 2005), this analysis can help policymakers obtain more information about the different dimensions of poverty, and hence design appropriate policies ,both social and economic, to reduce it.

The main findings are:

While the Logit-Probit analysis provides a general picture of poverty and brings to light the importance of one dimension; such as the acuteness of poverty in rural areas, and other interesting paradoxical conditions (education, type of job ... etc), the fuzzy sets analysis offers more robust and pertinent results than the other approaches. Indeed using the fuzzy set approach gives a higher percentage of poor, *i.e* 26.49 % while the Logit-Probit gives 24.30 %, and applying the upper poverty line exhibits a lower percentage of 23.80%. This gives more credence to the fuzzy set analysis.

Based on our empirical findings, one can advance the following **policy recommendations**:

- **A structurally sound socio-economic policy to reduce poverty must take into consideration labour market reforms and improvements of housing conditions,**
- **reduce regional imbalances though pro-rural development policies, and**
- **increase the stock of social capital through empowerment of civil society and networking.**

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Appendix (I)

Table (1): The number of Households in 53 communes on 31-12-2002

Communes	Nbr/H 1987	Nbr/H 1998	Growth Rate [a]	Estim 31-12-2002[b]	Areas[c]
TLEMCEN	18247	23407	0,022898	25626	U
BENI MESTER	2414	2736	0,011448	2863	R
AIN TALLOUT	1414	1376	-0,002473	1362	R
REMCHI	4863	6900	0,032317	7836	U
EL FEHOUL	909	1123	0,019405	1213	R
SABRA	3398	4045	0,015971	4310	R
GHAZAOUET	5420	6312	0,013947	6672	U
SOUANI	967	1511	0,041410	1777	R
DJEBALA	1910	1742	-0,008335	1685	R
EL GOR	913	1003	0,008583	1038	R
OUED CHOULI	809	663	-0,017930	617	R
AIN FEZZA	1318	1563	0,015620	1663	R
OULED MIMOUN	2924	3950	0,027719	4407	U
AMIEUR	1652	1884	0,012018	1976	R
AIN YOUCEF	1531	2038	0,026345	2261	R
ZENATA	423	553	0,024662	610	R
BENI SNOUS	1701	1825	0,006417	1872	R
BAB EL ASSA	1205	1618	0,027154	1801	R
DAR YAGHMOURASSEN	1183	1165	-0,001393	1159	R
FELLAOUCENE	1015	1316	0,023891	1446	R
AZAILS	977	967	-0,000935	963	R
SABAA CHIOUKH	632	699	0,009202	725	R
TERNI BENI HEDIEL	693	702	0,001174	705	R
BEN SEKRANE	1822	2265	0,019982	2452	R
AIN NAHALA	994	964	-0,002782	953	R
HENNAYA	3739	5238	0,031122	5921	U
MAGHNIA	11971	17206	0,033529	19632	U
HAMMAM BOUGHRARA	1602	1800	0,010650	1878	R
SOUAHLIA	2838	3817	0,027309	4251	R
M'SIRDA FOUAGUA	875	955	0,007985	986	R
AIN FETTAH	1292	1263	-0,002062	1253	R
EL ARICHA	728	733	0,000622	735	R
SOUK TLETA	624	517	-0,016955	483	R
SIDI ABDELLI	2174	2584	0,015830	2752	R
SEBDOU	3763	5469	0,034573	6265	U
BENI OUARSOUS	2052	1897	-0,007115	1844	R
SIDI MEDJAHED	998	1049	0,004541	1068	R
BENI BOUSAID	1314	1823	0,030212	2053	R
MARSA BEN M'HIDI	805	1022	0,021935	1115	R
NEDROMA	4776	5891	0,019258	6358	U
SIDI DJILLALI	940	786	-0,016134	736	R
BENI BAHDEL	432	450	0,003718	457	R
BOUIHI	1064	1120	0,004674	1141	R
HONAINE	907	993	0,008269	1026	R
TIANET	772	859	0,009755	893	R
OULED RIAH	481	653	0,028182	730	R
BOUHALLOU	921	965	0,004252	982	R
SOUK EL KHEMIS	1222	1092	-0,010173	1048	R
AIN GHORABA	647	736	0,011786	771	R
CHETOUANE	3283	6008	0,056477	7485	U
MANSOURAH	3396	6395	0,059226	8050	U
BENI SMIEL	604	624	0,002966	631	R
AIN KEBIRA	852	634	-0,026509	569	R
TOTAl	**114406**	**144906**		**159105**	

Source : RGPH, 1987, 1998.

Table (2) : Households sample distribution

N° Communes	Communes	Nbr/H surveyed
1	TLEMCEN	**86**
2	REMCHI	**26**
3	NEDROMA	**21**
4	GHAZAOUET	**22**
5	CHETOUANE	**25**
6	EL GOR	**7**
7	OULED MIMOUN	**15**
8	BENI SNOUS	**12**
9	BEN SEKRANE	**15**
10	MAGHNIA	**66**
11	HAMMAM BOUGHRARA	**12**
12	M'SIRDA FOUAGUA	**6**
13	SEBDOU	**21**
14	BENI OUARSOUS	**12**
15	SIDI MEDJAHED	**7**
16	MARSA BEN M'HIDI	**7**
17	SEBRA	**27**
18	HONAINE	**6**
19	BOUHALLOU	**6**
20	DJEBALA	**11**
21	MANSOURAH	**27**
22	AMIEUR	**12**
23	AIN TELLOUT	**9**
24	OULED RIAH	**5**
25	SOUK EL KHEMIS	**7**
26	AIN GHORABA	**5**
27	AIN FEZZA	**11**
28	AIN YOUCEF	**14**
		500

Table (3) : Description of Household variables

variables	Designation
NPER	Number of people in the household
NOCC	Number of people living in the household
NENS	Number of children in the household
NPIE	Number of rooms in the household
LOG 1	=1 if the household lives in a house of the type « modern housing, villa » =0 otherwise
LOG 2	=1 if the household lives in a house of the type « landlord » =0 otherwise
LOG 3	=1 if the household lives in a house of the type « collective building » =0 otherwise
LOG 4	=1 if the household lives in a house of the type « precarious house » =0 otherwise
SPOT 1	=1 if the source of drinking water is a personal water meter =0 otherwise
SPOT 2	=1 if the source of drinking water is a public fountain =0 otherwise
SPOT 3	=1 if the source of drinking water is a private well =0 otherwise
SPOT 4	=1 if the source of drinking water is a collectif well =0 otherwise
SPOT 5	=1 if the source of drinking water is from seller, tanker =0 otherwise
EUSE 1	=1 if sewage connected to sewage system =0 otherwise
EUSE 2	= 1 if sewage connected to pit = 0 otherwise
EUSE 3	= 1 if sewage is in the open air = 0 otherwise

Table (4) : Variables (Social Contacts)

Variables	Designation
CONTACT 1	= 1 if the household has a regular contact with the family =0 otherwise
CONTACT 2	= 1 if the household has a regular contact with neighbors =0 otherwise
CONTACT 3	= 1 if the household has a regular contact with friends =0 otherwise

Table (5) : Household head variables

Variables	Designation
GENDER 1	= 1 if the head of the household is a male = 0 otherwise
GENDER 2	= 1 if the head of the household is a female = 0 otherwise
CSA 1	= 1 if the head of the household is in agriculture = 0 otherwise
CSA 2	= 1 if the head of the household is in industry = 0 otherwise
CSA 3	=1 if the head of the household is in construction and public works =0 otherwise
CSA 4	=1 if the head of the household is in services =0 otherwise
CSA 5	=1 if the head of the household is in commercial activities =0 otherwise
CSA 6	=1 if the head of the household is in the Craft industry =0 otherwise
CSA 7	=1 if the head of the household is in Education =0 otherwise
CSA 8	=1 if the head of the household is in Health =0 otherwise
CSA 9	=1 if the head of the household is in Public services =0 otherwise
CSA 10	=1 if the head of the household is in other sectors =0 otherwise
INS 1	=1 if the head of the household is illiterate =0 otherwise
INS 2	=1 if the head of the household has a primary level of education =0 otherwise
INS 3	=1 if the head of the household has a secondary (intermediate) level of education =0 otherwise
INS 4	=1 if the head of the household has a secondary level of education =0 otherwise
INS 5	=1 if the head of the household has a university (higher) level of education =0 otherwise
SAN 1	=1 if the head of the household is in a good health =0 otherwise
SAN 2	=1 if the head of the household is sometimes ill =0 otherwise
SAN 3	=1 if the head of the household is very often ill =0 otherwise

Table (6) Estimated Parameter Values

	Rural areas			*Urban areas*		
	Logit		**Probit**	**Logit**		**Probit**
Variables	**Estim.**	**Odds ratio**	**Estim.**	**Estim.**	**Odds ratio**	**Estim.**
Const.	-1.559	*0.210*	-1.000	15.388	*4817511*	2.765
NPER	0.502	*1.652*	0.294	0.291	*1.337*	0.165
NOCC	-0.440	*0.644*	-0.251	0.456	*1.578*	0.256
NENS	0.498	*1.645*	0.305	-0.209	*0.811*	-0.117
NPIE	-0.097	*0.908*	-0.052	-0.565	*0.568*	-0.302
LOG1	-0.574	*0.564*	-0.336	7.497	*1802.121*	1.663
LOG2	-0.427	*0.652*	-0.235	7.864	*2602.580*	1.928
LOG3	-2.760	*0.063*	-1.623	6.417	*612.332*	1.104
LOG4	2.503	*12.214*	1.495	9.057	*8577.380*	2.599
SPOT1	1.139	*3.124*	0.688	2.769	*15.940*	0.356
SPOT2	-0.327	*0.721*	-0.180	1.781	*5.936*	-0.082
SPOT3	0.113	*1.119*	0.121	2.757	*15.754*	0.412
SPOT4	-2.950	*0.052*	-1.723	5.107	*165.132*	1.714
SPOT5	0.866	*2.378*	0.495	3.374	*29.199*	0.764
EUSE1	-0.935	*0.393*	-0.542	-1.414	*0.243*	-0.762
EUSE2	-1.668	*0.189*	-0.956	-1.858	*0.156*	-0.992
EUSE3	-0.935	*0.393*	-0.542	-1.414	*0.243*	-0.762
GENDER 1	-1.401	*0.246*	-0.833	8.054	*3147.147*	1.643
GENDER 2	-0.058	*0.944*	-0.067	7.434	*1691.746*	1.222
CSA1	1.855	*6.394*	1.113	3.120	*22.635*	1.216
CSA2	0.260	*1.297*	0.146	1.064	*2.897*	0.008
CSA3	-0.555	*0.574*	-0.273	3.594	*36.393*	1.471
CSA4	-0.495	*0.610*	-0.214	1.110	*3.035*	0.052
CSA5	0.892	*2.441*	0.558	1.374	*3.951*	0.205
CSA6	1.630	*5.102*	1.015	-1.086	*0.338*	-1.208
CSA7	-0.319-	*0.727*	-0.142	-0.656	*0.519*	-0.892
CSA8	-2.612	*0.073*	-1.542	3.157	*23.509*	1.409
CSA9	-0.856	*0.425*	-0.531	2.492	*12.089*	0.783
CSA10	-0.455	*0.634*	-0.223	2.118	*8.313*	0.621
INS1	0.449	*1.567*	0.253	3.135	*23.000*	0.602
INS2	1.452	*4.271*	0.854	4.565	*96.082*	1.414
INS3	0.389	*1.475*	0.220	1.852	*6.373*	-0.083
INS4	-1.471	*0.230*	-0.753	3.618	*37.276*	0.961
INS5	-1.978	*0.138*	-1.174	2.617	*13.689*	0.270
SAN1	-0.287	*0.751*	-0.194	-39.597	*6.358E-18*	-8.266
SAN2	-0.584	*0.558*	-0.315	-38.459	*1.984E-17*	-7.630
SAN3	-0.488	*0.614*	-0.290	-37.714	*4.177E-17*	-7.156
CONTAC1	1.354	*3.874*	0.780	-0.032	*0.969*	0.044
CONTAC2	1.983	*7.261*	1.149	-0.093	*0.911*	-0.035
CONTAC3	2.687	*14.682*	1.525	1.217	*3.379*	0.794
Numb. Obs	191		191	309		309
Final loss	69.9199507		69.349518	71.265361		70.641583
Chi 2	93		94.141	94.53044		95.77799
P Level	**0.0000027**		**0.0000019**	**0.0000017**		**0.0000011**
FD	39		39	39		39
Nb.0		134 (70.16%)			251 (81.23 %)	
Nb.1		57 (29.84 %)			58 (18.77 %)	

Appendix (II) : : Membership degrees

(1) Type of Housing

Characteristics	*Membership functions*
Individual house / villa	***0***
Landlord	***0.3***
Shared Building	***0.5***
Precarious Dwelling	***1***

2. Present occupancy Status

Characteristics	*Membership functions*
Owner	***0***
Rent	***0.5***
Free lodging	***0.6***
Temporary free lodging	***1***

3. Confort level

Characteristics	*Membership functions*
Separate kitchen + bath room + mains gas + hot water	***0***
	0.1
Separate kitchen + bath room + mains gas	***0.2***
Separate kitchen + bath room+ hot water	***0.4***
Separate kitchen + bath room	***0.5***
Separate kitchen + mains gas	***0.7***
Separate kitchen	***1***
None	

4. Education level

Characteristics	*Membership functions*
University	***0***
Secondary	***0.3***
Intermediate	***0.5***
Primary	***0.7***
illiterate	***1***

5. Present employment status

Characteristics	*Membership functions*
Permanent	***0***
Contract staff	***0.2***
Youth employment	***0.6***
Daily worker	***0.5***
unemployed	***1***

6. Equipements

Characteristics	*Membership functions*
Cooker + fridge + TV + satellite TV + PC	***0***
Cooker + fridge + TV + satellite TV	***0.1***
Cooker + fridge	***0.5***
Cooker	***0.8***
None	***1***

7. Type of health service

Characteristics	*Membership functions*
Private clinic	***0***
Private physician	***0.1***
Public hospital	***0.4***
Traditional medicines	***0.8***
None	***1***

8. Solidarity (family community…etc)

Characteristics	*Membership functions*
Much	***0***
Moderate	***0.3***
Little	***0.7***
None	***1***

Income (X9)

Characteristics	*Membership functions*
X>30001	***0***
15001<X<30000	***0.33***
10001<X<15000	***0.67***
X<10000	***1***