MODEL FOR MEASURING LEVELS OF POVERTY IN ARGENTINA

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Reception Date: 02/28/2014 - Approval Date: 05/05/2014

ABSTRACT

Poverty, like many other economic and social concepts, is a complex phenomenon to define. In general, it is associated to the lack of resources to meet the needs of a population or group of reference, without having the ability and opportunity to produce these resources.

As it is a complex and multidimensional phenomenon, there are many definitions and ways of measuring it.

The tools provided by the theory of fuzzy sets, let you capture the grays present in the standard of living of the population, nuances that occur not only phenomena of subjective nature, but also by situational phenomena and cyclical.

In this paper a model to classify households according to the membership degrees to all indigent and poor households is presented. Levels of poverty and indigence are determined taking into account household income and the appreciation of the Basic Food Basket and Cutting Edge Total.

KEYWORDS: Measures of Poverty; Poverty Lines; Fuzzy Sets; Degrees of Poverty.

INTRODUCTION

The indirect approach classifies as poor people who do not have sufficient resources to meet their nutritional and non-nutritional needs.

This method is characterized by using indigence lines (LI) and poverty (LP). The poverty line is the level of income required to achieve predetermined calorie consumption. Caloric needs are obtained from nutritional studies, making assumptions about the level of physical exhaustion.

Poverty lines set minimum income or expenditure that can maintain adequate standard of living, according to some chosen standard. It considered poor people or households with less than what is determined by the poverty line (Feres and Mancero, 2001) income.

Historically it has received much more attention in the functional form of a poverty measure that in the methods used to draw the line, the latter considered as fact. This topic is not unimportant as the way to fix it can be of great importance for policy decisions to be guided by the data of poverty (Ravallion, 2010). Improper conceptualization of LI and LP can lead to misdiagnosis and make an inefficient economic policy (Sen, 1983). Moreover, in most cases it may be even more important than the functional form. The standard is that no single poverty line exist, but many. This practice attempts to measure the standard of living of the population in terms of economic resources available to the household. While there has been much thought to how the data should be added on welfare in a single measure of poverty, little has been discussed about how to set these indicators (Ravallion, 2010).

A precise delineation of those who are poor and those who are not, sometimes fails to correctly display the reality. It may be that some people buy at prices above average (the price that takes into Argentina's National Institute of Statistics and Census (INDEC) to enhance the Basic Food Basket (CBA)), and need more money to complete their calorie needs and energy. The same would apply in reverse or in the case of economies of scale within the household that benefit larger households are presented. In those cases that do not conform exactly to the current methodology, additional studies and adaptations would be required to achieve more rigorous measurement. Then, the existence of price changes due to differences of areas within the same district or by those already mentioned economies of scale within the household can result in most cases significant.

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Similarly we can obtain the same conclusion in the case of food quantities defined in the CBA. For example, a person could profit more useful a different combination of obtaining the same goods fulfill the same protein and nutritional requirements (Sen, 1983). It could also be the case that the basket subtly less or more calories scope than defined by the CBA, and verify the same purpose to ensure the biological functionality of the individual.

In summary, to the extent that prices differ between different areas of the same economic region, would be correct to use different nominal LI. However, they may also differ in relative prices, generating a substitution effect amending combination of food items determining a differential total expenditure. Then this will not mean that some households are more homeless than others. Tastes may also differ systematically, generating a payment per calorie dissimilar. This is not necessarily indicating that household that pays more expensive every calorie is more destitute than the one that it will crave food more cheaply. So we must be wary of LI generated by the traditional method, in the sense that the people at the LI in different sectors, dates or geographical regions may have very different standards of living still receiving the same income (Sen, 1983).

The same phenomenon can be repeated with non-food expenditures. Tastes may differ and buy at different prices and substitutions are made between different goods belonging to the Total Basic Basket (CBT).

The aim of this paper is to present indigence lines and fuzzy poverty given the vagueness present in the data. This model will allow linguistically classify households according to their situation. Levels of poverty and indigence are determined taking into account household income and the appreciation of the CBA and CBT. Addition operation is shown by an illustrative example. We will try to verify that the application of fuzzy measurement of the living conditions of the population approach better diagnosis of social problems will get better treatment achieving poverty.

DEVELOPMENT

1. Theoretical Framework

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The tools based on fuzzy set theory resembles human reasoning in the use of inaccurate information to make decisions. Unlike the classic tools that require a deep understanding of a system, exact equations and precise numerical values, fuzzy models have an alternative way of thinking that allows modeling complex systems using a higher level of abstraction originating from the knowledge and experience (Carlsson and Fuller, 2010).

The fuzzy set theory provides a performing algebra, a language that is half conceptual-verbal and half mathematical-analytical. The greatest value of the fuzzy focus for economists is its potential to encourage, strengthen and extend the dialogue between ideas and evidence. This dialogue is the systematic interaction between economic theory and data analysis, the back and forth between the use of data to improve the theory and the use of theory to guide the exploration of the data. Most theoretical arguments are verbal formulations and try to theoretical relationships between sets. As the theory of fuzzy sets theory also deals with relations between sets offer an opportunity to create a close correspondence between theory and data analysis (Ragin, 2000).

With the theory of fuzzy sets, researchers can analyze the evidence in ways that directly reflect their theoretical arguments. The main problem arises from the dominance of conventional forms of quantitative analysis, economic analysis requires some analytical rigor but quantitative analysis often restricts the dialogue between ideas and evidence in unproductive ways (Richters, 1997).

Incorporating fuzzy sets allows gradualness without leaving the main emphasis on types and kinds of cases. The link between theory and data analysis in the social sciences can be greatly improved by the use of fuzzy sets for the simple reason that this tool can be perfectly adapted to theoretical concepts (Ragin, 2000).

This theory offers a lot of attractive aggregation connectors for integrating membership values representing uncertain information.

1.1. Fuzzy subsets

A conventional or crisp set is dichotomous. An object or is in or out of a set, therefore, a clear set is comparable with a binary variable, which takes two values, one (if

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it belongs) or 0 (if it is external). A fuzzy set, on the contrary, allows belongings in the range between 0 and 1 while the two extreme states of membership and not full membership.

The fundamental idea of a fuzzy set is to relax the requirement to admit intermediate values of class membership. In turn, we can assign intermediate values between 0 and 1 to quantify our perception on how these values are compatible with the class 0, that means the inconsistency (complete exclusion) and 1 support (full inclusion). The membership values then expressed the degree to which each element of the universe is compatible with the distinctive properties of the class (Pedrycz et al., 2011).

In the classic theory of sets, a subset A of a set E can be defined by its characteristic function $\mu_A : E \rightarrow \{0,1\}$. The value 0 is used to represent non-membership and the value 1 is used to represent the membership (Carlsson and Fuller, 2010).

A fuzzy subset $\tilde{A}$ of a set E , can be defined as a set of ordered pairs with the first element of the array E and the second interval (0,1), with a single ordered pair every element of E (Carlsson and Fuller, 2010).

A function is defined $\mu_{\tilde{A}} : E \rightarrow [0,1]$ which assigns to each element of the set E a value μ (x) in the interval [0,1], called the degree or level of membership (Zadeh, 1965).

In the same way that crisp subset, the value 0 is utilized to represent non-membership, the value of 1 to represent the membership. All values in the middle of 0 and 1 are used to represent intermediate degrees of membership.

This is called α-cut of $\tilde{A}$ fuzzy set is the crisp set $A_\alpha = \{x \in E / \mu_{\tilde{A}}(x) \geq \alpha\}$ that contains all elements of the reference set whose membership degrees to the fuzzy set is greater than or equal to the value of α (Lazzari, 2010). In particular, the α-cut is defined for α= 0 as the closure of the union of the A_α with $0 < \alpha \leq 1$. All fuzzy set can express their ass by α-cuts. The α-cuts are cuts of the fuzzy set that generates non-fuzzy sets (Buckley et al., 2010).

1.2. Fuzzy numbers

In practice, the exact values for the parameters of the models are not as common. Typically, uncertainty and imprecision arise due to lack of knowledge and incomplete

information reflected in the structure of the system parameters, contributions and potential limitations. The fuzzy numbers and quantities modeled inaccurate capture our innate concept of approximate numbers such as about 5 to about 10 (Pedrycz et al., 2011).

A fuzzy number is a fuzzy set of real numbers, with a convex function, a continuous normal and bounded support (Carlsson and Fuller, 2010) belonging.

This is called triangular fuzzy number (NBT) for the actual, continuous, fuzzy number determined uniquely by three real numbers $a1$, $a2$, and $a3$, such $a1 \leq a2 \leq a3$ (Figure 2.4), is usual to be represented by Ã = $(a1, a2, a3)$. Its membership function is given by (Lazzari, 2010):

$$\forall\ x \in R\ :\ \begin{cases} 0 & \text{si } x < \alpha 1 \\ \dfrac{x - a1}{a2 - a1} & \text{si } a1 \leq x \leq a2 \\ \dfrac{-x + a3}{a3 - a2} & \text{si } a2 \leq x \leq a3 \\ 0 & \text{si } x > a3 \end{cases}$$

= ¿ {}{}{}

And the α -cuts are , $A_\alpha = \left[(a_2 - a_1)\,\alpha + a_1\,,\,(a_2 - a_3)\,\alpha + a_3\right]$, $\forall\ \alpha \in [0\,,\,1]$

1.3. Language models

The existence of qualitative variables, inherent to human behavior, or material in the external environment are difficult to objective quantify, makes individuals have difficulty in representing an exact numeric value with the valuation of the various aspects related to their welfare to be evaluated. Also, it is often necessary to deal with variables that describe physical phenomena or human models by assuming a small finite number of descriptors. Sometimes we describe observations of a phenomenon characterizing its states are naturally translated in terms of an idea of the variable (Pedrycz et al., 2011). Under such

circumstances, it is more appropriate to express their views through linguistic values rather than exact numerical values.

This approach is a decision problem based on the theory of fuzzy sets and called linguistic approach. It applies when the variables involved are qualitative (Zadeh, 1975, Herrera and Herrera-Viedma, 2000; Lazzari, 2010). This makes it possible to model more adequately ot of real situations, since it allows representing information of individuals, which is almost always inaccurate, more appropriately.

Difference between a linguistic variable from a numerical is that their values are not numbers but words or sentences in natural language, or an artificial language (Zadeh, 1975). A linguistic variable can be considered both as a variable whose value is a fuzzy number or a variable whose values are defined in linguistic terms (Carlsson and Fuller, 2010).

When a language model used assumes the existence of an appropriate set of terms or tags, according to the problem domain, on the basis of which individuals express their opinions. One must agree on the level of distinction to which you want to express uncertainty, i.e. the cardinality of the set, and the semantics of tags, i.e. what type of membership functions used to characterize the linguistic values (Zadeh, 1975).

2. Classic method

In Argentina, to calculate the basic food basket (the first step in defining the lines) the calorie and protein requirements necessary are taken to an adult male, between 30 and 59 years of moderate activity (also called adult equivalent) given that they have daily 2700 kcal and are sufficient to cover the biological functionality of the individual in question (INDEC, 2012).

Due to the nutritional requirements differ by age and sex, it is necessary to make a match between the characteristics of each family member and their caloric expenditure. The reference unit, called adult equivalent, is an adult male between 30 and 59 years of moderate activity, equivalent to a daily intake of 2700 kcal. Relationships based on gender

and age people are set to build a table of equivalences[1]. This table is used to calculate the consumer units in terms of adult equivalent, which determine adult equivalent units of each particular household (INDEC, 2012).

To get the value of the extreme poverty line for that household i, the number of adult equivalent units by the value of the Basket referred multiplies.

$$LI_i = V_{CBA} . U^i$$

Where V_{CBA} is the monthly valuation of the basket and U^i these are the adult equivalent units for that home.

Then the actual total monthly income of the household is compared and is classified as indigent or not indigent, depending on whether it is below or above the monetary value for that period of the basic basket of home. Finally, the same procedure for each household in the sample is performed to classify all households as indigent or not indigent.

To assess the poverty line should be noted that households consume two types of goods: food and non-food. For the construction of the basic basket of non-food goods spending the observed proportion of these goods in the total household expenditure in a particular population group is used. The poverty line is obtained by calculating the Engel coefficient for the reference population and then multiplies it by the value of the indigence line corresponding to household composition.

$$\Theta = \frac{\text{Total Expenses}}{\text{Feeding Expenses}}$$

$$LP_i = LI_i . e$$

After calculating this line, the actual total monthly income of the household is compared and is classified as poor or not poor, depending on whether it is below or above the monetary value of the LP for that period. Finally, the same procedure for each household in the sample is performed, obtaining the percentage of poor households to total households.

[1] In Argentina, the equivalent table can be obtaining in the INDEC (2012).

3. Food basket and Total Fuzzy

Decision problems, particularly in management and economics, are affected by vagueness and uncertainty. Classical methods used for resolution offer a simplified representation of reality, which cannot reveal the complexity and movement of the economy. The main problems affecting the proper definition of poverty measures are the range of prices, tastes and customs, as well as the difficulty of measuring objective aspects of the capabilities of individuals.

To establish a rigid line that classifies households by poverty status exclusive-no poverty, sometimes fails to correctly display the reality. Then, the fuzzy systems have the ability to model forms of reasoning not necessary, that play an essential role in the remarkable human ability to make rational decisions in an environment of uncertainty and imprecision.

Suppose that when we model in an uncertain environment, it is possible to define the maximum and minimum values that can reach and take into consideration imprecise reliable (α – cut of level 0 $A_0=[a_1,a_3]$,). If you could specify a value a_2 in $[a_1,a_3]$ as possible, then we could define the uncertain value a fuzzy number in which the extreme values will be given by a_1 and a_3 the possible value will be a_2 . So with this three values a_1 a_2 and a_3 it can build a triangular fuzzy number (NFT) (Kaufmann, Gil Aluja and Terceño, 1994) and define its membership function.

For a Basic Food Basket Fuzzy (CBAF) will be necessary to approach the reality not only the values of the quantities but also the prices of the period.

The amounts of the food can then be expressed by a NBT for each item i (i=1,...,n) of the CBAF $Q^i=(q_1^i,q_2^i,q_3^i)$ and the maximum, minimum and media prices $P^i=(p_1^i,p_2^i,p_3^i)$ (Lazzari and Fernandez, 2006).

To enhance the CBAF for an adult NBT expressed by confidence intervals and operated with them (Kaufmann, Gil Aluja and Terceño, 1994).

Given the set of goods in the basket $C=\{C_1,\ldots,C_n\}$ the cardinal is $|C|=n$, the monthly valuation of CBAF is given by:

$$V_{CBAF}=\sum_{i=1}^{n} Q^i \cdot P^i \ / \ Q^i,\ P^i \subset R^+ \ \forall \ i=1,\ldots,n$$

Following this methodology, we can generalize the concept of adult equivalent correspondences for age and sex by establishing maximum, minimum and caloric needs of most potential to build NBT values representing daily caloric needs (Fernandez, 2012).

If the i-th household shows $U^j=(u_1,u_2,u_3)$ adults equivalents units and V_{CBAF} is the valuation of CBAF for adult equivalent unit for a given month, fuzzy poverty line (LIF) for this household is determined by:

$$LIF^j=U^j \cdot V_{CBAF}$$

Then, in order to classify a household as indigent or not indigent is necessary to compare their income with LIF for that household.

For lines fuzzy poverty, simply set the inverse of the Engel coefficient (which relates food expenditures for non-food) with fuzzy numbers. Likewise with food goods, there may be variations below or above the average basket in non-food baskets property caused by cultural factors, or other preferences that generate the same happiness to households. Then, in order to classify a household as indigent or not indigent is necessary to compare their income with LIF for that household. (α – cut of level 0 $A_0=[a_1,a_3]$,) and a value a_2 in $[a_1,a_3]$ as possible. You can define the uncertain value for all non-food expenditures with NBT with the values $a1$, $a2$, and $a3$

$$V_{CBTF}=(a_1,a_2,a_3)$$

Then, the inverse value of the fuzzy Engel coefficient is given by:

$$\Theta = \frac{\text{Total Fuzzy Expenses}}{\text{Total fuzzy food expenses}}$$

These costs can be expressed as NFT where the maximum, minimum and mean of total food expenditures and the reference population amounts are considered.

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And poverty line blurred for adult equivalent is determined by:

$$LP_f = V_{CBAF} . \tilde{e}$$

In order to classify a household as poor or non-poor is necessary to compare their income with the valuation of LP_f for that household.

$$LP_f^j = U^j \cdot LP_f$$

Being LP_f^j enhancement of the LP for the io-th household.

3.1. Levels of homelessness and poverty

Once calculated V_{CBAF}^j and LP_f^j, the actual total monthly household income is compared and determines whether these homes are completely destitute or homeless or poor or not poor, or if they are in the gray area. To classify households within the gray area, can be associated with the degree of membership to all indigent or poor households with a set of linguistic valuations. If the value for the home CBAF, is determined by a NFT (v_1, v_2, v_3), seven categories are established to classify households in linguistic form from placing the total household income (y) in the x axis (Figure 1 and table 1). $\mu(x)$ degree of membership function associated with that CBAF

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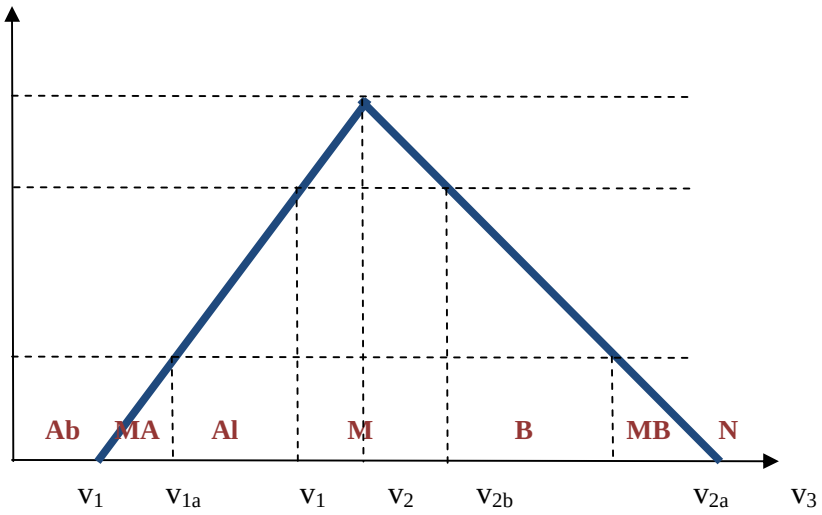

Figure Nº 1. CBAF
Source: Own Elaboration

Table Nº 1: Valuations language associated degree of membership to all indigent households

	Income	**Poverty degree**
Left Branch	$y < w_1$	Absolut
	$w_1 < y < w_{1a}$	Very higth
	$w_{1a} < y < w_{1b}$	Higth
	$w_{1b} < y < w_2$	Medium
Right Branch	$w_2 < y < w_{2b}$	
	$w_{2b} < y < w_{2a}$	Left
	$w_{2a} < y < w_3$	Very Left
	$w_3 < y$	Nule

Source: Own Elaboration

In the same way, it is possible to construct a similar set of valuations for the classification of households regarding the concept of poverty (Figure 2 and Table 2). If the value for the home CBTF, is determined by a NFT, seven categories are established to classify households in linguistic form in accordance with the concept of poverty.

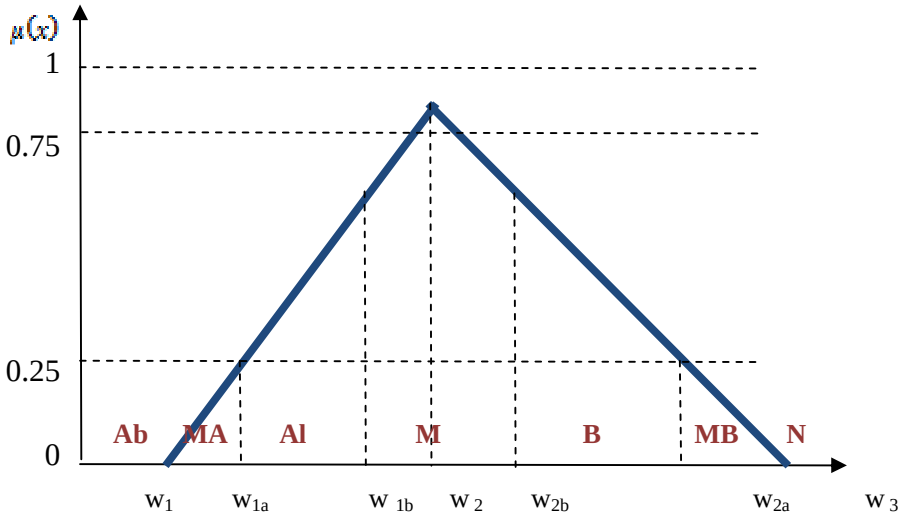

Figure Nº 2: CBTF
Source: Own Elaboration

Table N°2: Linguistic Valuations associated with degree of membership to all poor households

	Income	**Poverty degree**
Left Branch	y< w1	Absolut
	w1<y< w1a	Very high
	w1a<y< w1b	High
	w1b<y< w2	Medium
Right Branch	w2<y< w 2b	
	w 2b<y< w2a	Left
	w 2a<y< w 3	Very Left
	w3<y	Nule

Source: Own Elaboration

Using this approach allows not only capture the nuances but to evaluate the different situations within the uncertain areas. You may also set different methods to perform the evaluation.

4. Ilustrative example

A study was conducted to determine the degree of membership to all poor and indigent households given home.

For the month, the valuation of CBAF for adult equivalent is:

VCBAF= (72.29, 108.25, 166.72)

The lower (left) dimension reflects the case in which the individual has needed the least amount of food to maintain its biological functionality and purchased at the lowest price available in the market and the top (right) dimension reflects the case in which the individual has consumed more calories and also purchased at the highest price available in the market.

On the other hand, being considered more possible values for prices and quantities those used by the Institute of Statistics, the possible value of CBAF calculated is $108.25.

Second, the CBAF value of this family is calculated for the purpose of considering not indigent or indigent.

The composition of each household in adult equivalents determines a value for that specific CBAF home. The home sum U=(3,04; 3,36; 3,61) units of reference or equivalent adults.For that month, the value of the LIF of this household is:

$$LIF_h = (219.78, 363.72, 601.872)$$

Graphically, (Figure 3):

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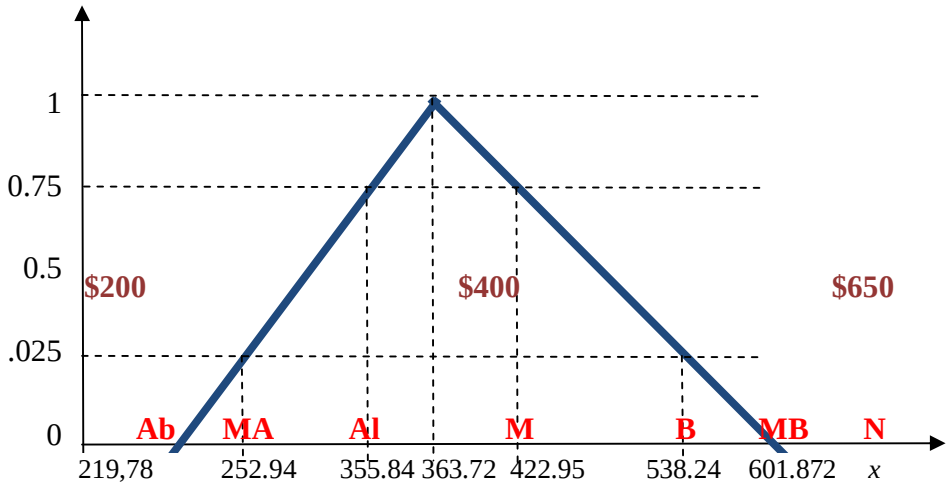

Figure Nº 3: Home CBAF analyzed
Source: Own Elaboration

It is possible to analyze different alternatives:

i) If your total household income is $ 200 for the reporting period, it shall be classified by the traditional method and the proposed method as an indigent household.

ii) If your total household income is $ 650 for the reporting period, it shall be deemed not indigent by both approaches.

iii) If your total household income is $ 400, the same shall be considered as indigent by the approach of traditional CBA, not the case if we use the approach of fuzzy basic food basket. This case is within the gray area, so the proposed method, the home has an average degree of destitution.

If we classify this household in relation to the total basket, simply multiply the value of the basic food basket for the fuzzy inverse of the Engel coefficient.

If the value of the inverse of the coefficient is Engel $\tilde{\alpha}=(2{,}05,2.07,2,1)$, and expression CBAF considering the minimum and maximum possible value is (72.29, 108. 25, 166.72).

Then, the poverty line for the adult equivalent expressed as a NFT will be determined by $LP_f = V_{CBAF}.\tilde{\alpha}=(148.19,224.07,345.11)$

If the value of the LP is calculated for this family, the poverty line is:

$LP^H = (450.49, 752.87, 1245.84)$

Graphically, (Figure 4):

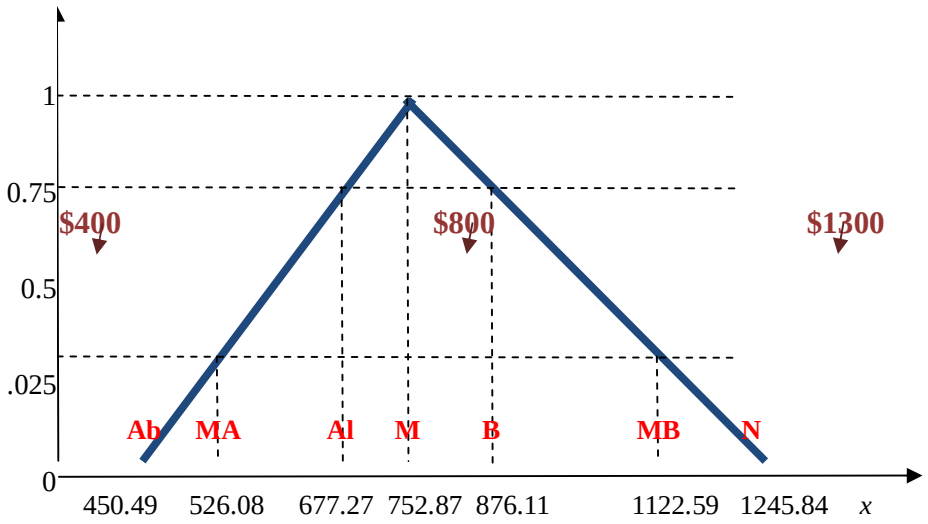

Figure Nº 4: LP_f for household analyzed
Source: Own Elaboration

In the same way as in the previous case, it is possible to analyze three alternatives:

i) If your total household income is $ 400 for the period analyzed, it will be classified as poor by both home methods.

ii) If your total household income is $ 1300, it will be considered as poor by both approaches.

iii) If your total household income is $ 800, the same shall be considered as poor by the classical approach was not so if we use the proposed approach. It is worth assessing what is the degree of membership to all poor households. This case is within the gray area, so that the household has an average degree of poverty.

After consulting the home, it is known that the family's monthly income is $ 725. According to the proposed model has a degree of (non-indigent) no destitution and an average degree of poverty.

Finally, the same procedure for each household in the sample is performed to classify all households.

CONCLUSION

The diagnosis of the actual situation of the living conditions of the population is often difficult to grasp when various grades are present in each case. The contribution made possible to identify the nuances of the complex phenomenon of poverty. By applying the fuzzy approach to the measurement of living conditions of the population better diagnosis of social problems offering better treatment poverty is obtained.

Poverty describes a wide range of circumstances associated with need, hardship and lack of access to resources. It is a comparative term used to describe a situation in which there is a certain stratum of population and the perceived lack, scarcity or lack of the most basic goods, such as food, housing, education or health care, for achieve a decent life. Traditionally defined poverty as material deprivation as measured by the income or consumption of the individual or family.

The fuzzy models allow for routine analyzes, as well as more extensive and profound than generally include the classics as special cases.

In this paper the concept of poverty and indigence lines became widespread considering the prices and quantities necessary to preserve its biological functionality and social integration. The main problems affecting the proper definition of the poverty lines are the range of prices, tastes and customs. For this reason, the vagueness and uncertainty exist, a new technique to meet these difficulties was proposed.

A Basket Basic Food Fuzzy allowed to consider the nuances present in the consumption habits of the population, without losing the aim of measuring the ability of these individuals to ensure their biological functionality was used. The extension of this conceptualization for the Total Basic Basket making flexible non-food items in the same, allows for a fuzzy measure poverty.

This proposal allows us to appreciate that membership - non-membership to all indigent households is not always univocal, but depends on the individual, the chances of

make purchases at better prices, economies at the household level, the educational level of the members, among other things. The theory of fuzzy sets is an accessible tool that allows flexible models that attempt to explain the phenomena of the social sciences, succeeding in some cases successfully. Thus not a strict line but blurred indigence can see shades of the phenomenon of poverty more comprehensive form.

From the analysis of the membership function values of each CBTF and CBAF household membership degrees to all indigent and poor households were established. Model performance was shown from an illustrative example.

It is possible to progress in the investigation of the composition of the basic food basket for the purpose of considering the inclusion of other items and new combinations of existing determination.

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BIOGRAPHICAL ABSTRACT

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ISSN 1668 – 8708 – Versión en Línea
ISSN 1669 – 7634 – Versión Impresa
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