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Linguistic Measures of Subjective and Objective Poverty

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Abstract

Last decades several studies of subjective welfare with a great diversity of approaches have appeared. Some have focused on finding variables that determine it. Others stress the importance on quantifying it. Some investigates the determinants that make some people declare high levels of welfare and others do not. One of crucial social problems in the study of welfare is the recognition, measurement and analysis of the causes of poverty.

It is necessary to complement the objective poverty analysis with subjective indicators of welfare in order to assess the correspondence between the objective improvements and the subjective perceptions.

In this paper, we propose an evaluation model of Economic Welfare which includes subjective and objective poverty indicators with the use of mathematical tools for the treatment of uncertainty, in particular, linguistic models.

Keywords

Linguistic models, poverty measures, objective poverty, subjective poverty.

1. Introduction

Welfare Economics can be defined as a branch of Economics that explains the satisfaction of the agents and the mechanisms that generate their increase and decrease. Its study is part of disciplines as diverse as psychology, politics, sociology, philosophy and economics. Utilitarianism posed by Bentham [1] and Mill [2] laid the foundations from which modern Economic Science began the study of welfare. Welfare is also an abstract concept with subjective

connotations, but correlated with objective economic factors and individual welfare refers to each person's perception of having covered their needs [3].

During recent years, subjective assessments of quality of life are considered when measuring development. It is often said that subjective welfare is a necessary and sufficient condition for human development. Subjective welfare refers to an assessment of the welfare of an individual obtained through a survey. Subjective happiness or welfare is a global assessment of the quality of life by each individual [4]. The employment of subjective welfare measures is based on the basic assumption the governments needs to evaluate the improvements in the quality of life of their citizens [5]. Traditionally, study, measurement and design of public policies have paid attention to economic indicators. Recent studies highlighted the importance of incorporating subjective indicators, such as care or perception of happiness [6]. During last decades several studies of subjective welfare that present a great diversity in the type of approach that they realize have appeared. Some have focused on finding the variables that determine welfare. Others stress the importance on quantifying happiness, and finally a group investigates the determinants that make some people declare high levels of welfare and others do not. Dimensions that agents consider important regarding their welfare and quality of life are the benchmark in the study of subjective welfare. The self-evaluation that the subjects make regarding the satisfaction and happiness they perceive in relation to the different dimensions is taken into account [7]. Main social problems in the study of welfare are the recognition, measurement and analysis of the causes of poverty. It is also fundamental to be able to design effective measures to reduce it. However, this concept presents significant difficulties when it’s intended to measuring it accurately. Evaluation of economic welfare can be based on two types of indicators: objective-quantitative indicators (poverty lines, unsatisfied basic needs, human development index, anthropometric indicators, etc.) and subjective-qualitative indicators (based on surveys that reveal perceptions of individuals or households) [8].

Subjective poverty approach defines as poor those who are not satisfied with their situation, because it is considered excluded from the normal way of life, regardless of the economic situation of the agent. Studying poverty from a subjective point of view means considering that any person or family can give their judgment about the degree to which it satisfies their basic needs. To determine whether a person or family considers themselves poor or not, two forms are generally used. It is possible to ask directly about certain perceptions about their condition or observe their behavior. Subjective poverty can be understood as the perception of poverty that has a sector of the population that feels and defines itself as poor because they cannot access a set of goods and services that they consider of great importance [9]. Recognizing what causes

subjective poverty can be a good mechanism to improve public policies based on a better understanding of the needs and expectations of the population and the redefinition of priorities [10]. Measuring welfare is a frequent task, and there is a high consensus on the need to quantify it, but there are some divergences as to which indicators use to reflect a society's welfare situation and little information on how population evaluates what happens with their own welfare [11].

Subjective measurements are based on population surveys where they are asked to define their situation, usually located at a point on a qualitative scale. In general, information of welfare level of each person is obtained through simple questionnaires with simple and direct questions that capture people's perception of their satisfaction with access to certain goods or services.

The existence of qualitative variables, inherent to human behavior, or elements of the external environment of difficult objective quantification, makes it difficult for individuals to represent with an exact numerical value the valuation of the different aspects related to the welfare to be assessed. Under such circumstances, it is more appropriate to express their responses by means of linguistic values rather than exact numerical values. This approach is based on fuzzy sets theory and is called linguistic approach. It is applied when the variables involved are of a qualitative nature [12, 13, 14]. It is possible to model in a more appropriate way a great number of real situations, since they allow representing the information of the individuals, that it is not always precise, in a more appropriate way. A linguistic variable differs from a numerical one in that its values are not numbers, but words or sentences of the natural language, or of an artificial language [12]. The use of the diffuse linguistic approach implies the need to operate with words [15].

It is necessary to complement the analysis of the population living conditions with the subjective indicators of welfare in order to assess the correspondence between the objective improvements and the subjective perceptions that the agents perform on them. Given that the type of questions used to define a subjective welfare indicators are qualitative in nature, the use of a linguistic model that operates with words directly will allow aggregating opinions of the individuals adequately without losing information. The proposed approach will let to capture the nuances and degrees of welfare present in human perceptions, whereas the classical models allow only binary contrasts between positive and negative perceptions, not including the variations of intensities between them. Application of linguistic models to evaluate the population's perceptions of their welfare makes it possible to analyse individuals' life quality under the use of linguistic variables belonging to the habitual language. In addition, it will allow studying and processing individual and aggregated opinions operating with words directly without losing information nor rigorous.

This paper is structured as follows. In first place, a Linguistic Combined Model for Economic Welfare is presented. A Welfare Linguistic Subjective Indicator and a Linguistic Poverty Line are combined to measure a household multidimensional poverty. Next section develops an example and finally some conclusions are presented.

2. Linguistic Combined Model of Economic Welfare Evaluation

Poverty is a multidimensional reality that is not usually completely measured because of its nature. Population's living conditions are characterized by subjective and objective aspects. Thus, poverty measures sometimes are in the need to combine subjective and objective features.

Since subjective well-being indicators are built through surveys that reveal the individual's perception in certain areas considered using qualitative scales, is very relevant the use of linguistic variables in their formulation [16]. Then, since poverty is a matter of degrees, a linguistic poverty line is used to evaluate objective welfare of each household [17].

First, households' perceptions in five chosen areas will be collected using a multiple choice survey (Appendix). With the information obtained, ILBE index will be calculated for each household [16]. Then, the fuzzy poverty line will be calculated for that household [17]. Finally, the subjective evaluation of the household will be contrasted with the degree of poverty for identifying different situations on multidimensional poverty.

2.1. Welfare Linguistic Subjective Indicator

Welfare Linguistic Subjective Indicator (ILBE) takes into account five areas of welfare: 1. health, 2. education, 3. housing, 4. income and 5.employment [16]. Economic welfare is determined by their perception about these aspects. These perceptions are taken from direct surveys of heads of households. The questionnaire induces households to assess their access to the five areas considered using linguistic labels. The assessment of each area will provide a component of ILBE and aggregation enable an indicator for each household.

According to the domain of the variables involved, it is assumed the use of one of the following sets of linguistic terms, in order to the head of household express their views on each question made:

$$S_1 = \{s_0 = \text{dreadful}, s_1 = \text{very bad}, s_2 = \text{bad}, s_3 = \text{mean}, s_4 = \text{good}, s_5 = \text{very good}, s_6 = \text{excellent}\}$$

$$S_2 = \{s_0 = \text{absolutely poor},\ s_1 = \text{very poor},\ s_2 = \text{rather poor}, s_3 = \text{nor poor or not poor}, s_4 = \text{somewhat poor},\ s_5 = \text{almost non poor}, s_6 = \text{non poor}\}$$

$$S_3 = \{s_0 = \text{unimportant},\ s_1 = \text{rather uninportant},\ s_2 = \text{little important}, s_3 = \text{careless},\ s_4 = \text{pretty important},\ s_5 = \text{very important},\ s_6 = \text{absolutely important}\}$$

With the information obtained in surveys the indicator value for a family is obtained. This value is calculated for each area of satisfaction for the selected household. The assessment of the degree of satisfaction of each home for each area that integrates the $ILBE_h$ is obtained by using the aggregation operator of linguistic information with the information gathered from surveys (Appendix).

- Health Area: Evaluation will be based on household responses to questions 1 (access to healthcare) and 2 (access to medicines and vaccination): $EAA(s_{q_1}, s_{q_2}) = s_{he}$ [1].

Where $s_{q_1} \in S_1$ is the response of question 1, $s_{q_2} \in S_1$ is the response of question 2 and s_{he} is the evaluation of the health area of this household.

- Education Area: Evaluation will be based on household responses to questions 3 (conformity to the educational level of the head) and 4 (access to the education system): $EAA(s_{q_3}, s_{q_4}) = s_{ed}$.

Where $s_{q_3} \in S_1$ is the response of question 3, $s_{q_4} \in S_1$ is the response of question 4 and s_{ed} is the evaluation of the education área of this household.

- Housing Area: Evaluation will be based on household responses to questions 5 (housing conditions) and 6 (neighborhood general conditions): $EAA(s_{q_5}, s_{q_6}) = s_{ho}$.

Where $s_{q_5} \in S_1$ is the response of question 5, $s_{q_6} \in S_1$ is the response of question 6 and s_{ho} is the evaluation of the housing área of this household.

- Income Area: Evaluation will be based on household responses to questions 7 (income) and 8 (household income need not to feel poor): $EAA(s_{q_7}, s_{q_8}) = s_i$.

Where $s_{q_1} \in S_1$ is the response of question 7, $s_{q_1} \in S_1$ is the response of question 8 and s_i is the evaluation of the income área of this household.

- Employment Area: Evaluation will be based on household responses to questions 9 (number of hours worked) and 10 (working conditions): $EAA(s_{q_9}, s_{q_{10}}) = s_{em}$.

Where $s_{q_1} \in S_1$ is the response of question 9, $s_{q_{10}} \in S_1$ is the response of question 10 and s_{em} is the evaluation of the employment área of this household.

Since not all areas that compose the indicator are equally important for all households, the survey includes a question which asks the degree of importance assigned to each family to each of them (Question 13, appendix) corresponding to a linguistic label in the set S_3.

If $s_{\alpha_{jh}} \in S_3$ is the linguistic label that shows the importance allocated by the household h the area j

[1] EAA: extended arithmetic mean [16].

$(j=1,...,5)$; the weighting, w_{jh}, correspondent must verify that $w_{jh} \in [0,1] \sum_{j=1}^{5} w_{jh} = 1$, and is obtained by applying $w_{jh} = \alpha_{j_h} \Big/ \sum_{j=1}^{5} \alpha_{j_h} \ (h=1,...,n)$.

Having assessed the components of the index and obtained their respective weights, the $ILBE_h$ is obtained by the use of aggregation operator of linguistic information $ILBE_h = EWAA_h(s_{he}, s_{ed}, s_{ho}, s_i, s_{em}) = s_h$ [2].

If it is wanted to express the degree of aggregate welfare of each household by a term of the set S_1, the sub index of the virtual label s_h is approximated to an integer value through the usual rounding operation (*round* (h)) and it is got a linguistic original label.

Questions 11 and 12 will be used to compare the consistency of the households' responses, $s_{q_{11}} \in S_2$ and $s_{q_{12}} \in S_1$.

2.2. Objective Poverty Evaluation

It is needed to classify the household according to their income, because it is important to analyze how poor households perceive their welfare as how they do the non-poor ones. For classifying the household, we will employ the Fuzzy Poverty Lines and the Poverty Degrees developed by Fernandez [17]. In this model, poverty is considered as a matter of degree.

First, a Fuzzy Basic Food Basket (CBAF) is determined to calculate the Indigence Line to the Equivalent Adult. To assess the CBAF for an adult fuzzy triangular numbers are expressed by its confidence intervals and are operated with them [18]. Given $C = \{C_1,...,C_n\}$, its cardinal is $|C| = n$ monthly valuation of CBAF is given by: $V_{CBAF} = \sum_{i=1}^{n} Q^i \cdot P^i \ / \ Q^i, P^i \subset R^+ \quad \forall i = 1,...,n$.

Being C_i each *n* component of the basket, Q^i the quantity of component *i* of the basket, P^i the price of that good [17]. Then, a fuzzy scale is constructed to determine the units of equivalent adults of each household, obtained from a fuzzy energy needs table [17]. Being U^h the units of equivalent adults of h-th household and V_{CBAF} the valuation of CBAF for an equivalent adult unit, the valuation of the CBAF for the h-th household is: $V_{CBAF}^h = U^h \cdot V_{CBAF}$.

In order to obtain the fuzzy poverty line, it is indispensable to establish the fuzzy inverse of Engel's coefficient $\tilde{e}$ [3]. Fuzzy poverty line for the equivalent adult will be determined by: $LP_f = V_{CBAF} . \tilde{e}$.

[2] EWAA: weighted arithmetic mean [16].
[3] Fuzzy inverse Engel's coefficient relates food expenditures with non-food ones using triangular fuzzy numbers [17].

Being LP_f the fuzzy poverty line for the equivalent adult and U^h the units of equivalent adults of h-th household, the valuation of the Poverty Line for the h-th household is: $LP_f^h = U^h \cdot LP_f$.

Once calculated LP_f^h, household's monthly effective total income is compared and it is determined whether it is completely poor, not poor, or whether it is in the gray area. For classifying households within the gray zone, it is possible to associate the degree of belonging to the set of poor households with a set of labels. It is possible to construct a set of labels to classify households with respect to the concept of poverty (Table 1 and Figure 1).

	$\mu(x)$	Associated Label
Left Branch	$\mu(x) \leq 0$	Absolute
	$0 < \mu(x) \leq 0{,}25$	Very High
	$0{,}25 < \mu(x) \leq 0{,}75$	High
	$0{,}75 < \mu(x) \leq 1$	Medium
Right Branch	$0{,}75 \leq \mu(x) < 1$	Low
	$0{,}25 \leq \mu(x) < 0{,}75$	Very Low
	$0 \leq \mu(x) < 0.25$	Null
	$\mu(x) \geq 0$	

Table 1. Poverty degrees.

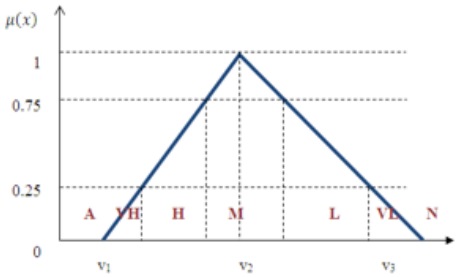

Figure 1. Poverty Degrees.

The use of this approach allows capturing the different degrees present when valuing a measure that represents welfare that is intended to measure. The use of fuzzy sets theory helps to understand the phenomenon dimensions more comprehensively.

2.3. Joint Poverty Analysis

In order to analyze the determinants of the non-poor / feeling poor and the poor / non feeling poor families, households will be separated into four groups.

The objective poorness or non-poorness will be assessed with the fuzzy poverty lines method. A household will be considered poor with a qualification lower than "High" (Left branch and $\mu(x) \leq 0.75$) and will be considered non poor in any other situation.

The subjective feeling of poverty will be determined with ILBE index. Once s_h is approximated to a label of the set S_1, it will be considered feeling poor households those who gets a valuation lower than "bad" (s_0, s_1 and s_2), and feeling non poor in any other situation.

Households will be categorized into 4 groups.

Group 1. Poor / Feeling Poor. Objective Poverty degree: "High", "Very High" and "Absolute" ILBE: "Bad", "Very Bad" and "Dreadful".	***Group 2. Poor / Non feeling poor.*** Objective Poverty degree: "High", "Very High" and "Absolute" ILBE: "Mean", "Good", "Very Good" and "Excellent".
Group 3. Non poor / Feeling poor.	***Group 4. Non poor / Non feeling poor.***

Objective Poverty degree: “Medium”, “Low”, “Very Low” and “Null” ILBE: “Bad”, “Very Bad” and “Dreadful”.	Objective Poverty degree: “Medium”, “Low”, “Very Low” and “Null” ILBE: “Mean”, “Good”, “Very Good” and “Excellent”.

Special attention will be paid to Group 2 and 4 in order to make deeper analysis of the determinants of perceptions of poverty.

3. Application

A household will be evaluated in order to classify it into one of the four groups outlined above.

In first place, it will be calculated the Fuzzy poverty line for that family, and then it will be compared with its income. For that period, the amount needed to buy the Fuzzy Basic Food Basket for the equivalent adult will be an approximate triangular fuzzy number: $V_{CBAF} = (1501.50, 1766.62, 2031.82)$ [17, 19]. Fuzzy inverse of Engel's coefficient will be $\tilde{e} = (2.30, 2.41, 2.50)$, and the poverty line for the equivalent adult will be an approximate triangular fuzzy number $LP_f = V_{CBAF}.\tilde{e} = (3453.45, 4257.4, 5079.55)$.

Household is structured as follows: Head of household, a female 35 years old, her son 18 years old and her mother 61 years old. This household represents $U^h = (2.17, 2.44, 2.59)$ units of equivalent adults. The fuzzy poverty line will be calculated and approximated to a triangular fuzzy number $LP_f^h = U^h \cdot LP_f = (7493.98, 10388.05, 13156.03)$ [17, 19].

The family declares to the interviewer that its monthly effective total income is $9500. Thus, its income belongs to the poverty set in a 0.69 degree; household presents a high level of objective poverty.

In a second phase, the household answer the subjective survey. The responses where:

Question	Valuation	Associated Linguistic Label	
1	Good	$s_{q_1} = s_4 \in S_1$	
2	Good	$s_{q_2} = s_4 \in S_1$	$s_{he} = EAA(s_{q_1}, s_{q_2}) = s_4$
3	Mean	$s_{q_3} = s_3 \in S_1$	
4	Good	$s_{q_4} = s_4 \in S_1$	$s_{ed} = EAA(s_{q_3}, s_{q_4}) = s_{3.5}$
5	Bad	$s_{q_5} = s_2 \in S_1$	
6	Bad	$s_{q_6} = s_2 \in S_1$	$s_{ho} = EAA(s_{q_5}, s_{q_6}) = s_2$
7	Very bad	$s_{q_7} = s_1 \in S_1$	
8	Bad	$s_{q_8} = s_2 \in S_1$	$s_i = EAA(s_{q_7}, s_{q_8}) = s_{1.5}$
9	Mean	$s_{q_9} = s_3 \in S_1$	

10	Mean	$s_{q_{10}} = s_3 \in S_1$
11	Rather poor	$s_{q_{11}} = s_2 \in S_2$
12	Bad	$s_{q_{12}} = s_2 \in S_1$

$s_{em} = EAA\left(s_{q_9}, s_{q_{10}}\right) = s_3$

Question 13: 1. Health → Very important → $s_{\alpha_1} = s_5 \in S_3 \rightarrow w_1 = 0.25$

2. Education → Very important → $s_{\alpha_2} = s_5 \in S_3 \rightarrow w_2 = 0.25$

3. Housing → Careless → $s_{\alpha_3} = s_3 \in S_3 \rightarrow w_3 = 0.15$

4. Income → Pretty Important → $s_{\alpha_4} = s_4 \in S_3 \rightarrow w_4 = 0.20$

5. Employment → Careless → $s_{\alpha_5} = s_3 \in S_3 \rightarrow w_5 = 0.15$

$ILBE_h = EWAA_h\left(s_{he}, s_{ed}, s_{ho}, s_i, s_{em}\right) = s_h = s_{2.92} \cong s_3 \in S_1 \rightarrow$ presents a mean feeling of poverty.

When classifying into one of the groups, this household belongs to Group 2 “Poor / Non feeling poor”. Further analysis will be needed to understand why this family doesn’t perceive poverty or maybe it weigh mostly access to certain goods or services than its own income.

4. Conclusions

Subjective welfare measures are a complementary tool of objective indicators. It is important to understand the connection between objective and subjective improvements.

The proposed approach allows showing different groups considering objective and subjective poverty. This disaggregated analysis will help the analysts to understand the determinants of poverty perceptions in relation to objective well-being.

The implementation of linguistic models will help to understand the degrees inherent in the analysis of human welfare.

In future researches it will be interesting to go deeper into the structure of the survey, the determinants of welfare perceptions versus the objective situation of poverty, and it will be possible to make contributions regarding the construction of a single index combining both approaches.

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Appendix. Survey form

1. You consider that your access to health care is:

Dreadful – very bad – bad – mean – good- very good – excellent.

2. You consider that your access to medication and vaccination, if needed, is:

Dreadful – very bad – bad – mean – good- very good – excellent.

3. You consider your education level is:

Dreadful – very bad – bad – mean – good- very good – excellent.

4. You consider that access to the education system is:

Dreadful – very bad – bad – mean – good- very good – excellent.

5. You consider that your housing conditions are:

Dreadful – very bad – bad – mean – good- very good – excellent

6. You think that the general conditions of their neighborhood (asphalt, lighting, sewers,etc.) are:

Dreadful – very bad – bad – mean – good- very good – excellent

7. You think your income is:

Dreadful – very bad – bad – mean – good- very good – excellent

8. How much extra home income your household need not to feel poor?

Income amount	*Linguistic label*	*Income amount*	*Linguistic label*
More than double	Dreadful	40 – 50% more	Good
double	Very bad	10 -30 % more	Very good
80 – 90% more	Bad	nothing	excellent
60 – 70% more	Mean		

9. Considering the number of the amount of hours that you work, you find it:

Dreadful – very bad – bad – mean – good- very good – excellent

10. You think that your working conditions are:

Dreadful – very bad – bad – mean – good- very good – excellent

11. Do you feel poor?

Absolutely poor – very poor – rather poor – nor poor or not poor – somewhat poor – almost non poor – non poor.

12. How do you evaluate your level of economic welfare?

Dreadful – very bad – bad – mean – good- very good – excellent

13. Indicate the importance of each area for your welfare.

area	Absolut. important	Very important	Pretty important	Careless	Little important	Rather unimportant	Unimportant
1. health							
2. Education							
3. Housing							
4. Income							
5. Employment							