On the definition and measurement of poverty: The contribution of multidimensional analysis

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On the definition and measurement of poverty: The contribution of multidimensional analysis[1]

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ON THE DEFINITION AND MEASUREMENT OF POVERTY:
THE CONTRIBUTION OF MULTIDIMENSIONAL ANALYSIS

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Abstract:

When defining poverty, a distinction should be made between the traditional unidimensional approach and more recent multidimensional ones. Whereas the traditional approach refers only to one variable such as income or consumption, multidimensional ones, such as Sen's capability theory or studies derived from the concept of fuzzy sets, extend the number of dimensions along which poverty is measured. The complex reality of poverty, however, makes it difficult to capture the nature of this phenomenon via a single uni- or multidimensional definition or measure. Here we try to define a broader framework of analysis that combines both approaches to improve the analysis of poverty at the level of definition and measurement and uses their policy implications in a complementary rather than in an antagonist way. We argue that uni-dimensional measures only plead for transfer policies that alleviate poverty in the short-term, whereas multidimensional measures permit the recommendation of structural socio-economic policies that could break the intergenerational reproduction mechanism of poverty in the long-term. We illustrate our framework using data from the European Community Household Panel.

Introduction

The multidimensionality of poverty is now widely recognized. The position taken by the World Bank in its report on poverty 2000/2001 relative to it[3], as well as, the adoption of a battery of official social exclusion indicators[4] by the European Union gives evidence that the multidimensional aspect of poverty has already become of great concern and is called to take a more and more important place in the study of this phenomenon.

The appearance of the multidimensional analysis of poverty constituted a clear breakthrough in the traditional treatment of this concept. Indeed, the study of poverty started with the work of Booth (1892) and Rowntree (1901), who were the first to introduce the economic concept of poverty, together with that of the poverty line and that of the Head Count ratio on the basis of the basic needs approach. The reference paradigm underlying their studies was the work of the material welfare school (Jevons, 1881; Marshall, 1920) based on the equivalence between income and welfare. Their leading contributions have been followed by numerous empirical, theoretical and methodological improvements that relied on the same paradigm.

During the 1970s, this approach began to be considerably criticized and, more particularly, doubt began to be cast on its results by the work of empirical sociologists[5]. This was the starting point for a great amount of studies of poverty taking different approaches. The latter can be divided in two main directions:

➢ The first one, following Sen's (1976) seminal paper, takes an axiomatic approach to poverty measurement. This direction of research provided us with a great number of mathematically sophisticated indicators based on incomes or expenditures. It gathers several informations about poverty like its prevalence, its intensity and the inequality between the poor in a single scalar measure.

➢ The second one attempts to take a more comprehensive view of poverty. Poverty has several dimensions, so it has to be dealt with in a multidimensional way. This multivariate direction includes the social exclusion approach of René Lenoir (1974), the work of Townsend (1979), the functionings and capabilities approach introduced by Sen (1980), the UNDP Human Poverty Index (1990, 1997, 1998)

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[3] World Bank Report (2000), *Attacking Poverty,* Washington
[4] Atkinson T., Cantillon B., Marlier E., Nolan B. (2002), *Social indicators: The EU and social inclusion,* Oxford University Press, Oxford, 240 p.
[5] Townsend, Abel-Smith (1965), *The poor and the poorest*

and the fuzzy sets approach applied to poverty which has had a great echo in Italy (Cerioli, Zani, 1990; Martinetti, 1994, 2000; Cheli, Lemmi, 1995).

This paper will be centered on this dichotomy between traditional and multidimensional approaches. The first part (Section 1) will deal with the differences between both approaches in terms of definition of poverty and the second (Section 2) in terms of measurement. The main purpose of this paper is to show that unidimensional approach, though having reached a high degree of sophistication, contain inherent deficiencies that can hardly be overcome unless using a multidimensional approach[6].

Moreover, the complex reality of poverty makes it difficult to capture the nature of this phenomenon via either a single uni- or multidimensional definition or measure. Poverty is actually a polysemic object of research that can be defined in several ways. We argue that each different existing definition and measure takes into account a peculiar facet of poverty. Each definition contains a part of truth but no single definition holds the truth in defining poverty. Here we try therefore to define a broader framework of analysis that combines both approaches to improve the analysis of poverty at the level of definition and measurement and uses their policy implications in a complementary rather than in an antagonist. We argue, following Dagum (2002)[7], that uni-dimensional measures only plead for transfer policies that alleviate poverty in the short-term, whereas multidimensional measures permit us to recommend structural socio-economic policies that could break the intergenerational reproduction mechanism of poverty in the long-term. It is from this difference in time that arises the idea of complementarity between these approaches.

We will endeavour to illustrate our framework (Section 3) using the data from the European Community Household Panel (ECHP).

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[6] Bourguignon F. in comment on Maasoumi E (1999), *Multidimensioned approach to welfare analysis*, in Silber J. (1999), *Handbook on Income Inequality Measurement,* Kluwer Academic Publishers, Dordrecht and Boston, : "The reason why multidimensionality may appear as one of the most fascinating problems in inequality (poverty) measurement is probably that it potentially permits to go beyond the strict utilitarian framework which lies behind most unidimensional inequality (poverty) measure."

[7] Dagum C. (2002), *Analysis and measurement of poverty and social exclusion using fuzzy set theory. Application and policy implications*, University of Bologna

Section 1. The concept of poverty and well-being: a change in paradigms

The first step in the process of poverty measurement consists of determining the definition underlying our reasoning. That means determining both how to assess individual well-being and at what level of well-being someone has to be considered as poor.

These questions constitute what Sen (1976) called the problem of identification which "involves the choice of a criterion of poverty (..), and then ascertaining those who satisfy that criterion (..) and those who do not"[8]. In this section we will focus on the difference of criterion of poverty between unidimensional approach and multidimensional ones in order to show the contribution multidimensional approaches can make to improve our understanding of the poverty phenomenon.

The traditional approach and its limits

The traditional approach to poverty is characterised by the fact that poor people are identified according to a shortfall in a monetary indicator. The theory implicitly underlying this assumption is the utilitarianism theoretically based on the criteria of utility and practically on the use of income or expenditure as a proxy of well-being. Henceforth, the criterion of poverty is here income and *poverty can be defined as a lack of economic welfare, i.e. income.*

In the case of the absolute poverty approach, poverty is a lack of income in order to satisfy the essential requirements for physiological survival. In the case of the relative approach of poverty, poverty is a lack of income in order to reach the average standard of living in the society in which one live.

The main criticism of this approach concerns two issues that it doesn't take into account and that constitute two pillars of the theoretical construction of Sen about capabilities.

The first is that traditional theory doesn't deal with the human diversity, i.e. both the variation of personal features of individuals and the differences in the socio-economic environment of each individual. This raises a problem when trying to make inter-personal comparisons. The common example is of an individual with a parasitic infestation. To fulfil his nutritional needs, the quantity of foods used will be higher than the one needed for a man who doesn't suffer from this parasitic disease.

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[8] The step of identification can be divided into the choice of an indicator, the choice of a unit of analysis and the choice of a poverty line. What we call criterion in this paper is the indicator that constitutes the metric to measure well-being. We won't talk in details about the others steps. See Ravallion (1992) or Ruggeri Laderchi (2000)

The second critique insists on the fact that in the traditional approach, individuals are denied the right to choose between different alternatives. The freedom of the individual to choose is a fundamental constituent of well-being. So, being deprived of it constitutes a clear reduction in well-being.

These critics shed light on the fact that the main problem of the traditional approach is that it fails to capture the complex reality of poverty at the level of each individual. Income can't take account of the diversity and the vague aspect of poverty so there is a structural theoretical conflict between the multidimensional nature of the poverty phenomenon and the unidimensional aspect of income-based approach.

On one hand, these criticisms about the imperfection of income as a proxy for well-being have called for an alternative paradigm on well-being that would permit a better comprehension of the poverty phenomenon.

On the other hand, despite the weaknesses of this theory it would be counterproductive to reject it. Indeed, as we will see in section 2, the simplicity of the computation of monetary indicators as well as the policy implications derived from them can happen to be useful in the framework of an overall fighting poverty strategy.

The contribution of multidimensional approaches

Multidimensional approaches such as Sen's capabilities allow us to have a more shaded comprehension of poverty because it takes into account its complex and pervasive nature.

As said before, the main multivariate analysis that have been developed are the social exclusion approach introduced by René Lenoir (1974)[9], the work of Townsend (1979), the UNDP Human Poverty Index (1990, 1997, 1998), the functionings and capabilities approach introduced by Sen (1985), and the fuzzy sets theory applied to poverty (Cerioli, Zani, 1990; Chiappero Martinetti, 1994, 2000; Cheli, Lemmi, 1995)[10].

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[9] Lenoir R. (1974), *Les exclus. Un Français sur dix,* Le Seuil or see Saith R., *Social exclusion: the concept and application to developing countries,* Queen Elizabeth House Working Paper Series N°72;

[10] Another approach has been explored by Valtriani P. (1993) who proposed a disjunctive concept of poverty. He says "the misunderstanding of poverty in France goes with the underestimation which stems from the very nature of the limited concepts used. Different poor populations are not gathered together, psychological poverty is not part of recognized concepts. The creation of a less minimal concept will provoke the integration of economic, sociological and psychological poverty into a disjunctive concept, instead of being conjunctive"

In this paper we are going to talk more particularly about (a) the functionings and capabilities approaches and (b) the fuzzy sets theory.

(a) The functionings and capabilities approach: constitutive plurality of well-being

As pointed out by Chiappero Martinetti (2000), "what mainly characterizes the capability approach with respect to other multidimensional approaches of well-being is that it is not simply a way to enlarge the evaluative well-being to variables other than income, but it is a radically different way to conceive the meaning of well-being".

Indeed, the capability approach represents a new framework for evaluating well-being. Its major feature is to interpret well-being as a matter of abilities in beings and doings instead of a matter of affluence.

The work of Sen (1985) starts from a critique of the traditional welfare approach based on utility. Indeed, for him, "insofar as opulence and utility have roles, these can be seen in terms of indirect connections with well-being and advantages". In his criticism of utilitarism, Sen considers that the possession of goods may not translate automatically into well-being as possession is different from ability to benefit from the characteristics of the goods possessed.

That's why to have a clear idea of well-being, we have to move from the informational space of utility to the informational space of functionings so as to understand what a person succeeds in doing with the commodities and characteristics at his/her command in order to satisfy his/her wants.

The capabilities approach permits us to overcome the two drawbacks raised against the traditional approach.

Concerning the first, Chiappero Martinetti (2000) notes that "functionings achieved are strictly related to the intrinsic characteristics of the people (age, gender, health and disability conditions) as well as to environmental circumstances (at the social-economic and institutional level but also referred to the household environment); and the conversion process of the available resources into well-being is strictly related to and dependent on these individual and environmental features."

Concerning the second, the concept of capability refers cogently to the freedom of choice between different alternatives that a person has to promote or achieve valuable functionings. Indeed, the functioning achieved is the chosen one between a set of feasible vectors of functionings. This set of vectors of functionings is the capability set. "It represents

the various combinations of functionings (beings and doings) that the person can achieve" (Sen 1985).

The criterion of poverty is here the *lack of fundamental capabilities, i.e. the lack of opportunity to attain basics functionings*. We therefore have to focus on the factors such as social obstacles or personal circumstances that can limit the capabilities of individuals to participate fully in the society to which they belong and to extend our field of research to others dimensions.

However, by so doing, we enlarge the set of qualitative and quantitative indicators that we have to deal with. This implies to find tools of measure enabling us to treat this wider set of variables. The fuzzy sets can be one of these tools.

(b) The fuzzy sets theory

Here we introduce the notion of fuzzy sets which, applied to the concept of poverty, is an attempt to take into account the multidimensional feature of poverty into the measurement tool and not a definition of the nature of poverty[11].

The theory of fuzzy sets was developed by Zadeh (1965) who noted that there are classes of objects that « do not have precisely defined criteria of membership » (p. 338) but rather can be characterised by "a continuum of grades of memberships" (p. 338).

Let X be a set and x belongs to X.

Let A be a fuzzy subset of X. A is characterised by:

$$[x, \mu_A(x)]$$

where μ_A is a mapping from X to the closed interval [0,1] and each $\mu_A(x)$ represents the grade of membership of x in A. The mapping μ_A is also called the membership function.

If A is a traditional subset, i.e. if we know exactly which element belongs to A and which not, then μ_A take the following form:

$\mu_A(x)=0$ if x doesn't belong to A;

$\mu_A(x)=1$ if x belongs to A;

If A is a fuzzy subset, then:

$\mu_A(x)=0$ if x does not belong to A

$0 < \mu_A(x) < 1$ if x belongs partially to A

$\mu_A(x)=1$ if x belongs entirely to A

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[11] Poverty is a field where, as shown for the case of the traditional approach by Ruggeri Laderchi (2000), definition and measurement are often interrelated.

As we will see in section 2, the entire problem consists in the formalisation of μ_A.

These basic definitions seem to suit the vague aspect of poverty. Indeed, if there are cases where the situation of a person is such that he should certainly be considered as poor and some where he should certainly not be considered as poor, there are others situations where it's not clear if someone has to be deemed poor or not. This analogy between the concept, poverty, and the theory, the fuzzy sets, makes it worth trying to apply this method in order to provide a better connection between theory and data analysis. This is what many researchers tried to do and there is now a quite consistent literature of articles applying fuzzy sets theory to poverty (Cerioli Zani (1990), Cheli and Lemmi (1994, 1995), Chiappero Martinetti (1994 2000), Costa (2002 2003) Dagum (2002) Vero (1999) Miceli (1997) Deutsch Silber (2003)…).

In itself, the fuzzy sets theory is not multidimensional. But moving to a multidimensional approach of poverty there are two points that make it an appropriate tool.

First, taking each dimension in turn, we are confronted by dimensions such as the sociological one or the psychological one that are not contained in precise boundaries. Hence, the deprivation of a person in these dimensions can be unclear.

Second, dealing with all the dimensions together, the state of a person can be unclear due to the fact that this person can manifest deprivation relative to a dimension, but not relative to the others. Hence, the membership of this person to the population of the poor is not precisely defined.

In its first applications to poverty, fuzzy sets have been used in order to derive multidimensional indicators. As we will see in section 2, it can also be used to endeavour to operationalise Sen's functionings (Chiappero Martinetti (2000)).

We have tried in this part of the paper to show the gain in terms of comprehension that can be achieved moving from the traditional to the multidimensional approaches. The latter lies mostly in the fact that it clearly improves our understanding of the overall phenomenon, dealing with it as a whole and not through a single dimension.

However, this gain in terms of understanding has its counterparts as it increases the difficulty to measure poverty. This will be the object of the next section together with the policy implications of the different measures.

Section 2: The measure of poverty: trying to operationalise functionings

In this section, through the presentation of (2.1) unidimensional measures of poverty, as well as (2.2) multidimensional ones, we will study the differences between them, their policy implications and the possibility to implement the functionings approach. For the latter issue, our analysis will be centered on the fuzzy sets theory that we consider to be a fitting method to account for the vague aspect of poverty.

Moreover, as pointed out by Sen (1985), talking about the assessment of interest, "It is quite unlikely that we get some *one* measure of interest that is superior to all others and applicable in all contexts." It's on the basis of this argument that we will propose to use these measures in a complementary rather than in an antagonist way.

2.1. the income-based poverty measurement

the second step highlighted by Sen (1976) in the process of poverty measurement is the problem of aggregation whose purpose is to aggregate the information collected in the identification phase into an index of poverty.

There are a number of indicators of poverty based on incomes. In this study, we have chosen to measure income-based poverty through the use of the most common ones which are (a) the head count ratio (HCR), (b) the poverty gap (PG) and (c) the Sen index. In this subsection, we shall briefly review these indexes, and stress on their policy implications[12].

a.) The simplest and most known measure of poverty is the Head Count Ratio (HCR), which indicates the proportion of poor people in the studied population. It is computed by taking the ratio between the number of poor units determined in the identification step and the total population.

With Z, the poverty line, y_i, the income of household i (if i is poor then $y_i < Z$), N, the total population and Q the population considered as poor, we can specify HCR:

$$HCR = \frac{Q}{N} \qquad \text{Head count ratio}$$

This index provides a simple quantitative information about the incidence of poverty in a given society. It is useful and often referred to, because easily understandable. Its main weakness is that it can't take into account the intensity of poverty, e.g. in a situation where a

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[12] Several surveys of poverty indices exist. Among them Atkinson (1987), Ravallion (1992)

poor gets poorer the HCR doesn't change (Monotonicity axiom). That's why beside the head count ratio we need others indexes of poverty.

b.) To overcome this drawback, we use the Poverty Gap, which measures the intensity (deepness) of poverty. The Poverty gap is the mean distance of the poverty line for the whole population, expressed as a percentage of the threshold value.

$$PG = \frac{1}{N} \sum_{i=1}^{n} \frac{G_i}{Z} = \frac{1}{N} \sum_{i=1}^{Q} (1 - \frac{y_i}{Z}) \qquad \text{Poverty gap}$$

where $G_i = Z - y_i$, if $Z > y_i$; else $G_i = 0$;

Here, in the case of a poor getting poorer (or richer but still under the poverty line) whereas the incidence of poverty (HCR) would be unchanged, the depth (PG) would change.

Most important for our purpose, the policy implications derived from income based measures can be easily found through the poverty gap because it gives us an idea of the cost of eradicating poverty, i.e. the additional quantity of resources that would normally be needed by the poor in order to reach the poverty line.

Following Ravallion (1992), two cases can be considered:

First, we make the hypothesis that policy makers can perfectly discriminate between the poor population (q) and the non poor population (n-q), then, the economic eradication of poverty will simply consist of redistributing to each targeted poor the equivalent of its income gap. The minimum cost C_{min} of eradicating poverty would be:

$C_{min} = (z-y_q).q$, where y_q is the mean income of the poor.

This cost is obviously a theoretical one as it doesn't take into account the others costs of the implementation of this kind of policy.

Second, we consider that policy makers can't discriminate at all between poor q and non poor (n-q) and so can't target their policy, the only way to be sure to eradicate poverty would be to transfer to the whole population n the amount of the poverty line z. This amount would represent the maximum cost C_{max} of eradicating poverty[13] :

$C_{max} = nz$

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[13] The values of C_{min} and C_{max} permits to estimate the savings that can be realized thanks to the

$$\frac{C_{min}}{C_{max}} = \frac{\left(z - \bar{y}\right)q}{zn} = \frac{q}{n} \cdot \left(1 - \frac{\bar{y}}{z}\right) = H.I = PG$$

we so have the relation $C_{min} = PG.C_{max}$ that implies that the minimum cost of eradicating economic poverty would be equal to the maximum cost nz multiply by the poverty gap.

The poverty gap has the weakness that it doesn't capture the severity of poverty as it can't take account of the transfer from the poor to the non poor. (transfer axiom).

To measure the severity of poverty we can compute the Sen index.

c.) The Sen index gathers together in the same scalar the information concerning the incidence of poverty, the intensity of poverty and the inequalities between the poor. Doing this, it respects the monotonicity and transfer axioms.

$$P_s=H[I+k(1-I)G_p]$$ Sen index

with G_p, the Gini coefficient between the poor; I, the Income Gap, $I=1-y_q/z$, y_q the mean income of the poor, and $k = q/(q+1)$

If there is no inequality between the poor we have $G_p=0$ and then $P_s=PG$

According to Cerioli and Zani (1990), the main criticisms to the traditional method are that (i) income is a somewhat imprecise concept (ii) the assessment of poverty on the basis of the sole monetary approach hides the plurality of situations faced by the poor and (iii) the separation between poor and non poor in a discriminant way is unrealistic. Indeed, this rigid discrimination between poor and non poor poses the problem of those people whose income is almost the same but who are not on the same side of the poverty line. Though they are bound to be confronted to the same economic problem they are not treated the same way.

The main advantages of traditional measures are from a practical order and lies in the simplicity of measuring them. They can be useful in counting poor people and targeting a population at economic risk. Concerning the anti-poverty strategy, these measures based on income give information on how could be implemented a transfer policy to allow poor people to reach the poverty line. These policies are useful because they can alleviate poverty but in the short term.

However, when you take poverty to be multidimensional in its causes and consequences, the problem is that there is no guarantee that an economic answer to the economic dimension problem would reach the other dimensions and that it would allow poor people to leave persistently from their situation of poverty.

To do this, we need information on how to implement a structural policy. Traditional measures seem unable to provide us with this kind of information. Henceforth, there is a need for measures of poverty that can take account of the multidimensionality of poverty in the spirit of the capabilities and functionings approach..

2.2. Fuzzy sets and functionings

We saw in the first section that fuzzy sets theory can be a useful tool when trying to deal with the multidimensional aspect of poverty. In this section, we expose some of the choice we have to make in order to operationalise Sen's theory and then how fuzzy sets permit to deal with the different dimensions of poverty so as to define a multidimensional index of deprivation and a functionings index.

According to Chiappero Martinetti (2000), to operationalise Sen capabilities, some choices have to be done: (a) the adequate evaluative space, (b) a list of capabilities or functionings and a set of indicators related to the selected dimensions of well-being with adequate criteria to measure and represent them and (c) the method to aggregate the elementary indicators to obtain an overall evaluation for each single dimension (functioning/capability) and to add up all the dimensions and to reach an overall evaluation of well-being. These points are treated in this section.

a. The adequate evaluative space: capability vs. achieved functioning;

In order to take account of the freedom parameter, which underlies Sen's concept, it would be of great interest to analyse well-being on the basis of the capability set. Nevertheless given the nature of capabilities, it is quite difficult to operationalise it and as pointed out by Sugden (1993), "given the rich array of functionings that Sen takes to be relevant, given the extent of disagreement among reasonable people about the nature of the good life, and given the unresolved problem of how to value sets, it is natural to ask how far Sen's framework is operational"[14].

Brandolini and D'Alessio (1998) have exposed three reasons to stay at the level of functionings instead of capabilities. First, trying to measure capabilities implies the enumeration of the whole set of alternatives which, in theory, can be infinite. Second, The time dimension can create problems. Third, capability measurement is highly demanding in terms of information. Statistical database gives information on what occurred and not on what

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[14] Sugden R. (1993), *Welfare, resources and capabilities: a review of inequality reexamined by Amartya Sen,* Journal of economic literature, 31, pp.1947-1962

could have occurred. This difficulty in dealing with a set of unobservable options has led many researchers to opt for the analysis of functionings.

These are also the reasons why we will restrict our work to an operationalisation of the functionings.

b. Choice of dimensions and indicators

If we argue that poverty is multidimensional, we have to say what we mean by multidimensional, i.e. what is a dimension, and what are the multiple dimensions of interest in constituting well-being, hence poverty.

Indeed, the choice of the set of indicators of living condition is a fundamental step of the multidimensional poverty measurement process and has obviously a great importance in terms of results and policy implications.

The questions we have to answer are (Alkire 2002), how many dimensions can we have? Is there a definite set of dimensions that can be constructed or are every possible dimension relevant in defining the multidimensionality of poverty?

We found two ways to choose indicators of living conditions, other than by hunch, one *a priori* and one *a posteriori*.

The *a priori* is to rely on recommendations made by the *bon sens* of a philosopher or a school of long tradition. The problem is then to see at what extent we can follow the recommendations of this kind of list. It clearly depends on the database we work with. The result is then a compromise between data and theory.

The *a posteriori* is the result of applying a multivariate technique of data analysis (PCA, cluster analysis) on the sample but as pointed out by Schokkaert and Van Ootegem (1990) there is no guarantee that the list is exhaustive.

In our application, the list of elements we have chosen is derived from the a priori method. The topic of constitutive dimensions of well-being has been debated many times so that, except for controversial point, the basis of this kind of list can be reliable.

c. Using fuzzy sets theory to aggregate dimensions and operationalise functionings;

To see how to aggregate the elementary indicators to obtain an overall evaluation for each single dimension, let's turn to the fuzzy sets theory.

This step consists of two operations. The first one (c.1) is to specify the membership function for each indicator, and the second (c.2) to specify the weighting structure.

c.1 The membership function

Here we are going to identify how we can compute on one hand, a multiple deprivation ratio, on the other hand, a functionings ratio.

Let X be a set representing a population and x belongs to X are the individuals.

Let A be the fuzzy subset consisting of the poor. μ_A is the membership function. Then, we have:

➢ $\mu_A(x)=0$ if x does not belong to A, i.e. x is certainly not poor;

➢ $0<\mu_A(x)<1$ if x belongs partially to A, i.e. x is partially poor;

➢ $\mu_A(x)=1$ if x belongs entirely to A, i.e. x is certainly poor.

Moving forward to the operationalisation of functionings, we have to pose the problem in the opposite sense. Following Chiappero Martinetti (2000), we let F be "the fuzzy subsets that defines the position of each individual according to the degree of achievement of a given attainment (functionings)." In this case, if:

➢ $\mu_F(x)=0$, there is a complete failure in achieving the functioning represented by X

➢ $0<\mu_F(x)<1$, there is a partial achievement of the functioning represented by X

➢ $\mu_F(x)=1$, there is a complete achievement of the functioning represented by X

The central problem of this approach is to give an appropriate definition of the membership function. Several proposition have been made in the literature, in this paper, we apply the method proposed by Cerioli and Zani (1990)[15].

Let $D=[D_1,..,D_k]$ be the set of the living conditions indicators, i.e. the list of the dimensions and their components chosen in the previous step

Let K_j be the subset of individuals being deprived in D_j; k_{ij} is then the value that denotes the degree of deprivation of variable j by individual i.

Let H_j be the subset indicating the level of achievement of the functionings represented by D_j; h_{ij} is then the value that denotes the degree of achievement of functioning j by individual i.

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[15] Other approaches using fuzzy sets have been used to compute multidimensional indexes of deprivation like the TFR, which has been introduced, by Cheli and alii (1994) and Cheli and Lemmi (1995).

In the first application to poverty by Cerioli and Zani (1990), three cases are considered: dichotomous variables, categorical variable and continuous variables.

They are presented below explaining each time both the case of computing the multidimensional deprivation ratio and the functionings index.

Dichotomous variables:

Deprivation index

The typical case of dichotomous variables is the possession or not of durable goods. But there are also some questions about subjective feelings that are dichotomous, i.e. answered by yes or no (e.g. in the ECHP, HF003: "Can the household afford keeping its home adequately warm?").

In the case of dichotomous variable, the membership function is:

$\mu_{Kj}(i) = 1$ if $k_{ij} = 0$

$\mu_{Kj}(i) = 0$ if $k_{ij} = 1$

The first case stands for an individual i deprived of good j ($k_{ij}=0$). The second, for an individual i possessing the good s ($k_{ij}=1$). We are here confronted to a traditional set.

Operationalising functionings

In this case, the possession of the good or a positive answer about a subjective question denotes an achievement in the functioning:

$\mu_{Hj}(i) = 1$ if $h_{ij} = 1$

$\mu_{Hj}(i) = 0$ if $h_{ij} = 0$

Here the situation is different. The possession of good j ($h_{ij}=1$) will denote an achievement in the functioning ($\mu_{Hj}=1$), while the deprivation denotes ($h_{ij}=0$) a failure in the achievement of the functionings represented by H_j ($\mu_{Hj}=0$).

Categorical variables

Deprivation index

The categorical variables are those that present several modalities (more than two). For instance, in the ECHP, the question : "How is your health in general? (PH001)".

The variable presents m modalities $\{k_{ij}^{(1)}, \ldots, k_{ij}^{(m)}\}$, ranked from the modality with a higher risk of poverty to the one with the lower, i.e. in a decreasing risk of deprivation (and so as to have a correspondence with the continuous variables).

For the PH001 variable it means that the values would be {*1.Very Bad, 2.Bad, 3.fair,4. Good, 5.Very Good*}. We assign a score $c_j^{(r)}$ to each modality respecting the ordering we choose. The correspondence with the integers is often chosen so that $c_j^{(r)}=r$.

Here the membership function to the fuzzy subset K_j of the individuals deprived in j will be:

$$\text{Categorical variable}\begin{cases} \mu_{K_j}(i) = 1 & \text{if} \quad O < c_{ij} \leq c_{\text{inf}, j} \\[2mm] \mu_{k_j}(i) = \dfrac{c_{\text{sup},j} - c_{ij}}{c_{\text{sup},j} - c_{\text{inf}, s}} & \text{if} \quad c_{\text{inf}, j} < c_{ij} < c_{\text{sup},j} \\[2mm] \mu_{K_j}(i) = 0 & \text{if} \quad c_{i, j} \geq c_{\text{sup},j} \end{cases}$$

$C_{\text{inf},j}$ and $C_{\text{sup},j}$ stands for the two thresholds values. The value being arranged in a decreasing order of deprivation, $C_{\text{inf},j}$ is the threshold under which the individual is certainly deprived in the dimension represented by the indicator K_j, and $C_{\text{sup},j}$ is the threshold above which the individual is certainly not poor relative to dimension K_j. If c_{ij} is between these two thresholds then the individual i is partially deprived in K_j. In this paper, we've chosen the lowest modalities as $c_{\text{inf},j}$ and the highest modalities as $c_{\text{sup},j}$.

The case of the categorical variables is the most debatable in that we have to make the hypothesis that the modalities are equally spaced.

Operationalising functionings

In this case, we make the same reasoning but the membership function is not the same.

The value being arranged in a decreasing order of deprivation, i.e. the highest values denote a higher achievement of the functionings, we have:

Categorical variable $\begin{cases} \mu_{H_j}(i) = 0 & \text{if} & O < c_{ij} \pounds c_{inf,j} \\ \mu_{H_j}(i) = \dfrac{c_{ij} - c_{inf,j}}{c_{sup,j} - c_{inf,j}} & \text{if} & c_{inf,j} < c_{ij} < c_{sup,j} \\ \mu_{H_j}(i) = 1 & \text{if} & c_{i,j} \, ^{\text{a}} \, c_{sup,s} \end{cases}$

Continuous variable:

Deprivation index

An obvious example of a quantitative continuous variable is income or expenditure. The values are ranged in a decreasing order of deprivation, i.e. the highest value denotes the lowest risk of being poor. The underlying hypothesis is again that there should be a value $k_{j,sup}$ above which the individual is certainly not deprived relative to K_j, and a value $k_{j,inf}$ under which the individual is certainly deprived in K_j. Between these two values the situation of the individual respect to the dimension is not clear. We have three cases[16] :

Continuous variable $\begin{cases} \mu_{K_j}(i) = 1 & \text{if} & 0 \, \pounds \, k_{ij} \, \pounds \, k_{i,inf} \\ \mu_{K_j}(i) = \dfrac{k_{j,sup} - k_j}{k_{j,sup} - k_{j,inf}} & \text{if} & k_{j,inf} < k_{ij} < k_{j,sup} \\ \mu_{K_j}(i) = 0 & \text{if} & k_{ij} \, ^{\text{a}} \, k_{j,sup} \end{cases}$

μ_{Kj} is assumed to be linear in this specification and is a decreasing function.

We could find many ways to fix k_{inf} and k_{sup}. An interesting possibility would be, as proposed by Cerioli and Zani (1990) to fix k_{inf} at a level of subsistence (absolute poverty) and k_{sup} at a level of the mean or the median per capita income (relative poverty).

Operationalising functionings

In the case of functionings, if the values are still ranged in a decreasing order of deprivation, that means that the highest value denotes a higher achievement of the functioning. We then have:

Continuous variable $\begin{cases} \mu_{H_j}(i) = 0 & \text{if} & 0 \, \pounds \, h_{ij} \, \pounds \, h_{j,inf} \\ \mu_{H_j}(i) = \dfrac{h_{ij} - h_{j,inf}}{h_{j,sup} - h_{j,inf}} & \text{if} & h_{j,inf} < h_{ij} < h_{jsup} \\ \mu_{H_j}(i) = 1 & \text{if} & h_{ij} \, ^{\text{a}} \, h_{j,sup} \end{cases}$

μ_{Hj} is assumed to be linear in this specification and is an increasing function.

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[16] For income between h_{inf} and h_{sup}, the membership function takes value between 0 and 1. $\mu_A(i) = f(y_i)$ where f is a decreasing function of income. That's why we can choose linear function. Cerioli and Zani proposed that an alternative to the a priori specification of the functional form of μ_A is to evaluate f through subjective judgments of the individuals themselves.

d.2 Aggregation and weighting procedure

It is now necessary to aggregate these values. By so doing, poverty can be regarded as an accumulation of deprivation situations.

The aim of the aggregation is to gather several sets of information into a single measure. In the multidimensional approach of poverty, while it is possible to consider methods for combining these indicators into a single measure, there seems to be no adequate theory underlying such an aggregate so that the weighting procedure is inevitably arbitrary or debatable. The best method to aggregate is to rely on a frequency-based approach (Brandolini D'Alessio 1998)[17].

Let's remember that:

- ➢ A is the subset of the poor and μ_{Kj} the degree of membership of individual i (i=1..n) relative to indicator K_j (j=1..m);
  - ➢ F is the subset that defines the position of each individual according to the degree of achievement of the functionings and μ_{Hj} is the degree of membership with respect to functioning H_j;

We will derive two ratios of deprivation and functionings[18]: (1) a multidimensional ratio of deprivation or functionings, for each individual (country in the case of the ECHP) i and (2) most important in terms of policy implications, a ratio of deprivation or functionings according to each dimension;

1. Fuzzy ratio of each household (country);

a. multiple deprivation index

Here we make the weighed average of each dimension membership degree μ_{Kj}:

$$\mu_A(i) = \frac{\sum_{j=1}^{m} \mu_{K_{ij}} w_{K_{ij}}}{\sum_{j=1}^{m} w_{K_{ij}}}$$

Where w_{Kj} is the weight of indicator K_j. Cerioli Zani (1990) and Cheli Lemmi (1995) have proposed the following frequency-based weighting measures.

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[17] Another solution is to give equal weights to every dimension. That is what has been done by the UNDP for its Human Development Index.

[18] Dagum (2002), Costa (2002, 2003)

$$w_{K_{ij}} = \frac{1}{\ln(F(K_{ij}))}$$

Where $F(K_{ij})$ represents the rate of individuals deprived in K_j:

The rationale behind the choice of the inverse function of the number of individuals in the reference population deprived in the indicator j for the weight w_{Kj} is to say that the more an attribute is present in the population, the more it is important, so it has to have a greater weight in the end.

It is a useful ratio to target policies when you study a population at a disaggregated level to compare the situation of different subgroups of the population, e.g. socioeconomics group, women and men, children and elderly, etc... In our application we apply this formula to compute the index of each country

b. functionings ratio.

The computation is the same, making the weighted average of each dimension membership degree μ_{Hj} :

$$\mu_F(i) = \frac{\sum_{j=1}^{m} \mu_{H_{ij}} w_{H_{ij}}}{\sum_{j=1}^{m} w_{H_{ji}}}$$

with
$$w_{H_{ij}} = \frac{1}{\ln(F(H_{ij}))}$$

This ratio can stand for the well-being of individual i.

2. A fuzzy ratio of the population according to each dimension (indicators);
a. deprivation index

This second result is of a great importance for our purpose because as pointed out by Dagum (2002), "it contains the basic information that political decision makers need for the design of structural socioeconomic policies aimed at the steady abatement of the main causes

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of poverty [..]."[19] It simply consists in the mean through the population of the membership functions for the dimension K_j.

$$\mu_A(K_j) = \frac{\sum_{i=1}^{n} n_{ij}\mu_{K_j}}{\sum_{i=1}^{n} n_{ij}}$$

It's worth stressing that it is a unidimensional ratio because talking about one dimension, and a multidimensional ratio because constituted of several variables.

b. functionings ratio

As for the precedent ratio we make the same calculus using the appropriate notation.

$$\mu_F(H_j) = \frac{\sum_{i=1}^{n} n_{ij}\mu_{H_j}}{\sum_{i=1}^{n} n_{ij}}$$

The above methodology has the advantage to be able to deal with the different dimensions constitutive of well-being. By so doing, it is able to give us insight about the socio-economic policy that one should implement to eradicate poverty.

Making a parallel with traditional measures it is also a way to remedy to their drawbacks. Indeed, in this section, we presented the income-based measures and their ability to guide us on how to implement a transfer policy. However, these measures don't provide us with the information needed to implement structural socio-economic policies. Thanks to the ratio computed on each dimension, multidimensional measures provide some insights to support the elaboration of these kinds of socio-economic policies.

Henceforth, it might be interesting to see how we could use both approaches in a complementary way, instead of opposing them. That's what we are going to see in the next section through an application to the European Community Household Panel.

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[19] Dagum (2002), p.20. We find the same idea in Costa (2002 2003).

section 3: Application to the ECHP and policy implication: A broader framework of poverty analysis

To illustrate our ideas, we used the data of the European Community Household Panel (ECHP), which is a multidimensional survey on 15 European countries performed every year since 1994[20]. The ECHP is designed as a longitudinal survey and it has been repeated with approximately the same sample since its launch in 1994[21].

The ECHP is the first real comparative household panel study released covering European Union member States. It contains sampled micro-data at individual and household level. It is a multi-dimensional and multi-purpose survey.

Our initial project was divided in two parts:

The first one consisting of the application of both traditional and multidimensional measures of poverty to one of the seven waves to see the complementarity of these measures and the second in making a longitudinal study in order to illustrate the difference between short term and long term poverty.

The preliminary results of the first part are presented here.

We analysed the data of the 7th wave of the survey related to the year 2000. We had to eliminate Germany, Sweden, Luxembourg and The Netherlands because of the lack of some important data[22].

3.1. monetary based poverty.

Monetary resources are measured with reference to the household equivalent total net income, i.e. total household income minus taxes and social contribution divided by the corresponding value of the OECD equivalent scale[23], which controls for the household size in relation to the age of individual household members. The poverty line (Z) is set at 60% of the median equivalized income, which is the European norm, and expressed in purchasing power standards (PPS).

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[20] The countries are: Germany, Denmark, The Netherlands, Belgium, Luxembourg, France, United Kingdom, Ireland, Italy, Greece, Spain, Portugal, Austria, Sweden, Finland.

[21] We have to note that 2001, which is the 8th wave of ECHP will be the last wave. It will be replaced by the EU-SILC (European Survey of Income and Living Conditions) from 2004 (2005 for UK).

[22] This is due to the fact that Germany and Luxemburg for the year 2000 use their own national survey, the GSOEP for Germany and the PSELL for Luxemburg. For Sweden it is because it joins the survey later and had to harmonize the data. The elimination of The Netherlands is based on the fact that some data where not so clear.

[23] According to the modified OECD equivalent scale the number of adult equivalents in a household is $n_e=1+0.5*(n_a-1)+0.3*(n-n_a)$ where n_a is the number of adults (more than 14 years) and n the household size.

The results are presented in table 3.1.

2000	Z	HCR	PG	SEN
Denmark	9808	11.49%	2.42%	3.54%
Belgium	8617	13.48%	3.20%	4.72%
France	8044	15.61%	3.59%	5.21%
Ireland	7039	20.09%	4.98%	6.89%
Italy	6914	18.46%	5.87%	8.41%
Greece	5291	19.87%	6.50%	8.98%
Spain	5968	17.97%	5.28%	7.61%
Portugal	4660	20.83%	6.21%	8.77%
Austria	8953	11.61%	2.55%	3.84%
Finland	7122	10.88%	2.22%	3.28%
UK (BHPS)	8303	18.62%	5.41%	7.80%

Table 3.1: Poverty rates in Europe in 2000.
Source: Author computation based on the ECHP (7th wave)

In 2000, the lowest poverty line was in Portugal. There, a person was considered poor if he or she had less than 4660 PPS of equivalized income. The highest was in Denmark were this line is set at 9808 PPS in equivalized income[24]. This shows the disparity of the situation European countries have to face.

As mentioned in section 2, the HCR is a measure of the incidence of poverty. Here it is a relative measure and so reflects the inequality of the equivalized income distribution within countries. In Europe poverty is more concentrated in Southern Europe, Portugal, Greece, Italy, Spain, and Anglo-Saxon countries, Ireland and United Kingdom, whereas the North of Europe is less poor.

Portugal and United-Kingdom, though having really different relative poverty line, respectively 4660 and 8303 PPS in equivalized income, display both high rate of poverty, i.e. 20.83% and 18.62%. this gives an idea of the high degree of inequality in these two countries, but to know more about that we have to look at the Poverty Gap.

Considering that the PG is the average income shortfall from the poor, the higher it is, the higher is the intensity of poverty. The PG tends to be higher in countries that display a higher poverty rate, i.e. Portugal, Greece, and lower in countries with lower poverty rates, i.e. Denmark or Finland. But there are cases where it is not the case. Ireland has a poverty rate (20.09%) at the level of those of Greece (19.87%) and Portugal (20.83%). However, the Irish PG is lower (4.98%) than those of Greece (6.50%) or Portugal (6.21%). That means that people deemed poor in Ireland seem to be concentrated just below the poverty line. So an

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[24] The poverty line of Luxembourg is three times more, 13594 PPS of equivalized income. But we excluded it from our study.

economic policy of transfers aimed at raising the income of poor people in Ireland would need a lower amount of resources than in Greece or Portugal.

A third index gives us information on the severity of poverty, the Sen index, which combine incidence and intensity of poverty with inequality among the poor. In Europe, we found that the same countries as for the other index have the highest value for the Sen index: Greece (8.98%), Portugal (8.77%), Italy (8.41%), UK (7.8%), Spain (7.61%). The Northern countries have lower values. The case of Ireland is a bit special with an intermediate value respective to the high poverty rate.

These measures allow us to have a consistent vision of income based indicators in Europe. They are important for assessing poverty risks in each country and to specify anti-poverty strategy. Each measure gives a particular information on monetary poverty but to have an overall view of the problem we have to use them all because concentrating on one measure could lead to biased conclusions and policies.

In terms of policy implications we can see that transfer policies, as aforementioned, can be advocated in different ways in Ireland or Portugal, whereas no information is given about structural policies. We are going to see if this information can be provided by the fuzzy sets.

3.2. Fuzzy sets approach applied to the ECHP

The ECHP provide us with a large set of indicators that can represent various functionings. These indicators separated into categories such as housing conditions, possession of durable goods, general financial situation, perception of hardships etc.. We selected the variables on the basis of their presence in all the countries and we mixed both objective and subjective information

For our purpose, following different lists of indicators[25], we identified seven dimensions to be studied, namely economic resources, housing conditions, material control over one's environment, education, bodily health, affiliation or social interactions and satisfaction with one's situation. Each of these dimensions is represented by a set of indicators. These dimensions that can be considered as being constitutive of well-being. That

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[25] Starting from the work of Cheli Lemmi (1995), Chiappero Martinetti (2000), Brandolini D'Alessio (1999), Nussbaum (2000), Alkire (2002), Costa (2002 2003)

is deprivation in one of these dimension would increase the index of poverty and decrease the associated index of functionings.

A. The dimension *Economic resources* gathers an objective information, the equivalized income which is a continuous variable[26] and several subjective information such as the affordability to do different things (see the list in annex), ability to make ends meet or to save money.

B. The dimension *Housing conditions* is related to information about the accommodation , i.e. the absence or not of some basic housing facilities (Heating, Bath,..) and a crowding index[27].

C. In this dimension we gathered information on what Nussbaum (2000) called *Material control over one's environment*[28]. It contains objective information on the possession of durable goods, the tenure status and the labor market status. It is called *DURABLE* in the tables.

D. The dimension *Education* has just one indicator, which is the highest level of education completed by the reference person of the house[29].

E. The dimension *social interaction and environment* informs us on the social relations of the person (talk to neighbours, see friends) and if there are environmental problems (crime, noise) in the area where he/she lives (these are all subjective judgement).

F. The dimension *Health* relies on two indicators, one objective, the presence or not of a chronic disease, and one about the person's own perception of her health.

G. The dimension *Subjective Satisfaction* which is constituted of four question about the satisfaction of the person with his/her work, financial situation, housing situation and amount of leisure time.

We computed the multiple deprivation (functionings) index for each country and for each dimension following the methodology described in the previous section.

The results for the multidimensional deprivation index and the functionings index are presented in tables 3.2 and 3.3, which contain the ratio for each dimension and the overall

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[26] A person was considered totally poor if his/her equivalized income was less than the 5th percentile, and not poor if it was more than the median

[27] We gave the following decreasing values to the crowding index

Number of person per room	]0,1]	]1,2]	]2,3]	]3,4]	>4
Score	5	4	3	2	1

[28] Nussbaum (2000), "Material control over one's environment: Being able to hold property (both land and movable goods), not just formally but in terms of real opportunity; and having property rights on an equal basis with others; having the right to seek employment on an equal basis with others; having the freedom from unwarranted search for seizure. In work, being able to work as a human being, exercising practical reason and entering into mutual relationships of mutual recognition with other workers".

[29] There are three values according to the ISCED scale. ISCED 0-2 corresponds to less than second stage of secondary education, ISCED 3 to corresponds to second stage secondary school and ISCED 4-5 to more than second stage.

ratio for each country. The detailed results for each dimension deprivation indexes and weights are presented in annex.

COUNTRY	Eco	HOUSING	DURABLE	EDU	SOCIAL	HEALTH	SATISF	Overall
Denmark	0.080	0.018	0.098	0.523	0.098	0.278	0.235	0.095
Belgium	0.099	0.027	0.136	0.512	0.161	0.214	0.294	0.123
France	0.113	0.036	0.138	0.682	0.166	0.287	0.332	0.135
Ireland	0.093	0.029	0.111	0.683	0.087	0.202	0.297	0.104
Italy	0.178	0.033	0.128	0.757	0.195	0.206	0.446	0.152
Greece	0.283	0.071	0.123	0.701	0.121	0.192	0.463	0.171
Spain	0.149	0.029	0.112	0.714	0.109	0.251	0.388	0.124
Portugal	0.224	0.105	0.164	0.845	0.204	0.313	0.457	0.204
Austria	0.123	0.033	0.134	0.651	0.122	0.219	0.235	0.124
Finland	0.138	0.021	0.124	0.518	0.172	0.370	0.294	0.135
UK BHPS	0.116	0.014	0.052	0.397	0.167	0.268	0.293	0.101

Table 3.2: Multidimensional deprivation index in Europe in 2000.
Source: Author computation based on the ECHP (7th wave)

The membership degrees of Portugal and Denmark to the fuzzy subset of deprivation in the Social dimension are 0.204 and 0.098. Portugal is more deprived than Denmark in this dimension.

COUNTRY	Eco	HOUSING	DURABLE	EDU	SOCIAL	HEALTH	SATISF	Overall
Denmark	0.920	0.982	0.902	0.477	0.902	0.722	0.765	0.905
Belgium	0.901	0.973	0.864	0.488	0.839	0.786	0.706	0.877
France	0.887	0.964	0.862	0.318	0.834	0.713	0.668	0.865
Ireland	0.907	0.971	0.889	0.317	0.913	0.798	0.703	0.896
Italy	0.822	0.967	0.872	0.243	0.805	0.794	0.554	0.848
Greece	0.717	0.929	0.877	0.299	0.879	0.808	0.537	0.829
Spain	0.851	0.971	0.888	0.286	0.891	0.749	0.612	0.876
Portugal	0.776	0.895	0.836	0.155	0.796	0.687	0.543	0.796
Austria	0.877	0.967	0.866	0.349	0.878	0.781	0.765	0.876
Finland	0.862	0.979	0.876	0.482	0.828	0.630	0.706	0.865
UK BHPS	0.884	0.986	0.948	0.603	0.833	0.732	0.707	0.899

Table 3.3: Functionings membership degree in Europe in 2000.
Source: Author computation based on the ECHP (7th wave)

The membership degrees of Portugal and Denmark to the fuzzy subset of achievement of functionings in the Social dimension are 0.687 and 0.902. Denmark has a higher achievement than Portugal in this functionings.

Though a really accurate study of each country would be needed to understand the results and before making conclusions, we briefly try to stress on the main implications in terms of socio-economics policies these measures can have.

These preliminary results show that in many dimensions there is high (low) degree of achievement (deprivation) in Europe for most of the dimensions we treated.

There is a correspondence, talking about the countries, with the results found with the income-based measures. Southern Europe countries seem to be poorer (Portugal 0.204, Greece 0.171), and Northern countries in a better situation (Denmark 0.095 Finland 0.124). There is a difference for UK and Ireland that display two of the lower (higher) multidimensional poverty (functionings achievement) membership degree (UK 0.101 (0.899), Ireland 0.104 (0.896)).

The computation of a ratio for each dimension permits us to advocate several socioeconomic policies. The dimension showing the lowest degree of achievement is education and, at a lower scale health and subjective appraisal. These results are important in terms of policy implication as they tend to show the need for education and health policies that are of a structural nature and could be efficient in the long term to eradicate poverty.

A wider analysis framework

Poverty is truly a multidimensional phenomenon and so requires multidimensional policy and program interventions.

We've seen that income-based measures of poverty enable us to advocate transfer policies that could be efficient in the short term to alleviate poverty. In the same time it seems that multidimensional indices can provide us with information for implementing socioeconomics policies that could be efficient in the long term.

This distinction between short term and long term leads us to believe that it might be of great interest to attempt to conciliate both approaches in a same wider framework that would combine all the information at our disposition, income-based and multidimensional so as to be more efficient in poverty reduction strategies. Hence, from this difference of time can arise the idea of the complementarity of these two approaches. Transfer policies would help to alleviate poverty in the short term whereas socio-economics policies should aim at reducing poverty in the medium long term.

Conclusion: give robustness to the results

In this paper we have tried to explain what can be the potential contribution of multidimensional analysis in terms of definition and measurement of poverty. We also tried to define a broader framework of policy fighting combining short term transfers policies and long term structural policies.

Nevertheless, the research on which this paper is based is on-going. There is still work to do and results have to be taken with caution. As said before, our initial project was divided in two parts:

The first one consisted of the application of both traditional and multidimensional measures of poverty to the 7th wave of the ECHP to see the complementarity of these measures. This is the part we presented here and that has to be explored in more depth.

The second part consists of making a longitudinal study in order to illustrate the difference between short term and long term poverty. Indeed, a study on one wave may reveal itself not statistically robust enough in order to justify intergenerational reproduction of poverty breaking policies. It is proposed that panel data analysis can be useful in order to give robustness to the results found. Indeed, panel data allow us to explore the dynamics of poverty and makes it possible to distinguish between transitory and persistent poverty and between short and longer term effects of policy.

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ANNEX : THE LIST OF DIMENSIONS

A. **Economic resources**;

    A1. Household equivalent total net income, i.e. total household income minus taxes and social contribution (HI100) divided by the corresponding value of the OECD equivalent scale (HD005). Q

    A2.Ability to make ends meet (HF002) categorical

    A3.Affordability to keep its home adequately warm (HF003) D

    A4.Affordability to pay a week's annual holiday from home (HF004) D

    A5.Affordability to replace any worn-out furniture (HF005) D

    A6.Affordability to buy new rather than second-hand, clothes (HF006) D

    A7.Affordability to eat meat, chicken or fish every second day, if wanted (HF007)

    A8. Is there some money left to save (HF013)

    A9. Repay debts other than mortgage (HF001)

B. **Housing conditions**;

    B.1 The crowding index: i.e. number of person (equivalent?) per room, i.e. Household size (HD001)[30] divided dimension of the household residence (HA006A[31])

    B.2 Basic housing utilities

        B2a. Indoor flushing toilet (HA010)

        B2b. Bath (HA009)

        B2c. Damp walls (HA019)

C **. Material Control over one's environment**

    C1. Durable goods

      C1a.colour TV HB002

      C1b.video recorder HB003

      C1c. micro wave HB004

      C1d. dishwasher HB005

      C1e. telephone HB006

    C2. Tenure status HA023

    C3. Labor market status: main activity status PE002

D. Education

D1.Higher level of education completed by the reference person (PT022)

E. Social interaction and environment;

E1. affordability to have friends or family for drink or meal at least once a month (HF008)

E2. How often do you talk to your neighbour (PR003)

E3. How often do you meet friends or relatives not living with you (PR004)

E4. Is there any pollution crime or other environmental problem caused by traffic or industry (HA021)

E5. Is there crime problem in the area of the household residence HA022

E6. Does the accommodation have noise from the neighbours or from outside (HA015)

F. Bodily health: To have good health, including reproductive health; to be adequately nourished; to have adequate shelter;

F1. how is your health in general (PH001)

F2. Do you have any chronic physical or mental health problem, illness or disability? (PH002)

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[30] Total number of household member at present

[31] number of room without kitchen

G. Subjective Appraisal : Satisfaction,

        G1. satisfaction with your work or main activity (PK001)

        G2. satisfaction with financial situation (PK002)

        G3. satisfaction with housing situation (PK003)

        G4. satisfaction with amount of leisure time. (PK004)

ECONOMIC DIMENSION

COUNTRY	a1	a2	a3	a4	a5	a6	a7	a8	a9	Eco
Denmark	0.238	0.402	0.016	0.105	0.178	0.034	0.007	0.018	0.311	0.080
Belgium	0.249	0.403	0.022	0.161	0.181	0.046	0.018	0.067	0.168	0.099
France	0.256	0.468	0.041	0.232	0.232	0.042	0.025	0.046	0.231	0.113
Ireland	0.281	0.499	0.029	0.248	0.136	0.023	0.007	0.056	0.238	0.093
Italy	0.247	0.565	0.171	0.382	0.592	0.115	0.044	0.169	0.111	0.178
Greece	0.258	0.669	0.314	0.497	0.730	0.205	0.267	0.361	0.110	0.283
Spain	0.260	0.538	0.432	0.401	0.422	0.052	0.012	0.058	0.184	0.149
Portugal	0.260	0.646	0.604	0.617	0.722	0.384	0.033	0.162	0.141	0.224
Austria	0.248	0.481	0.016	0.203	0.372	0.091	0.050	0.103	0.114	0.123
Finland	0.256	0.446	0.049	0.271	0.229	0.082	0.038	0.081	0.253	0.138
United-Kingdom	0.246	0.408	0.010	0.142	0.127	0.045	0.068	0.192	0.255	0.116

Table A1a: Fuzzy deprivation index for the economic variables.

COUNTRY	a1	a2	a3	a4	a5	a6	a7	a8	a9
Denmark	1.435	0.910	4.114	2.252	1.725	3.379	4.963	4.006	1.167
Belgium	1.390	0.910	3.833	1.824	1.708	3.074	4.013	2.696	1.781
France	1.361	0.759	3.186	1.460	1.459	3.158	3.689	3.079	1.466
Ireland	1.271	0.696	3.557	1.396	1.995	3.763	4.931	2.881	1.435
Italy	1.398	0.572	1.767	0.962	0.525	2.160	3.132	1.778	2.201
Greece	1.356	0.402	1.158	0.699	0.314	1.585	1.322	1.019	2.210
Spain	1.347	0.620	0.839	0.914	0.863	2.958	4.408	2.851	1.693
Portugal	1.348	0.438	0.504	0.483	0.326	0.956	3.415	1.821	1.961
Austria	1.395	0.731	4.165	1.594	0.989	2.392	2.994	2.274	2.172
Finland	1.363	0.808	3.022	1.305	1.475	2.500	3.271	2.511	1.373
United-Kingdom	1.403	0.898	4.559	1.955	2.060	3.096	2.689	1.651	1.365

Table A1b: weights for the economic variable

HOUSING CONDITIONS

COUNTRY	b1	b2a	b2b	b2c
Denmark	0.0152	0.0067	0.0091	0.0597
Belgium	0.0141	0.0116	0.0143	0.1032
France	0.0192	0.0153	0.0201	0.1462
Ireland	0.0513	0.0123	0.0141	0.0549
Italy	0.0797	0.0081	0.0091	0.0809
Greece	0.0932	0.0532	0.0370	0.1273
Spain	0.0675	0.0021	0.0043	0.1222
Portugal	0.0816	0.0707	0.0689	0.3310
Austria	0.0355	0.0263	0.0166	0.0632
Finland	0.0315	0.0152	0.0159	0.0251
United-Kingdom	0.0133	0.0040	0.0039	0.0542

Table B1: Fuzzy deprivation index for the housing conditions variables.

COUNTRY	b1	b2a	b2b	b2c
Denmark	4.18896	5.01234	4.69485	2.8187
Belgium	4.26398	4.45285	4.24756	2.27114
France	3.95075	4.18254	3.90929	1.9225
Ireland	2.97037	4.40224	4.26312	2.90191
Italy	2.52914	4.81537	4.69925	2.51495
Greece	2.37263	2.93393	3.29759	2.06113
Spain	2.69524	6.17248	5.43959	2.10202
Portugal	2.5055	2.64956	2.67522	1.10551
Austria	3.33954	3.63673	4.09869	2.76084
Finland	3.459	4.18777	4.14169	3.68532
United-Kingdom	4.32363	5.51006	5.5516	2.91454

Table B2: weights for the housing conditions variables.

MATERIAL CONTROL OVER ONE's ENVIRONMENT

COUNTRY	C1a	C1b	C1c	C1d	C1e	C2	C3
Denmark	0.007	0.138	0.439	0.423	0.002	0.283	0.202
Belgium	0.020	0.185	0.245	0.516	0.042	0.200	0.247
France	0.024	0.196	0.302	0.497	0.018	0.303	0.276
Ireland	0.013	0.126	0.196	0.598	0.040	0.126	0.255
Italy	0.012	0.252	0.762	0.672	0.026	0.193	0.307
Greece	0.018	0.464	0.831	0.731	0.024	0.122	0.297
Spain	0.006	0.199	0.384	0.681	0.030	0.102	0.313
Portugal	0.018	0.331	0.603	0.710	0.075	0.278	0.218
Austria	0.012	0.229	0.309	0.367	0.024	0.336	0.230
Finland	0.041	0.237	0.156	0.428	0.008	0.254	0.246
United-Kingdom	0.006	0.027	0.086	0.578	0.010	0.143	0.038

Table C1: Fuzzy deprivation index for the material condition over one's environment.

COUNTRY	C1a	C1b	C1c	C1d	C1e	C2	C3
Denmark	4.97	1.98	0.82	0.86	6.20	1.26	1.60
Belgium	3.89	1.69	1.41	0.66	3.18	1.61	1.40
France	3.73	1.63	1.20	0.70	4.03	1.19	1.29
Ireland	4.34	2.07	1.63	0.51	3.21	2.08	1.37
Italy	4.40	1.38	0.27	0.40	3.64	1.64	1.18
Greece	4.03	0.77	0.18	0.31	3.75	2.10	1.21
Spain	5.08	1.62	0.96	0.38	3.52	2.28	1.16
Portugal	4.00	1.11	0.51	0.34	2.60	1.28	1.53
Austria	4.39	1.47	1.17	1.00	3.72	1.09	1.47
Finland	3.19	1.44	1.86	0.85	4.86	1.37	1.40
United-Kingdom	5.04	3.63	2.45	0.55	4.60	1.94	3.26

Table C2: weights for the material condition over one's environment.

EDUCATION

COUNTRY	d1	weight d1
Denmark	0.523	0.648
Belgium	0.512	0.670
France	0.682	0.382
Ireland	0.683	0.382
Italy	0.757	0.279
Greece	0.701	0.355
Spain	0.714	0.337
Portugal	0.845	0.168
Austria	0.651	0.429
Finland	0.518	0.658
United-Kingdom	0.397	0.924

Table D: Fuzzy deprivation index and weight for the education

SOCIAL INTERACTION AND ENVIRONMENT

COUNTRY	e1	e2	e3	e4	e5	e6
Denmark	0.018	0.294	0.235	0.045	0.091	0.129
Belgium	0.067	0.288	0.227	0.102	0.180	0.230
France	0.046	0.355	0.210	0.166	0.190	0.210
Ireland	0.056	0.141	0.085	0.067	0.106	0.088
Italy	0.169	0.199	0.193	0.167	0.160	0.345
Greece	0.361	0.075	0.120	0.127	0.048	0.174
Spain	0.058	0.125	0.093	0.097	0.112	0.224
Portugal	0.162	0.160	0.257	0.182	0.218	0.281
Austria	0.103	0.237	0.290	0.050	0.049	0.186
Finland	0.081	0.219	0.227	0.130	0.222	0.232
United-Kingdom	0.192	0.276	0.195	0.069	0.146	0.217

Table E1: Fuzzy deprivation index for the social interaction and environment variable

COUNTRY	e1	e2	e3	e4	e5	e6
Denmark	4.006	1.224	1.447	3.093	2.395	2.051
Belgium	2.696	1.243	1.482	2.286	1.715	1.471
France	3.079	1.037	1.560	1.797	1.661	1.561
Ireland	2.881	1.958	2.464	2.699	2.242	2.435
Italy	1.778	1.615	1.646	1.790	1.831	1.064
Greece	1.019	2.595	2.123	2.067	3.039	1.749
Spain	2.851	2.083	2.380	2.332	2.189	1.496
Portugal	1.821	1.831	1.358	1.706	1.525	1.270
Austria	2.274	1.438	1.237	3.003	3.014	1.682
Finland	2.511	1.521	1.482	2.044	1.506	1.462
United-Kingdom	1.651	1.289	1.632	2.676	1.921	1.527

Table E1: Weights for the social interaction and environment variable

HEALTH

COUNTRY	f1	f2
Denmark	0.226	0.352
Belgium	0.267	0.175
France	0.359	0.236
Ireland	0.189	0.217
Italy	0.350	0.131
Greece	0.211	0.176
Spain	0.307	0.209
Portugal	0.435	0.242
Austria	0.257	0.189
Finland	0.325	0.430
United-Kingdom	0.256	0.281

Table F1: Fuzzy deprivation index for the health variables

COUNTRY	f1	f2
Denmark	1.489	1.044
Belgium	1.322	1.744
France	1.025	1.445
Ireland	1.668	1.528
Italy	1.050	2.032
Greece	1.556	1.739
Spain	1.181	1.564
Portugal	0.833	1.418
Austria	1.360	1.667
Finland	1.124	0.843
United-Kingdom	1.363	1.270

Table F2: Weights for the health variables

SUBJECTIVE APPRAISAL: SATISFACTION

COUNTRY	g1	g2	g3	g4
Denmark	0.216	0.309	0.182	0.258
Belgium	0.282	0.367	0.222	0.341
France	0.321	0.457	0.257	0.347
Ireland	0.296	0.444	0.221	0.294
Italy	0.465	0.569	0.364	0.445
Greece	0.471	0.564	0.391	0.468
Spain	0.390	0.513	0.302	0.405
Portugal	0.453	0.606	0.400	0.434
Austria	0.224	0.371	0.161	0.247
Finland	0.288	0.383	0.236	0.298
United-Kingdom	0.337	0.402	0.179	0.340

Table G1: Fuzzy deprivation index of the variables

COUNTRY	g1	g2	g3	g4
Denmark	1.532	1.175	1.703	1.356
Belgium	1.264	1.003	1.506	1.074
France	1.135	0.783	1.359	1.059
Ireland	1.218	0.812	1.512	1.225
Italy	0.766	0.564	1.010	0.809
Greece	0.752	0.572	0.940	0.760
Spain	0.942	0.667	1.197	0.903
Portugal	0.792	0.501	0.917	0.834
Austria	1.496	0.990	1.826	1.397
Finland	1.244	0.960	1.442	1.209
United-Kingdom	1.088	0.912	1.720	1.080

Table G2: weights