Evaluating subjective suffering in Italy with partially ordered sets

La valutazione del disagio soggettivo in Italia attraverso gli insiemi parzialmente ordinati

Marco Fattore, Filomena Maggino[1]

Abstract The goal of the chapter is to investigate the effects of the global economic crisis on subjective well-being, and on its connections to objective life conditions. The study focuses primarily on suffering people that is on people who are suffering from health, economic, cultural or relational aspects, at objective or subjective level. What are the patterns of "suffering"? How are they changing over time and during the economic crisis? Is a polarization process going on in the Italian society, worsening the conditions of suffering people and sharpening the distance between them and other social groups? The chapter deals with these questions, analyzing data from the "Multipurpose Survey on Families" held by the Italian National Institute of Statistics (ISTAT), over years from 2005 to 2010. The analysis will be pursued both at national and regional level, over different years, to give a comprehensive and dynamical picture of "suffering" in Italy. To deal with such complex datasets, comprising many variables of an ordinal kind, new statistical tools will be used, based on the theory of partial orders. These tools allow us to address the construction of synthetic indicators avoiding aggregative procedures, which are unfeasible with qualitative data. To present and justify the use of such new statistical tools, a part of the chapter will be devoted to the methodological issues to face when using subjective data and, more generally, large sets of weakly interdependent ordinal variables.

Key words: Suffering, Subjective well-being, Quality of life, Italy, Gender, Synthetic indicators, Partially Ordered Set.

[1] Dipartimento di Statistica e Metodi Quantitativi, Università degli Studi di Milano-Bicocca, marco.fattore@unimib.it

Dipartimento di Statistica, Informatica, Applicazioni "G. Parenti" (DiSIA), Università degli Studi di Firenze, filomena.maggino@unifi.it

1. Introduction

The dimensions of human suffering are different, are related to different human physical and psychological aspects and refer to different life domains. The psychological aspect of suffering can be observed through different lens, among which the subjective wellbeing / ill-being can represent one of the most meaningful. Self-perceptions are in fact a key element in one's own personal life and may strongly contribute to personal happiness and overall life satisfaction, particularly in a "beyond GDP" perspective. In this chapter, we thus adopt the subjective point of view and perform a first study of subjective suffering in Italy across the beginning of the global economic crisis.

1.1 Defining subjective wellbeing

One of the most accepted and adopted definitions of *subjective wellbeing* conceives it as a composite construct described by two distinct components, cognitive and affective (Diener, 1984).

The *cognitive component* is related to the process through which each individual retrospectively evaluate (in terms of "satisfaction") her/his own life, as a whole or in different domains. The subjective evaluation is made by taking into account personal standard (expectations, desires, ideals, experiences, etc…). Consequently, the level of satisfaction is expressed as a function of the reached objective, fulfilled ambitions, comparing ideals, experiences, other persons. In other words, satisfaction with life is the result of a cognitive process, allowing the individual to evaluate her/his present situation with reference to *standards* (Nuvolati, 2002) individually defined.

The affective component refers to the emotions experimented by individuals during their daily lives and relates to the individuals' present situation. The emotions can be positive (*pleasant affects*) or negative (*unpleasant affects*), which are considered conceptually distinct and influenced by different variables (Bradburn, 1969; Diener & Emmons, 1984; Argyle, 1987). Observing this component is particularly important since it allows us to obtain information about the temperamental structure used by each individual in facing everyday life. According to some authors, like Veenhoven, affects' determinants are universal and consequently not produced by individual response-styles or cultural differences.

The combination of the two components allows subjective wellbeing to be assessed. Summarizing, the concept of subjective wellbeing can be framed through the following dimensions:

1. "cognitive" dimension
    - satisfaction with life as a whole
    - satisfaction with different life domains
1. "affective" dimension
    - positive *affect* (happiness, serenity, etc…)
    - negative *affect* (concern, anxiety, stress, etc…)

- *affect* related to particular situations or activities (family, work, etc…).

1.2 Observing subjective wellbeing: life domains

Life satisfaction, as well as other relevant concepts and dimensions, has to be assessed and observed within each *life domain*. Life domains represent segments of reality in which fundamental concepts should be observed, monitored, and assessed. Typically, domains refer to households and families, income and standard of living, housing; health, transport, environment, leisure and culture, social security, crime and safety, education, labour market, working conditions, and so on. Generally, the differences concern the importance assigned to each domain. Actually, a shared list of domains and their priorities and importance does not exist, also because the list strictly depends on value judgments, valid and acceptable in a certain place and/or time (Noll, 2004). However, many scholars noticed that many domains recur in empirical studies (Felce & Perry, 1995; Nuvolati, 1997; Johansson 2002; Stiglitz et al., 2009), highlighting how human conditions lead individuals to face challenges that are common all over the world and that require collective solutions. In other words, even though different life domains can be identified, a core group of them really characterizes human lives and through them wellbeing can be observed. This could suggest that, while discomfort in some domains is not crucial and can be compensated by wellbeing in other domains, suffering in some domains, such as health, economics, family and friends relations, can turn out to be crucial for subjective wellbeing. Observing different combinations of wellbeing/ill-being levels in those domains can describe different intensity of suffering and risk of suffering. Monitoring the incidences across time of such combinations allows the community's conditions to be assessed especially during difficult moments, like economic crisis. The observing and monitoring exercise should take into account that, as several scholars asserted recently (Diener, 2000; Veenhoven, 2004), what really regulates the intensity of subjective suffering and explain variability in subjective wellbeing is inequality, which represents an important additional indicator. So the analysis of what are the patterns of "suffering" and how are they changing over time should represent a crucial interest not only at scientific level.

The aim of this contribution is two-fold. On the one hand, we want to outline the features and the dynamics of suffering in Italy in recent years, comparing data from year 2007 and data from year 2010. Has the global crisis had an effect on the level of suffering in Italy? Are there any geographical differences in the distribution and patterns of suffering? Are there evidences of divergent paths across territorial areas or social groups? We will try to address these questions through official statistics, namely using data from the "Multipurpose survey about families: aspects of daily life". On the other hand, we want to pursue this goal, introducing and applying an innovative data analysis methodology, drawing on the concepts of partial order and partially ordered set ("poset", for short). The theory of partial orders is in fact the most natural setting to address evaluation and multicriteria decision problems involving multidimensional systems of ordinal data, overcoming the limitations of

classical aggregative/compensative procedures, based on composite indicators or counting procedures.
The chapter is organized as follows. Paragraph 2 describes the datasets used in the analysis. Paragraph 3 provides some basic definitions of partial order theory and outlines the data analysis methodology. Paragraph 4 develops the analysis of suffering data and presents the results of the study. Paragraph 5 concludes.

2. The data

As already mentioned, the analysis described in this Chapter is based on data from the "Multipurpose survey about families: aspects of daily life". held by the Italian National Statistical Bureau on a yearly basis. The survey investigates a number of different aspects of daily life at individual and familiar level. Here, we consider subjective data pertaining to satisfaction on one's own economic status, health, family relationships and friendship. In the original dataset, satisfaction is expressed on a 4-degree scale: 1 – "very", 2 - "enough", 3 - "little" and 4 - "not at all". In the following analysis, scores have been reversed, so that 1 stands for "not at all" and 4 stands for "very". To get an insight of the temporal evolution of the self-perception of wellbeing, we consider both data from year 2007 and data from year 2010, so as to assess suffering level and patterns before and after the beginning of the global economic crisis. This also in consideration of the specific features that the crisis has in Italy, where global issues and historical national problems add up together. At territorial level, we consider five big geographic areas, or macro-regions, namely North-West (Lombardy, Piemonte, Valle d'Aosta, Liguria, Emilia-Romagna), North-East (Veneto, Trentino Alto-Adige, Friuli Venezia Giulia), Centre (Tuscany, Marche, Lazio, Umbria), South (Abruzzo, Molise, Campania, Basilicata, Puglia, Calabria) and Islands (Sicily and Sardegna). We also take into account sex, so as to be able to analyze data for men and women separately. In both years considered, the number of records in the datasets is about 48000; of these, about 14% have missing data. Since they do not appear to be systematic with reference to both sex and territorial areas, we simply deleted non-complete records from our analysis. This could slightly affect precision of the estimates, but should not introduce any bias. Computations have been performed using the programming language R and the package PARSEC (Fattore & Arcagni, 2014), for poset analysis.

3. Partially ordered sets and the suffering evaluation procedure

When dealing with multidimensional ordinal data, classical statistical procedures, based on score aggregation, cannot be pursued. A different mathematical language is needed, namely partially ordered set theory. Thus, in this paragraph, we give some essential definitions pertaining to partially ordered sets and provide an outline of the evaluation procedure used to assess suffering. We limit ourselves to the very basic

concepts, avoiding too much technical details. Interested readers can find a more comprehensive introduction to partial orders and to the evaluation procedure in (Davey and Priestley, 2002; Fattore, 2014; Fattore and Maggino, 2014; Fattore, Maggino and Colombo, 2012; Fattore, Maggino and Greselin, 2011; Fattore, Bruggemann and Owsinski, 2011).

We start introducing basic partial order concepts through a simple example. Let **v** and **w** be two ordinal variables, on a four-degree and a three-degree scale respectively, coded as 1, 2, 3, 4, and 1, 2, 3 (notice that these are not numbers, but just symbols; as such, they cannot be manipulated algebraically). Suppose to collect data on **v** and **w** jointly, on a statistical population. Each statistical unit is assigned a pair (*x*,*y*), where *x* may assume degree 1, 2, 3 or 4 and *y* may assume degree 1, 2, 3. The pair (*x*,*y*) is called a *profile*. There are 12 possible profiles and to each of them the number of statistical units sharing it (its *frequency*) is assigned. In a natural way we can, for example, compare and order profile (4,2) and profile (3,1), stating that the first is greater than the second, since it is greater on both components. But we cannot order profiles (2,1) and (1,3), since the first is smaller than the second on the second component, but it is greater on the first. In practice, not any pair of profiles built on **v** and w can be unambiguously compared and ordered, due to "conflicting" scores. The set P of 12 profiles built on **v** and **w** is in fact a *partially ordered set* (or a *poset*, for short), not a *completely ordered set* (such as the set of natural numbers). We can depict the set P and the partial order relation in a simple, yet effective way, by means of a Hasse diagram, as in Figure 1. The diagram is to be read from top to bottom. Each node represents a profile (reported inside a circle). If profile **p** is greater than profile **q**, and there are no other profiles between **p** and **q**, than node **p** is put above node **q** and an edge is drawn from the former to the latter. By transitivity, comparable nodes are linked by downward/upward sequences of edges. So node 33 is greater than nodes 32 and 23, but it is also greater than nodes 13, 22, 31 21, 12 and 11, which are connected to it by upward paths.

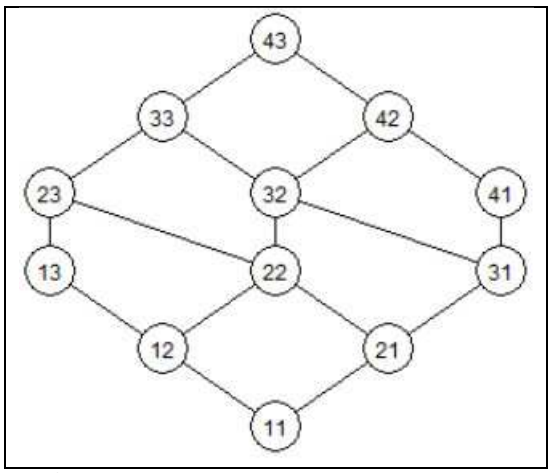

Figure 1. Hasse diagram of poset P. Nodes connected by downward/upward paths are comparable.

We now introduce a few and very simple concepts of partial order theory that will play a central role in the evaluation methodology applied to suffering data.
A partial order where any two elements are comparable is called a *linear order* or a *total order* or a *complete order*. A subset C of P which is a linear order is called a *chain*. The sequence 33-23-13-12 in the Hasse diagram of Figure 1 is an example of a chain. At the opposite, a subset of P such that any two elements are incomparable is called an *antichain* (e.g., the set of profiles 23, 32, 41 in Figure 1). Consider now node 22. The set of elements equal or smaller than 22, i.e. profiles 22, 21, 12 and 11 constitutes the so-called *downset* of 22 (in formulas, 22↓). Similarly, the set of profiles 22, 32, 23, 42, 43, i.e. the set of elements greater than or equal to 22, constitutes the *upset* of 22 (in formulas, 22↑). A profile not belonging to 22↓ or to 22↑ belongs to the *incomparability set* of profile 22. *Extending* a poset means turning some incomparabilities into comparabilities (i.e. enlarging the subset of elements that can be compared). If all the incomparabilities of a poset are turned into comparabilities, one gets a so-called *linear extension* of P, that is an extension that is also a complete order. A simple but fundamental result of partial order theory states that the set S of all possible linear extensions of a poset P characterizes P itself, i.e. different posets have different sets of linear extensions and given the set of linear extensions of P, one can reconstruct P. Linear extensions are the "building blocks" of posets and will play a crucial role in the evaluation methodology described in the following. Figure 2 and 3 give examples of these concepts.

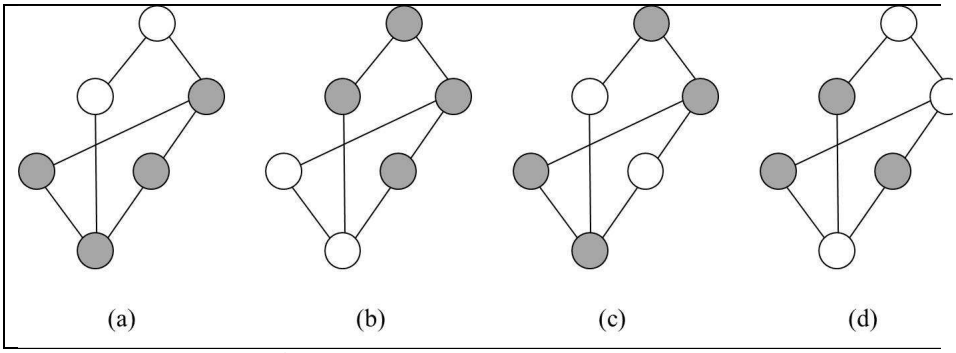

Figure 2. Hasse diagram of a poset. In grey : (a) – downset; (b) – upset; (c) – chain; (d) - antichain

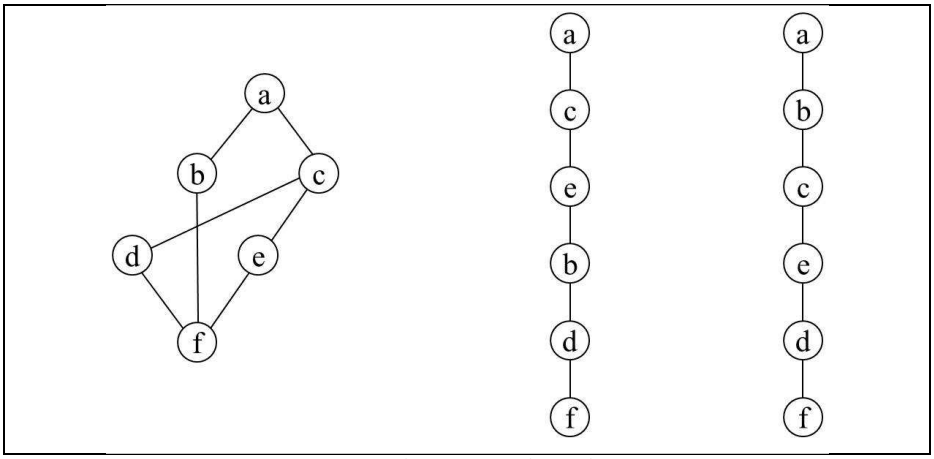

Figure 3. Hasse diagram of a poset and of two of its linear extensions.

The starting point motivating the use of poset concepts and tools to address suffering evaluation is the consideration that we deal with multidimensional ordinal information and not with numerical data. Aggregation approaches, leading to classical composite indicators, cannot be applied, since ordinal scores are not numbers. Suffering profiles are instead naturally described as a partially ordered set, *via* Hasse diagrams, in such a way that synthetic suffering scores will be computed avoiding aggregative/compensative procedures. As we shall see, in fact, the adopted evaluation methodology relies on the ordinal nature of the data only. We describe the methodology as a step by step procedure in the following.

Step 1. **Construction of the satisfaction poset**. Generalizing what depicted in Figure 1, to build the basic structure on which the evaluation procedure is based, it is sufficient to apply the following partial ordering criterion to satisfaction profiles (technically called, *product order*): let $\mathbf{p} = (p_1,\ldots,p_k)$ and $\mathbf{q} = (q_1,\ldots,q_k)$ be two satisfaction profiles on k ordinal domains or *attributes* (in our study, k = 4). We put $\mathbf{p} \leq \mathbf{q}$ if and only if $p_i \leq q_i$ for each i = 1,…,k. We put $\mathbf{p} < \mathbf{q}$ if $\mathbf{p} \leq \mathbf{q}$ and there is at least an index j such that $p_j < q_j$. With this definition, the set of satisfaction profiles becomes a partially ordered set; as such, it can be conveniently represented as a Hasse diagram (see for example Figure 5). The chosen partial order simply states that statistical unit **a** is more satisfied than statistical unit **b** if **a** (i.e. its profile) is satisfied not less than **b** on each attribute and more than **b** on at least one attribute.

Step 2. **Threshold selection**. Some profiles in the satisfaction poset may indeed represent unhappy or suffering situations. Due to multidimensionality, however, it is unlikely that a yes/no classification is effective. Some profiles could in fact represent, at different degrees, "partially" suffering configurations. So our aim is to assign a suffering score (possibly 0) to each profile in the satisfaction poset, identifying to what degree a profile may be considered as a suffering one, Since there is no natural scale against which to assess satisfaction and suffering, we address this identification problem as a multidimensional comparison issue. In practice, a set of suffering profiles that can be considered "on the edge" of suffering have to be exogenously identified, similarly to the threshold specification in classical monetary poverty studies. All of the other satisfaction profiles are then

compared to the threshold, as described in Step 3, to get a suffering degree. Due to multidimensionality, more than one profile may be "on the edge" of suffering; the suffering threshold is in fact an antichain of satisfaction profiles, describing alternative suffering patterns. The choice of the threshold is a critical, but unavoidable, step as in classical evaluation studies (e.g. on poverty), given that the evaluation process follows a comparison perspective.

Step 3. Suffering degree evaluation. Differently from the unidimensional case, due to partial ordering not any suffering profile may be unambiguously compared with the elements of the threshold. A profile whose scores are worse (in a satisfaction perspective) than those of an element of the threshold, represents a suffering condition (since it is "worse" than a "suffering profile"). But in many cases, ambiguities arise and some profiles cannot be classified as below or over elements of the threshold, due to conflicting scores. Suffering identification must account for such ambiguities. In practice, an identification function *Idn(·)* is to be defined such that:

- elements of the threshold are scored 1 by *Idn* (i.e., they are classified as suffering profiles);
- profiles below an element of the threshold in the satisfaction poset are similarly scored 1 by *Idn* (that is, profiles in the downset of elements of the threshold are classified as suffering profiles);
- profiles above *any* element of the threshold are scored 0 by *Idn* (i.e. they are classified as "non-suffering" profiles, since they represent situation that are better than any suffering patterns identified in the threshold; technically, these profiles belong to the intersection of the upsets of the elements of the threshold);
- all other profiles are scored by *Idn* in (0,1), i.e. they are scored as "ambiguously" suffering profiles, in a fuzzy sense.

To operationally define the identification function, we start by considering the set S of linear extensions of the satisfaction poset P. In a linear extension (which is, in practice, a complete ranking of profiles), a profile is either above or below (or coincide with) a profile of the suffering threshold and thus can be unambiguously identified as a "suffering profile" or a "non-suffering profile". Thus, on a linear extension one can define a 0-1 identification function assigning value 1 to profiles classified as "suffering" and 0 to all of the others. In different linear extensions, profiles classified as "suffering" are different. In fact, only profiles in the downset of the suffering threshold are scored 1 in each linear extension and, similarly, only profiles in the intersection of the upsets of threshold profiles are always scored 0. All of the other profiles are scored differently on different linear extensions (see Figure 4 for a simple example). As a result, counting the proportion of linear extensions where a profile is scored 1, one gets a non-linear identification function assigning suffering values in [0,1] to profiles of the satisfaction poset P. It is important to notice that final numerical scores are directly assigned to profiles, without any preliminary transformation of ordinal degrees into numerical scores and without any aggregative procedure. The poset approach to suffering evaluation is, in a sense, a counting approach, but differently from other counting methodologies (Alkire and Foster, 2011) we count over linear extensions and not over satisfaction attributes. This leads to a much more effective way of exploiting the informative

power of the data, as revealed by comparing the identification function computed by the poset-based methodology, to the analogous functions computed in classical counting procedures, which are usually 0-1 functions (Alkire and Foster, 2011) or at most linear functions (Cerioli and Zani, 1990).
Once the identification function has been computed, each statistical unit is assigned the score of the profile he/she shares, getting a distribution of suffering scores over the population. Usual statistical indicators can then be computed to build a synthetic picture of the data.

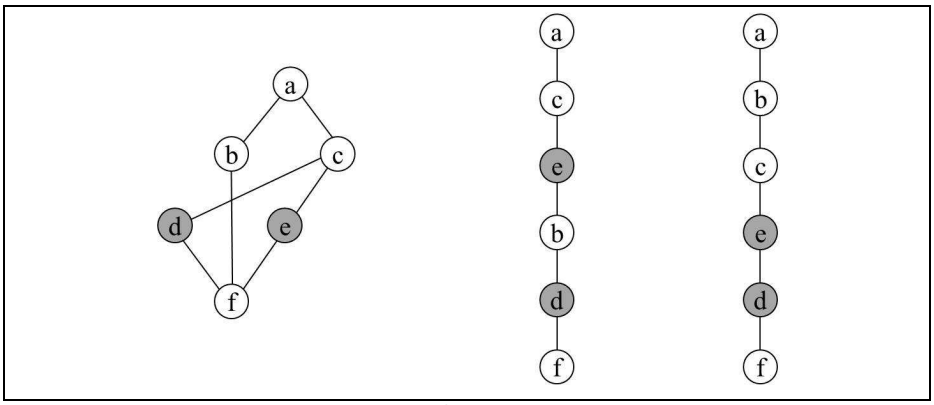

Figure 4. In grey, the selected threshold. Node **f** is below the threshold both in the poset and its linear extensions.

Nodes **a** and **c** are above the threshold in the poset and its linear extensions. Node **b** is incomparable with elements of the threshold. It is above all elements of the threshold in one of the depicted linear extensions, but not in the other.

4. Subjective suffering in Italy before and within the economic crisis

In Italy, the (generically called) "crisis" and its consequences are inextricably intertwined with some historical, distinctive, and often problematic features of the Italian institutional and socio-economic asset. Official regional figures reveal a complex pattern composed of different socio-economic territorial entities, coexisting within the same national context and moving on different and divergent paths. Considering high level indicators, Italian interregional "distances" in terms of economic performances are comparable to those existing across the whole European Union. And they seem to keep on increasing. With this premise, we move to the analysis of suffering in Italy at national and subnational level.

4.1 Suffering score computation

To make the suffering analysis as clear as possible, we apply the poset-based evaluation methodology step by step.

Step 1. **Construction of the satisfaction poset**. With four ordinal attributes, 256 subjective satisfaction profiles may be generated; each of them corresponds to a configuration of satisfactions, i.e. to a sequence of four ordered symbols chosen in the set {1,2,3,4}. Partially ordering the set of profiles according to product order, as outlined in paragraph 3, one gets the satisfaction profile P, whose Hasse diagram is depicted in Figure 5.

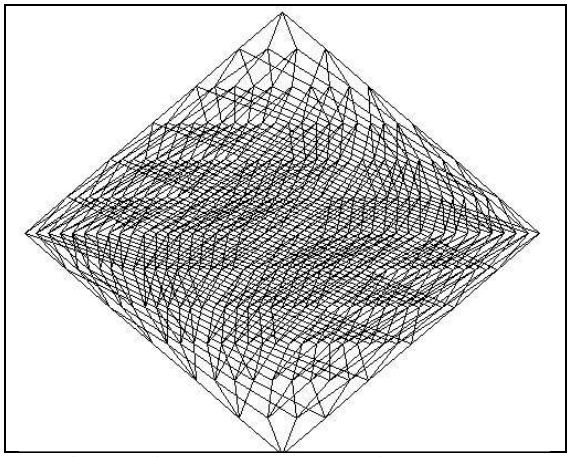

Figure 5. Hasse diagram of the satisfaction poset built on the four subjective attributes considered in the study.

We have omitted to draw nodes as circles, to ease readability. The diagram is indeed quite intricate, but gives an overall impression of the complexity of the partial order structure underlying the data. To each node, the percentage of statistical units sharing the corresponding profiles is associated, separately for year 2007 and year 2010.

Step 2. **Threshold selection**. The second and more delicate step is the selection of the suffering threshold. Suffering is a multidimensional experience. As such, many different suffering patterns may exist and more than one pattern may represent the "edge" between non-suffering and suffering profiles. Identifying thresholds is always a difficult task, even in unidimensional studies (like those pertaining to monetary poverty); a task that should be performed according to a shared process, based on declared criteria. Here we select a threshold based on some basic considerations, so as to show how the methodology can be effectively put to work. We consider the economic and health attributes as the most relevant and specify the threshold as composed of two profiles, namely 2232 and 2223 (the first digit refers to the economic situation; the second to health; the third to family and the fourth to friendship). In practice we state that to be considered as "unambiguously suffering" a profile must comprise at least three attributes scored "little", two of which must pertain to economy and health, and the fourth attribute cannot be scored higher than "enough". It may be argued that this choice is rather strong, in that three attributes out of four must be unsatisfactorily scored. In fact, our aim is to identify relevant suffering situations. Notice that the threshold is not a function of the frequency

distribution. In this sense we are assuming an "absolute" assessment perspective, rather than a "relative" one. Consistently with this remark, the threshold is the same for both considered years.

Step 3. **Suffering degree evaluation**. The computation of the identification function would require listing all the linear extensions of the satisfaction poset. This is computationally unfeasible, due the their extremely huge number. In practice, one samples from the set Ω of linear extensions using the Bubley-Dyer algorithm (Bubley and Dyer, 1999), that assures for the asymptotic uniformity of the extraction probability over Ω. In this study, we sampled $5 \cdot 10^8$ linear extensions, using the R package PARSEC (Fattore and Arcagni, 2014). Computing the identification function, each satisfaction profile (i.e. each node in the Hasse diagram) gets a score in [0,1], that can be interpreted as the degree of suffering of the profile. Ordering profiles according to increasing suffering scores, one obtains the graph of the identification function, as depicted in Figure 6.

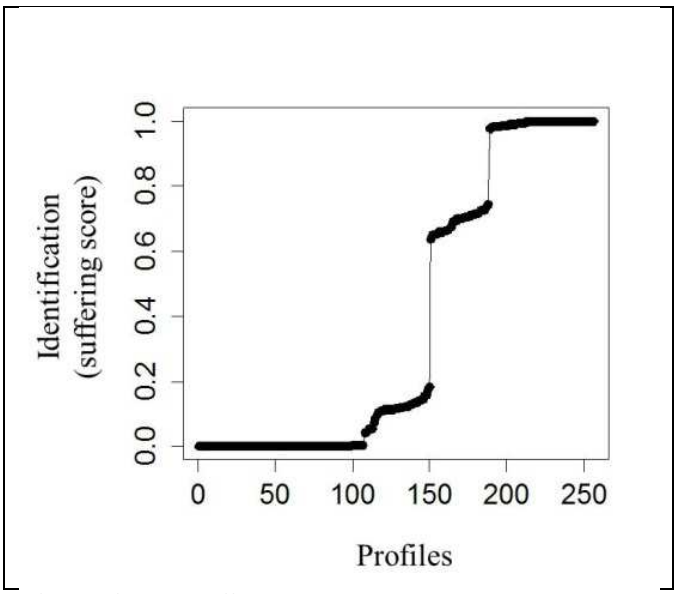

Figure 6. Identification function (suffering scores), given the threshold (2223, 2232). Profiles are numbered and listed according to increasing suffering scores.

As expected, the identification function assumes values between 0 and 1 reproducing the nuances and vagueness of multidimensional suffering. Only profiles in the downset of the threshold are scored 1; similarly, only profiles in the intersection of the upsets of elements of the threshold are scored 0. All of the other profiles are scored strictly higher than 0 and strictly lower than 1. Notice also that profile scores do not lie on a straight line; the graph shows cluster of profiles scored similarly and may somehow reminds of a sigmoid shape. This reveals the existence of "non-linearities" that would not be accounted for properly, by aggregative or counting approaches. Notice also that the identification function does not primarily measures the intensity of suffering, but the degree of membership of a profile to the

set of suffering profiles, identified by the suffering threshold. From this point of view, it is a truly fuzzy measure of suffering.
Given the identification function, one can then proceed to computing synthetic indicators for years 2007 and 2010. In this concise study, we mainly consider two suffering measures. The first is the average identification score over the population (or subpopulations), here called *overall suffering level*, which is an analogous of the Head Count Ratio adopted in classical poverty studies. However, here we are not simply counting the proportion of "suffering people", but the "average degree of membership" of individuals to the class of suffering individuals. So the average identification suffering score must be interpreted as the "relative amount of suffering in the population". In principle, it may vary between 0 (when no statistical unit is suffering, even partially), and 1 (when all of the statistical units have unambiguously suffering profiles). The second indicator is the average identification score restricted to individuals with a non-null suffering degree. This indicator varies between 0 and 1 and is simply the average degree of membership to the suffering group, excluded non-suffering people. In the following, this measure is called *specific suffering level*. High values of the specific suffering level reveals that suffering people are likely to be "really suffering", i.e. to suffer globally from the different perspectives implied by the selected threshold. When this occurs, one can state that the population is somehow split into two groups: "completely suffering" and "completely non-suffering" people.

4.2 Data analysis and interpretation

Main results for year 2007 and 2010 are listed in Table 1, Table 2 and Table 3. The average suffering score in 2007 is 0.102, basically the same as in 2010 (0.101); in practice, the "fuzzy" Head Count Ratio is about 10% in both years. Interestingly, in both years, Italian population appears polarized in two groups. In fact, about 90% has a suffering degree smaller than 0.2, while the remaining 10% has a suffering degree greater than 0.6. Focusing only on the subpopulation of statistical units with a non-zero suffering score, the average suffering degree increases to 0410 in 2007 and to just a little bit less in 2010 (0.405). These reveals that those who suffer in some aspects of their life, are quite highly suffering. Both levels, overall and specific, increase moving from the North to the South of Italy, showing again that as suffering spreads, it become also deeper and less vague and ambiguous. The existence of a "North-South" axis in socio-economic performances is a historical feature of Italian situation. Here we have evidences that the same holds for subjective suffering.

Table 1. Overall and specific suffering levels at national and macro-regional scale, for years 2007 and 2010.

	SUFFERING LEVEL			
	2007		2010	
REGION	OVERALL	SPECIFIC	OVERALL	SPECIFIC

Italy	**0.102**	**0.410**	**0.101**	**0.405**
North-West	0.080	0.364	0.083	0.377
North-East	0.077	0.359	0.079	0.366
Centre	0.099	0.427	0.100	0.399
South	0.132	0.445	0.132	0.440
Islands	0.144	0.450	0.128	0.439

Besides territorial differences, suffering level worsen when comparing females to males. At national level, in 2007 males have an average suffering level equal to 0.086 while for females it is 0.117. Also the specific average suffering level is greater for females (0.429) than for males (0.384). The divergence between male and female average suffering levels is a common feature of Italian macro-regions, particularly in the South region, where the spread between males and females is almost 5 percentage points (males: 0.107; females: 0.154) and the specific suffering level ranges from 0.404 (males) to 0.477 (females). On the whole, the maximum specific suffering spread is between males in North-West and North-East (0.336) and women in the South (0.477). The same pattern repeats three years later. In 2010, male average suffering is 0.088, while for females it equals 0.120. Similarly, male specific suffering level is 0.378, while the female one is 0.427. This feature can be again invariably observed in each of the territorial areas under consideration. On the whole the maximum spread of overall suffering level across Italy in 2010 may be observed between males in the North-East (0.068) and females in the South (0.150): a difference of more than 8 percentage points compared to an average national level equal to 0.101. Again, an even wider spread exists when specific suffering level is considered, ranging from 0.338 for males in the North-West, to 0.460 for females in the Islands macro-region.

Table 2. Overall suffering levels for males and females at national and macro-regional scale, for years 2007 and 2010.

	OVERALL SUFFERING LEVEL			
	2007		2010	
REGION	MALES	FEMALES	MALES	FEMALES
Italy	0.**086**	**0.117**	**0.088**	**0.115**
North-West	0.065	0.094	0.075	0.091
North-East	0.065	0.089	0.068	0.088
Centre	0.087	0.110	0.081	0.117
South	0.107	0.154	0.112	0.150
Islands	0.130	0.156	0.113	0.142

Table 3. Specific suffering levels for males and females at national and macro-regional scale, for years 2007 and 2010.

	SPECIFIC SUFFERING LEVEL			
	2007		2010	
REGION	MALES	FEMALES	MALES	FEMALES

Italy	0.**384**	**0.423**	**0.378**	**0.427**
North-West	0.336	0.386	0.356	0.394
North-East	0.336	0.376	0.338	0.390
Centre	0.414	0.437	0.358	0.431
South	0.404	0.477	0.419	0.456
Islands	0.440	0.458	0.414	0.460

Comparing data pertaining to 2007 and 2010, we notice that suffering levels and patterns are quite similar. The first year of the crisis does not seem to have affected much the subjective quality-of-life self-perception. Looking at the results, some interesting hints nevertheless emerge. In fact, one can see that suffering levels (overall and specific) slightly increase over time in the northern macro-regions and slightly decrease in the southern macro-regions. These figures may be affected by approximations, due to the sampling of linear extensions, but on the whole they suggest an unexpected dynamics. Why regions that historically perform neatly better than the others show an increase in subjective suffering, while the latters do not? May life-styles matter, in this respect? Perhaps, some people living in more "developed" regions and big city areas are more affected by possible changes in their daily life and expectations, than people from medium and small-size cities, living in a better environment. Many hypotheses can be made, but more evidences are needed to pursue them and get to final conclusions. Anyway, these first results indeed suggest interesting research paths, to be explored using new waves of the Multipurpose survey.

5. Conclusion

In this chapter, we have outlined a new methodology to address synthetic evaluation of multidimensional suffering (and other social issues) based on ordinal data. Evaluation is addressed as a benchmark problem where incomparabilities between suffering profiles play a central role, leading to fuzzy-like suffering measures. The methodology proves effective in accounting for nuances and subtleties of suffering evaluation, overcoming the limitations of composite indicator and classical counting procedures. Computational aspects are indeed a key issue in the partial order approach to suffering evaluation. The R package PARSEC provides all the basic routines to work out the computations, which however may require several hours, on standard personal computers, to be carried out. The chapter focused on subjective suffering in Italy before and just after the beginning of the socio-economic crisis, comparing years 2007 and 2010. Four subjective life satisfactions ordinal attributes have been considered, namely satisfaction pertaining to one's own economic status, health, familiar and friendship relationships. Data have been extracted from the "Multipurpose survey on families, aspects of daily life", held by the Italian National Bureau of Statistics on an yearly basis. The aim of the study was to stress the relevance of subjective data about wellbeing and to introduce and spread a new and alternative evaluation methodology to the social scientist community; thus a limited

number of attributes and covariates have been selected, to ease computations and exposition. Notwithstanding this, some interesting results have been obtained and deserve further research. Particularly, there are some evidences that suggest how the crisis may worsen the self-perception of people in territorial areas that are more developed from an economic point of view. We cannot here deepen the analysis and find out the "mechanism" behind this fact. What neatly emerges, however, is the complexity and subtlety of suffering that eludes trivial interpretations and requires more sophisticated "observational tools", that is statistical procedures capable to capture its fundamental features. In this respect, the evaluation methodology based on partial order theory applied in this study seems to prove effective and opens new possibilities of describing and understanding such a complex social issue.

References

1. Alkire S., Foster J. (2011). Counting and multidimensional poverty measures, Journal of Public Economics 95, 476 – 487.
2. Argyle, M., (1987). *The Psychology of Happiness*, Methuen, London (trad. it. *Psicologia della felicità*, Cortina Editore, Milano).
3. Bradburn N.M. (1969) *The Structure of Psychological Wellbeing*. Aldine, Chicago.
4. Bubley, R., & Dyer, M. (1999). Faster random generation of linear extensions. Discrete mathematics, 201, 81–88.
5. Cerioli A., Zani S. (1990). A Fuzzy Approach To The Measurement Of Poverty. In Dagum C., Zenga M. (Eds.) Income and Wealth distribution, Inequality and Poverty, (pp. 272-284). Springer-Verlag, Berlino Heidelberg.
6. Davey, B. A., & Priestley B. H. (2002). Introduction to lattices and order. Cambridge: Cambridge University Press.
7. Diener, E. (1984) "Subjective Wellbeing" in *Psychological Bullettin*, 95.
8. Diener, E. (2000). Subjective Well-Being. The Science of Happiness and a Proposal for a National Index. *American Psychologist, 55*, 34-43.
9. Diener E. and Emmons R.A. (1984). "The independence of positive and negative affect". *Journal of Personality and Social Psychology*, 47 (5).
10. Fattore M., Partially Ordered Set, Entry title. In: Michalos AC (Ed.). Encyclopedia of Quality of Life and Well-Being Research. Springer Dordrecht, Netherlands: Springer, pp 4627-4631, 2014, ISBN 978-94-007-0752-8
11. Fattore M., Grassi R., Arcagni A., "Measuring structural dissimilarity between finite partial orders", in: Bruggemann R. Carlsen L., Wittmann J. (Eds.) Multi-Indicator Systems and Modelling in Partial Order, Springer, Berlin, 2014
12. Fattore M., Arcagni A., "PARSEC: an R package for poset-based evaluation of multidi-mensional poverty", in: Bruggemann R. Carlsen L., Wittmann J. (Eds.) Multi-Indicator Systems and Modelling in Partial Order, Springer, Berlin, 2014
13. Fattore M., Maggino F., "Partial orders in socio-economics: a practical challenge for poset theorists or a cultural challenge for social scientists?", in: Bruggemann R. Carlsen L., Wittmann J. (Eds.) Multi-Indicator Systems and Modelling in Partial Order, Springer, Berlino, 2014
14. Fattore M., Maggino F., Colombo E., ''From composite indicators to partial orders: evaluating socio-economic phenomena through ordinal data'', in Maggino F., Nuvolati G., (Eds.) Quality of life in Italy: researches and reflections, Social Indicators Research Series, Springer, 2012.
15. Fattore M., Maggino F., Greselin F., ''Socio-economic evaluation with ordinal variables:integrating counting and poset approaches '', Statistica & Applicazioni, Partial Orders inApplied Sciences, Special Issue 2011, pp. 31-42. Vita e Pensiero, Milano.
16. Fattore M., Brueggemann R., Owsiński J., ''Using poset theory to compare fuzzy multidimensional material deprivation across regions", in Ingrassia S., Rocci R., Vichi M. (eds.) New Perspectives in Statistical Modeling and Data Analysis, Springer-Verlag - 2011, ISBN 978-3-642-11362-8.

17. Felce D. & Perry J. (1995). “Quality of Life: Its Definition and Measurement”. *Research in Developmental Disabilities*, 16 (1), pp. 51-74.
18. Johansson S. (2002). “Conceptualizing and Measuring Quality of Life for National Policy”. *Social Indicators Research*, 58, pp. 13-32.
19. Noll H.-H. (2004) *Social indicators and indicators systems: tools for social monitoring and reporting*, paper presented at OECD, World Forum “Statistics, knowledge and policy”, Palermo, 10-13 November 2004.
20. Nuvolati G. (1997). Uno specifico settore di applicazione degli indicatori sociali: La qualità della vita. In: Zajczyk F. *Il mondo degli indicatori sociali, una guida alla ricerca sulla qualità della vita*. La Nuova Italia Scientifica, Roma, pp. 69-94.
21. Nuvolati G. (2002). *Qualità della vita e indicatori sociali.* Seminar held at the PhD degree programme “Scienza tecnologia e società”, aprile, Dipartimento di Sociologia e di Scienza Politica, Università della Calabria. Available on http://www.sociologia.unical.it/convdottorati/nuvolati.pdf.
22. Stiglitz J. E., A. Sen & J.-P. Fitoussi eds. (2009) *Report by the Commission on the Measurement of Economic Performance and Social Progress*, Paris. http://www.stiglitz-sen-fitoussi.fr/en/index.htm.
23. Veenhoven, R. (2004). Happiness as a Public Policy Aim: The Greatest Happiness Principle. In A. Linley & S. Joseph (Eds.), *Positive Psychology in Practice* (pp. 658-678). Hoboken: John Wiley.