Quality of work and elderly care - Preliminary experiments

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Abstract—This paper focuses on the definition and measurement of quality of work (QL) by using a multidimensional approach, based on fuzzy logic. The multidimensional nature of quality of work has been widely acknowledged in economic and sociological literature and attempts at measuring its different dimensions can be found at European level in the work carried out by the European Foundation for the Improvement of living and working conditions. The European Commission and the International Labour Office have also identified different dimensions for quality of work and proposed new indicators to measure them. In this paper an attempt is made to maintain the complexity of the quality of work concept by using a technique that allows measurement without introducing too strong assumptions and makes the rules for judging the different dimensions of QL and their interactions explicit.

I. INTRODUCTION

This paper is one of the several papers that Modena and Reggio Emilia University research Unit has produced in the field of a wider contest called “Beyond GDP”. In particular in this direction the Italian Ministry of University has financed to this group one project: “Working and living conditions in the capability approach” 2011-2013 among the Italian Projects of National Interests (PRIN). The University of Modena and Reggio Emilia research unit focus on the interaction of living and working/employment conditions. The definition of quality of life and working conditions and their interactions are used at the micro level Amartya Sen’s individual well-being approach and, at the macro level, an approach to the labor market that, according to classical political economy, takes into account the social process that enables people to work (Picchio 1992, 2003), formal, à la Sen, their capabilities and sustaining their functionings, taking care also of the well-being of the family dependent members.

Following Sen (1997) analysis of the socio-economic costs of non-employment, we will first of all estimate the costs of non-employment for the individuals’ well being and analyses the impact of non-employment situation on the household’s well-being. In this context it becomes important to take into proper consideration the welfare system that sustains the household and its well-being.

The research unit will then focus on the connections between the quality of paid work and wellbeing, both of the employed ones and that of their family members. The analysis of the quality of life, work, and relational interaction with other household members’ and their wellbeing, can be carried out only through a methodological approach that considers the multidimensionality of the phenomena under scrutiny and adopts different techniques to handle the latent and manifest variables appropriately.

Several methods are proposed to pursue the objectives of the project. We shall follow fuzzy modeling based on the approach of knowledge-based system like fuzzy experts system

The research unit will define the design of macro and micro indices, building a tree in which, starting from the lowest level (the root), the final evaluation of the level of total quality is given by the macro-indices (the branch-points), then reaching the relevant micro-indices by successive aggregations in the formulation of macro-indices. Finally, we shall analyze causal relationships in order to find the variables that influence the quality of work and the different well-being dimensions. Empirical analysis will focus on Italy using IT SILC, Labour Force Survey Data and Istat multipurpose surveys. In this paper we present the problem relative to elderly care. This type of service, is, in Italy, delegated to three different categories: women that have in their extended family one ore more ancient relatives who need of aid, social, private or public, cooperatives or group of persons who offer, with fee, at home or in external structure customer assistance, private home assistance, furnished, prevalently, by stranger women arriving from East Europe countries. The first case is very frequent in Italy. It enters in the evaluation of non-paid work as it is a work, that officially doesn’t produce an income, but produces two results: the reduction of time of paid work for women and their sacrifice in the viewpoint of work satisfaction, career, independence and cultural awareness. This situation is typical in the south of Italy and in poor families, producing a deep difference in the women’s emancipation in the country. In the north of the country are present other chances offered by structures that offer domestic or not services and stranger women arriving from poor countries of the East Europe. All these two services are, in several cases, very onerous. We will use the data arriving from a very wide surveys submitted to a group of these structures in Modena province, to evaluate...
the work conditions of these particular workers. The paper is the first result of an interdisciplinary partnership, between researchers in different disciplines (economists, sociologists, mathematicians) sharing a common view: since living and working conditions are intrinsically multidimensional and mediated by human interpretation and perceptions, their quantification is not well achieved by classical mathematics or statistics. Therefore the group used techniques able to tolerate vagueness and imprecision and capable of capturing the complex interrelated dimensions of quality of work according to individual perceptions. In this paper we deal with the identification of the dimensions relevant to defining quality of work and the building of a system that accounts for different indicators of these dimensions.

II. QUALITY OF WORK

The crucial role played by work in an individual’s life has been widely stressed in the literature. In the words of Gallino (1993):

“Work produces an important share of material and immaterial culture, by greatly increasing the distance between human beings and all other species […]. By intervening in the natural environment and in the artificial environment, made of culture, work continuously changes human living conditions and therefore can be considered as one of the main agents of social evolution. It can establish social relations amongst people that materialize in the building of collectivity, groups, organizations characterized by different forms of cooperation, collaboration and integration. [In so doing] by requiring that everyone cooperates with others not by ideological persuasion but by an intrinsic need, work confers direction, aim, identity on individual life” (Gallino, 1993, p. 396, our trans.).

Hence work alters the environment, the characteristics of artefacts produced, and the very relations among persons. From this derives also the multidimensional character of the notion of quality of work. More recently the multidimensional nature of quality of work has been widely acknowledged, as is visible in the research work carried out by the European Foundation for the Improvement of living and working conditions (Merllié and Paoli 2001); the European Commission and the International Labour Office, too, have identified different dimensions for quality of work and proposed new indicators to measure them. (EC, 2001; ILO, 2003). Not only earnings but also other dimensions (like for instance safety at work, social protection, type of job contracts) appear relevant in an extended definition of quality of work. The literature has not only addressed the importance of extending the definition of quality of work to other than monetary dimensions, but has also dealt with questions regarding the existence of compensating differentials amongst the different elements that compose the quality (like for instance whether a lower paid job is characterized by better workplace relations or by safer work and if these elements compensate for the lower wage). If, conversely, the differentials are not such as to compensate — as occurs in the segmented labour markets — it becomes important to have available instruments that enable understanding (and measurement) as to which jobs (in terms of position, type of contract) and in which contexts (industry, type of enterprise, regional area) jobs characterized by different quality are concentrated, and whether there are individual and family characteristics more correlated to the risk of finding oneself in jobs or workplaces that can be defined as low quality.

In working on the scheme originally proposed by Gallino, we took into account six different dimensions that are defined by the combination of a relevant number of indicators and elementary variables. Each dimension allows one to analyse how, by starting from individual perception by the worker, work matches and sometimes comes into conflict with individuals’ specific targets and needs. Work is of a high quality if according to Gallino every analytical dimension taken into account “shows properties aimed at significantly satisfying the corresponding needs” (Gallino, 1993, p. 393, our trans.). It is difficult to establish a ranking amongst the different dimensions and every dimension is involved in the determination of quality of work with the same weight.

The different dimensions that we will include in the definition of our goal that is the quality of work are:

- Control dimension (Control): relation with colleagues, relation with management/entrepreneur, autonomy in managing working rhythms, possibility of direct agreement with colleagues.
- Economic dimension (EconomDim). In this dimension we consider earnings, seniority, job security, social insurance, profit sharing, wage, career perspectives and parental leaves and protection.
- Ergonomic dimension (ErgonDim): work environment (individual space, smokes and fumes, dust) pace and intensity, cognitive effort and stress.
- Complexity dimension (JobComplex): acknowledgment of one’s capabilities, job variety and richness, effort required, training.
- Social dimension (SocialDim): In this dimension we include elements connected to others’ esteem, acknowledgment of professional abilities, career perspectives, sharing firm’s decision, work life satisfaction and job satisfaction.
- Work life balance (WorkLiBal): includes maternity protection, parental leaves, management and availability of paid holidays, participation of employees in management of working hours distribution and shifts, availability of family-friendly policies.

These different dimensions are the macro-indicators that will produce the final goal. Each of them is the final aggregation of the variable involved in their definition. To produce the singular and final aggregations, we have choose more fuzzy expert systems. The sample of firms and the technique used to read the data enable one to understand how the quality of the workplace is constituted in the context of specific firms and how its elements, workplace relations and organizing structures can change with regard to the type of firm and the product market conditions.
III. THE FUZZY APPROACH

To face this complex problem and to reach an aggregated value of the quality of work we propose a Fuzzy Expert System (FES), which utilizes fuzzy sets and fuzzy logic to overcome some of the problems that occur when the data provided by the user are vague or incomplete. The power of FES comes from the ability to describe linguistically a particular phenomenon or process, and then to represent that description with a small number of very flexible rules. In a FES, the knowledge is contained both in its rules and in fuzzy sets, which hold general description of the properties of the phenomenon under consideration. One of the major differences between a FES and another Expert System is that the first can infer multiple conclusions. In fact it provides all possible solutions whose truth is above a certain threshold, and the user or the application program can then choose the appropriate solution depending on the particular situation. This fact adds flexibility to the system and makes it more powerful. FES uses fuzzy data, fuzzy rules, and fuzzy inference, in addition to the standard ones implemented in the ordinary Expert Systems. Functionally a fuzzy system can be described as a function approximator. More specifically it aims at performing an approximate implementation of an unknown mapping \( f : A \subseteq \mathbb{R}^n \rightarrow \mathbb{R}^m \) where \( A \) is a compact of \( \mathbb{R}^n \). By means of variable knowledge relevant to the unknown mapping, it is possible to prove that that fuzzy systems are dense in the space of continuous functions on a compact domain and so can approximate arbitrarily well any continuous function on a compact domain. The following are the main phases of a FES design:

- Identification of the problem and choice of the type of FES, which best suits the problem requirement. A modular system can be designed. It consists of several fuzzy modules linked together. A modular approach may greatly simplify the design of the whole system, dramatically reducing its complexity and making it more comprehensible;
- definition of input and output variables, their linguistic attributes (fuzzy values) and their membership function (fuzzification of input and output);
- definition of the set of heuristic fuzzy rules. (IF-THEN rules);
- choice of the fuzzy inference method (selection of aggregation operators for precondition and conclusion);
- translation of the fuzzy output in a crisp value (defuzzification methods);
- test of the fuzzy system prototype, drawing of the goal function between input and output fuzzy variables, change of membership functions and fuzzy rules if necessary, tuning of the fuzzy system, validation of results.

In Fig.1 there is the painting of the first level of aggregation. The rules that we have choose is to consider every macro-index at the same level.

IV. ECONOMIC DIMENSION

In this paper we enter into details of the “Economic Dimension” system. The economic dimension is the output of these eleven inputs:

- A01: Earnings
- A02: Earnings related to seniority
- A03: Job security
- A04: Social insurance
- A05: Profit sharing schemes
- A06: Firm’s pay differentials schemes
- A07: Fringe benefits
- A08: Learning and training
- A09: Maternity protection
- A10: Parental leaves
- B07: Career perspectives

Each one of these elements refers to the worker’s subjective perception of her job’s characteristics with reference to the above elements. Fig. 2 shows the structure of the system.

In the structure of the fuzzy system some intermediate variables appear:

- 1st level of intermediate variables: career perspectives, earning and protections.
- 2nd level of intermediate variables: earnings variability and level enter in earnings and parental and social protections enter in protection.

All the variables obtained by the partial aggregation of initial inputs, may be at every level defuzzified to obtain a better understanding of the evolution of the system. In the analytical framework proposed the economic dimension will be considered of high quality if, according to the worker, it will be able to satisfy his needs, in terms of earnings,
career and protection on job stability. To close the system we had to specify monotonicity types and relative weights. The monotonicity is connected with the decision of what type of function connects the several inputs. Looking at the first level of aggregation we have to decide if the function \( f(\text{career, earnings, protection}) = \text{economic dim} \) is monotonic increasing in every variable or not. In this case the reply is Yes. The weights range is the interval \([1, 2] \). In this aggregation we have given the same weight to the three inputs. In defining earnings we have given more weight to the variable that refers to the level of gross earnings rather than to fringe benefits. We have given more weight to seniority in evaluating the dimension connected to wage variability. The variable Social protection is positively influenced by job stability that has a high weight.

All the inputs are described by three linguistic attributes low, medium, high:

The second level of intermediate variables is described by five linguistic attributes like in the figure below that describes the Career variable.

The first level of intermediate variables are described by seven linguistic attributes like in the figure below that describes the variable earnings: The “economic dimension” output is described by eleven linguistic attributes:

The system presents eight rule blocks for a total of 274 rules.

The rule blocks contain the control strategy of a fuzzy logic system. Each rule block confines all rules for the same context. A context is defined by the same input and output variables of the rules. The ‘if’ part of the rules describes the situation, for which the rules are designed. The ‘then’ part describes the response of the fuzzy system in this situation. The processing of the rules starts by calculating the ‘if’ part. The operator type of the rule block determines which method is used. We choose the MIN t-norm as AND operator.

The fuzzy composition eventually combines different rules to one conclusion. We choose the Bounded Sum as fuzzy operator for the aggregation method of the result to enable all firing rules to be evaluated. Different methods can be used for the defuzzification, resulting either in the ‘most plausible result’ or the ‘best compromise’. We choose a ‘best compromise’ method like CoA (Center of Area).

V. RESULTS

The sample that we used to test the model is made up of employees working in firms of different dimension and belonging to different industries (mechanical, building, services, food industry, information technology, textiles) in the same area (Modena) having a common economic and welfare system. We have tested our expert system with 719 records of employees of these firms. The statistics referred to in this
Section must be considered as referring to the sample of firms not randomly selected from the population of firms in Modena. Each firm was analysed to reconstruct its structure and dimensions connected to quality of work, and it is possible to read the results of the output of the system both by firm and by the whole sample constructed. Deeper analyses of the results are currently in progress to match the richness of the fuzzy expert system outcome with the richness of case studies. In Table 2 we report the value of the variables that compose the analysed dimension and some individual characteristics referring to the worst cases in terms of the economic dimension. Amongst 10 employees at the bottom of the distribution of the economic dimension 9 are women, 5 were born in Southern Italy and 5 are in non-standard employment. They fare very badly in each component of the dimension, and a good degree of satisfaction shown by some of them in maternity protection is not sufficient to increase the value of the whole output of this dimension. By comparing the output of the fuzzy expert system with the mean of the different variables involved in the measurement of this dimension one may find that standard techniques tend to overestimate (with respect to the fuzzy output) the value of the economic dimension. By reading the results of the output of the system both by firm and dimensions connected to quality of work, and it is possible to test the implications of adopting different techniques for measuring the economic dimension.

### TABLE II

**Individual records ordered by the output of the economic dimension: last 10 according to output of economic dimension.**

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In Table 3 we report the value of the variables connected to the best cases according to the ranking of the economic dimension. Women and men are equally present in this group. There is a prevalence of workers with more than 35, with high specialization and seniority; 4 of them are in apical positions. In this case the distance between the fuzzy output and the arithmetic mean of each indicator is lower than in the bottom end of the economic dimension distribution. A deeper analysis on the distance of the two different measures along the distribution and for different groups of workers is required to test the implications of adopting different techniques for descriptively analysing the distribution of quality of work and its dimensions across the sample of firms analysed show a high degree of variation.

As Table 4 shows, the different dimensions (that have been measured by separate intermediate systems) are positively related and the final output of the system (variable quality of work) is positively related to all the dimensions, the correlation coefficients being high with respect to social and control dimensions. As far as the dimension that is central to this paper (the economic dimension) is concerned, the results of this correlation analysis show a higher correlation of the economic dimension with the complexity dimension and with the social dimension whereas the correlation with the ergonomic dimension is weaker.

* * *

This is not consistent with the literature on compensating differentials amongst the different elements that compose the quality of work and is more consistent with the existence of segmented labour markets.

### VI. Conclusion

In providing a synthesis of one dimension of quality of work, the fuzzy expert system that we have proposed here turns out to be a more flexible and powerful tool than traditional techniques used to define quality of work. The fuzzy expert system allows one to consider the relation amongst elementary variables/indicators and, therefore, amongst the analytical dimensions that we have defined, weighting and ranking them according to a system of rules that, step by step, can incorporate status of art, theoretical framework and researchers’ views. The expert system can be used both to study individual cases, or particular types of work or to provide a comparative analysis of different labour markets.

The system allows one to investigate when a trade-off between the different dimensions arises. Traditional discussion on the compensating differentials between monetary and non-monetary characteristics and on segmented labour markets can be...
therefore be tackled on completely different grounds. This technique proves to be superior to other techniques since it enables one to account for the interrelations amongst the different dimensions (it also allows the same variable to enter in different dimensions with different weight), to specify rules of judgement on the meaning of the values assumed by different variables and to relate the output of the system with individual characteristics (age, gender, education, work experience), job characteristics and characteristics of the firm (size, economic situation of the firm’s good market, union presence). In other words, the system provides an output that captures labour market segmentation and could detect the dimensions, that endogenously contribute to determine segmentation.

REFERENCES