

Well-being and/or quality of life in E.U. Countries through a multidimensional index of sustainability

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Abstract

The aim of this paper is to demonstrate that Sen’s theory of well-being can be applied to make operational the concept of sustainable human development through the building of a multidimensional index of sustainability which takes into account, at the same time, economic, social and environmental variables. This index, which may be considered an alternative to the current measures of welfare/sustainability, shows how Sen’s theory of well-being can be useful to sustainable development. It has been applied to EU countries using the standardised deviation methodology being this the closest and most suitable methodology to be applied to the multidimensional indices. Factor analysis is also utilized in this paper. Lastly, the comparison between Sen’s trend of sustainability and GDP trend index number, which are both of them applied to Italy, will show how much the criticisms and the limitations directed towards the indicator of GDP are founded.

JEL Classifications numbers: I31, Q01, Q56

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1. Introduction

The possibility of creating more adequate indicators of sustainable development, as an alternative to the conventional measures based on the utilitarian/welfarist theories, is the topic of this paper.

More specifically, we intend to demonstrate that Sen’s theory of well-being can be applied to make operational the concept of sustainable human development. Taking into account the multidimensional nature of this concept, an index of sustainability will be built

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with a view to verifying its operational value, even though we are aware that limited availability of statistical data make it difficult to apply Sen's theory of well-being. There have been some attempts to apply this theory¹, but the issue concerning whether it can be useful to sustainable development through the building of indices of sustainability is almost an unexplored field owing especially to the multidimensional nature of this index. We have tried to address this issue through the standardised deviation methodology, which represents one of the approaches of synthesis of social indicators.

The paper is divided into seven sections. The first explains Sen's theory of well-being and the reasons why it is different from utilitarianism/welfarism. The issue of how Sen's theory could provide a basis for an index of sustainable development is also addressed in this section.

The second one is a brief review of conventional and existing sustainable development indicators and points out their main weaknesses. The main point of this section is to analyse how Sen's ideals can "fix" some of the weaknesses.

The third section deals with the principles of how to build the empirical index (main problems, aggregating of different units, etc). The fourth one presents the data: i.e. the variables, the countries and the years taken into consideration.

The fifth section shows the results obtained from the methodologies used; while, a comparison between Sen's trend of sustainable development and GDP trend index number is presented in the sixth paragraph. The conclusions are presented in the seventh and last section.

2. A brief handling of Sen's theory of well-being

The discussion presented in this section aims to explain how Sen's theory of well-being can be useful to sustainable development. We think that Sen's theory can provide a basis of reference for building an index of sustainability. Therefore, in order to evaluate what the role played by the environment in a wide view of sustainable development² is, we have

¹ Cf., for example, Casini and Bernetti, (1996); Chiappero Martinetti, (2000); Brandolini and D'Alessio, (1998); Comim, (2001); Robeyns, (2000); Saith, (2001).

² Sustainable development is considered in this work as a broader concept than environmental protection. It implies the quality of

first to examine the main features of Sen's theory of well-being and Sen's equation of well-being. In fact, the latter, which includes, among its factors, also the environmental component, will introduce us into the concept of sustainable development.

In *mainstream* theory, the concept of well-being is measured exclusively on the grounds of the possession of commodities or income. This theory is based on the concept of utility, which is perceived as a measure of well-being of individuals. Sen, instead, considers that goods or income are an instrument for reaching well-being, but, they are not themselves an index of well-being. It follows that utility is considered as one of several aspects of being which are relevant for a general evaluation of well-being.

Particularly, in Sen's theory of well-being called also *capability approach*, it is necessary to take into consideration what the persons are able to do not only with the instruments they have but also and especially with the *capabilities* they have. Three new analytical categories enter the field of welfare economics: *functionings*, *capabilities* and *freedom*.

Functionings and *capabilities* are the constituent elements of well-being. These economic categories redefine the concept of well-being. A functioning which is defined as "an achievement of a person: what he or she manages to do or to be" (Sen, 1985, p. 10), is a concept clearly distinct from the concepts of commodities and utilities. Instead, *capability* indicates the various achievable functionings. The capability of a person, represented by the set of functionings, reflects the real opportunities that he/she has regarding the life he/she can lead.

With reference to *freedom*, it constitutes one the relevant factors of differentiation from the traditional theories. In an acceptance of multidimensional development, this analytical category, plays such a key role that for Sen, development is freedom. "Development can be seen [...] as a process of expanding the real freedoms that people enjoy" (Sen, 1999, p. 3). This means that the primary aim of a process of economic development does not reside in material welfare but in the enhancement of opportunities and of freedoms.

life, intra and inter-generational equity, social and ethical dimensions of human welfare. For these reasons, human development

The latter regard the economic and social sphere (such as, education and health care) or political and civil features (as for example, liberty to participate in the political life).

Furthermore, it should be noted that not only is freedom an abstract concept but also an “operational” idea because it focuses directly on quality of life. For this reason, it assumes a precise content, namely the capability to choose and attain achievements. This capability is closely linked to the level of *well-being* reached by individuals, in the sense that individual freedom is a component of *well-being*. This is a different concept from the traditional concept of *welfare* and, therefore different from the welfarist theory. The welfarist theory is inadequate in dealing with freedom for two reasons: “first, freedom is concerned with what one *can* do, and not just with what one does do. Second, freedom is concerned with what one can *do*, and not just with what utility that doing leads to” (Sen, 1984, p. 318).

While the welfarist theory refers to the situation in which a person achieves a level of satisfaction of personal desires or preferences, or a given level of happiness, the level of well-being depends on the individual capability to achieve his/her own aims. It might seem, from what has been mentioned so far, that Sen focuses more on individual well-being rather than the social one. However, a deeper interpretation of Sen’s well-being, seems to show that the well-being of a person is connected to social well-being and that individual freedom implies social freedom (Sen, 1999).

After having examined the conceptual definitions of the above mentioned analytical categories, it seems appropriate to address in brief the problem of evaluating well-being.

Following Sen, we can represent the person’s state of well-being as a vector of functionings from which a person selects some on the basis of the kind of life he/she chooses while, a person’s capability is the set of feasible vectors³. We express the evaluation of well-being as a function of the capability set of the chosen combination of functionings, considered jointly as two “objects of value”⁴, in order not only to formalise the evaluative approach but also to point out the role played by the individual choices.

as conceived by Sen seems to be the closest concept to the idea of sustainable development.

³ Person’s capability set has to be interpreted in the sense of person’s opportunities to achieve well-being or, using Berlin’s terminology, *positive freedom* (Berlin, 1969).

⁴ Objects of value can be identified with a characterization, among the possible functionings, of the *relevant* functionings. These

In analytical terms, if f_i is a vector of functionings and Q_i are the capabilities - which depend on the amount of income and the available goods and services (indicated with x_i) as well as on two variables that influence the conversion of individual resources into well-being, represented by a vector of personal characteristics⁵ θ_i and by a vector E_i of environmental indicators (Chiappero Martinetti, 1996, p. 39) - the equation of well-being for the individual i , is as follows:

$$WB_i = g_i [f_i; Q_i | Q_i = h_i(x_i, \theta_i, E_i)] \quad (1)$$

From this equation, by preferring those components useful to our object of study, it is clear that, the environmental component is included in the quality of life hence in the conception of well-being. It is also relevant to observe that when we refer to the environmental component, we generally link it to the widely discussed and controversial concept of sustainable development. The link between well-being and sustainable development is then straightforward⁶. A higher level of sustainable development means a higher level of well-being, thus of quality of life. The issue of how Sen's theory of well-being could provide a basis for an index of sustainable development here arises. The review of Sen's theory described so far allows us to represent all the economic categories and their relations in Fig. 1.

represent the level of well-being satisfactorily. Therefore, in the concept of sustainable development, the *relevant* functionings could constitute the value-objects which satisfy the principles of environmental sustainability, economic efficiency and intergenerational equity.

⁵ In order to understand what personal characteristics are, we have to refer to the new approach proposed by Lancaster. "The tastes which are accepted as given for each individual are not preferences over collection of specific goods but deeper preferences over objectives which are to be achieved by the consumption of goods. It is the attributes or characteristics of different goods which provide the means for conveying embodied characteristics which contribute to consumption objectives. It is not food as such but the taste, hunger-abating nutritional, and other characteristics of food that directly impinge on the consumer's preferences"(Lancaster, 1979, p.7). In terms of Sen's approach, the well-being of a person requires the specification of his capabilities, that is, the functions used which he is able to exercise with a basket of goods. Therefore, a set of function of utilization is associated to each person, everyone of whom specifies a pattern of possible uses of the characteristics of the possessed goods. It follows that the well-being of a person may be explained as the evaluation of the function of utilization adopted corresponding to a given vector of the characteristics of goods. With reference to environmental quality, this is definable if we identify the constitutive characteristics of it. For example, if we take into consideration pollution and degradation, its characteristics are given by better features of the environmental quality of the area in terms of sustainability of the resources (i.e.soil, air and water), while as regards as biodiversity, its characteristics are made up of biological diversity as characteristic of the ecosystems.

⁶ The link between sustainable development and well-being comes from the fact that both of them are considered forward-looking concepts. But, if it is clear, on the one hand, that sustainable development is a forward-looking concept for guaranteeing the needs of present and future generations, it is not as clear why well-being can be considered a forward looking concept too. The distinction between welfare and well-being may be of some help. While the former is a snap-shot in time concept since it produces only temporary benefits (such as the increase in material wealth which can create only temporary happiness and satisfaction), the latter is a forward-looking concept. The explanation lies in the fact that, when we deal with well-being, we usually think about a lasting development, which should increase the standard of living of present and future generations. To increase well-being means, for example, the possibility to raise the educational level especially in developing countries, to get a more equitable income distribution, to promote human and political rights, to ensure a better environmental quality etc. All these economic policy actions differently from the ones deriving from welfare, should last over time and for this reason they are similar to those contained in the sustainable development concept.

In order to analyse this issue in a proper way, we have to consider the multidimensional nature of sustainable development and have to state from the beginning that, the concept of sustainable development, is based on the human development approach. More specifically, we identify development with freedom. In fact, the contribution given by Sen and the innovative value of this theory consist in promoting a process of “sustainable human development” which, according to the Human Development Reports (UNDP) seeks to put people back at the centre of development. This kind of development is even defined as “ethical development” to indicate “the project of rethinking and redefining “development,” since some development economists have become disenchanted with the view that “economic growth” is the chief objective, and that per capita income is the measure of development” (Qizilbash, 1996, p. 1209).

The desire to improve the quality of life is implicit in this definition of human development. The possibility to raise the educational level especially in developing countries, a more equitable income distribution, the promotion of human and political rights and a better environmental quality are all aspects which surely contribute to the improvement of the quality of life. Therefore, the link human between well-being and quality of life becomes evident. From this perspective, environmental well-being finds its appropriate space. Not only has the environmental component the same weight as the social and the economic ones, but is also included in the quality of life through a process of identification of the relationships between the components of natural capital and the quality of life itself. In this sense, the analytical categories of *functionings* and *capabilities* have an instrumental role. In fact, on the basis of Sen’s capability approach, the human development idea seems to be the precondition to achieve sustainable human development at the environmental level as well. In other words, in order to achieve a high level of sustainability, it is indispensable to reduce poverty, i.e. to trigger a process of human development. In fact, human development creates those conditions of stability and human progress, necessary for the preservation of the environment. This means that there is an interrelation among the socio-economic, political and environmental variables. The sustainability problems go further than the environment, because there is a

need for a flexible economic and social system able to resist the shocks in order to safeguard the welfare of future generations.

However, in order to better explain the matter in question, i.e. how human development is a precondition to sustainable development, we have to refer to developing countries on the one hand and developed countries on the other hand. In developing countries, a sustainable development at an environmental level presents greater difficulties. Though being aware of unavoidable simplifications of a problem which has not yet been solved at a theoretical and empirical level, we can state that urban poverty and a low level of rural livelihood could accelerate environmental degradation because pressure on forest, fisheries and lands would increase (Harris, 2000). In developed countries, instead, it is more likely that a sustainable development which is environmentally friendly may take place because the conditions to reach a human development should be more favourable⁷. To this purpose, it can be useful to note that recent literature has hitherto overlooked that economic growth is not main responsible for environmental degradation; rather, it can be a component able to stimulate a process of economic development, if it does not exceed the rate of the natural regeneration of the resources. The challenge is to bring back, a more balanced relationship between environmental quality and economic growth among the components of quality of life and well-being. This relationship can be positive, as the so called “inverted Kuznets curves” have demonstrated at least for some pollutants, or it turns out in a trade-off (Arrow, 1995; Grossman, 1995; Rothman and De Bruyn, 1998).

For all these reasons, it emerges that the sustainable development issue which is nowadays only a theoretical concept, may become operational and implemented in our societies if and only if it is inserted in that multidimensional paradigm of development conceived and created by Sen. This is the main point that helps us to understand how Sen’s theory of well-being could provide a basis for building an index of sustainable development.

3. A critical review of current measures of welfare/sustainability

⁷ However, as we will note later when we will examine the results deriving from the empirical analysis, this is not a case which can be generalised.

In order to justify the building of our index using Sen's theory, we have to start from the criticisms directed to the current measures of welfare/sustainability, such as, GDP, Genuine Savings, the ISEW and the HDI, which are considered to be unsuitable measures of sustainability. As it is not possible to analyse in full the problems regarding the evaluation of GDP, we will limit ourselves to point out some aspects useful to the objectives of our study.

National Income Accounting, which GNP and GDP derive from, has substantial validity as financial measure providing information about flows of money, while, it is much more problematic and subject to criticism as a measure of the progress of an economy, in terms of human happiness or welfare (Anderson, 1991).

The current weaknesses in the calculation of GDP are well known. They include distribution of income, equal evaluation of all goods and services and exclusion of all non profit activities or non money transactions. There are also weaknesses regarding the level of welfare, such as better health, sanitary and hygienic conditions of the population or changes in work conditions, and numerous leisure activities (Anderson, 1991; Beckermann, 1995; Mishan, 1993). Furthermore, the benefits deriving from material wealth and its depreciation, except for the value of housing, are not counted⁸; while, relevant stocks, such as "environmental wealth", human beings and, their respective depreciation are not considered. A paradoxical situation follows due to the fact that the activity to repair environmental damage is included as part of income⁹. "Moreover, conventional measures of GNP ignore costs that arise from externalities - the cost of associated pollution, environmental damage, resource depletion [...]. In all of these cases, prevalent prices do not capture the true marginal social value or cost of a good or a service" (Ray, 1998, p. 16).

The conclusion deriving from these criticisms is that per capita income "does not serve as a unilateral guarantee of success in "human development"(ibidem, p. 29). The first attempts to

⁸ "The value of timber is counted in the GNP, but no account is taken of the benefits which were derived from the existence of the forest, such as the absorption of carbon dioxide (unless these benefits were paid for) or of the loss these benefits when the forest is destroyed" (Anderson, 1991, p. 27). While, only NDP includes an allowance for capital depreciation.

⁹ A step towards sustainability could happen if the natural resources were accounted for as being used in production and, therefore, subject to depreciation adjustments (Permann, et al, 1999, p. 502).

reformulate some alternative approaches to the traditional methodology of GDP calculation consist of the *Greening GNP and NNP*¹⁰, *Genuine Savings approach*.

Focusing our attention on the latter approach, we can point out some of its weaknesses. A valid criticism regards the interactions between developing and developed countries. Developed countries import raw materials from the developing ones. However, it is not correct to consider only the physical flux of imports. It is necessary to consider also the consequences on the countries which export such raw materials in terms of their sustainability. It follows that, on the one hand, developed countries import not only resources but also the sustainability of poor countries; on the other hand, they export manufacturing products and their unsustainability¹¹ (Pearce, Markandya and Barbier, 1989, pp. 45-47). Genuine Savings are considered to be dependent on GDP since this is considered to be the central measure of development/progress and some GDP variables appear, in the Genuine Savings formula, before adding or subtracting certain values. The effect is to leave the North with positive rates of Genuine Savings and many resource-rich Southern countries with negative or near-zero rates.

For the reasons examined, it appears that the Genuine Savings approach basically fails as a measure of sustainability. However, it should be noted that this measure could become a reliable indicator of sustainable development only on condition that it has a central role in economic development policies.

¹⁰ For a detailed examination of these more “sustainable” macroeconomic measures cfr. Hanley et al. (1997) and Hanley (2000).

¹¹ This issue about unsustainability is rather controversial because it seems on the one hand, that developed countries have clean air, clearer technology and waste-disposal systems, while, on the other hand, developing countries are characterized by polluted air, open waste disposal systems and polluting technology. In the reality, things are different. Developed countries are to be significantly blamed for being exporters of unsustainability in developing countries as it is supported by some evidence (Nath, V., 2001). In a first instance, the former used a conspicuous proportion of their environmental resources for their national economic growth processes and are building up their environmental currency reserves at the cost of their depletion in developing countries. For example, developed countries account for much larger footprints as compared to developing countries. This is because developed countries are using both a higher proportion of the earth’s carrying capacity and the same carrying capacity available with developing countries to foster their domestic growth. Through trade, developed countries appropriate carrying capacity from developing countries and they are able to increase their ecological footprints. Over-consumption is one of the main reasons of large footprints in developed countries. (ibid.). According to Catton (cit. in Nath, 2001) in 1790, the American estimated average daily energy consumption was 11,000 kcal, while, in 1980, this increased to 210,000 kcal/day. The high growth in energy and material consumption in developed countries is reducing the ecological space available to poor countries and furthermore is producing trans-boundary externalities. Secondly, rich countries produce most of the global warming gases that cause climatic change and developing countries have to bear the most environmental damaging effects. Another good example of developed countries being exporters of unsustainability is given by trans-border waste movement. In 1980s, developed countries have exported a significant amount of hazardous waste to developing countries through legal or illegal contract which allowed to accept waste in exchange for cash. (Third world network, cit. in Nath, 2001). Furthermore, the environmental disaster caused by collapse of rich cacao Brazilian farms due to a decline in world’s chocolate prices is another example of unsustainable patterns in developing countries (Nath, 2001). In conclusion, from above, it may be extrapolated that developed countries have found much easier to change the policies of the developing countries rather than change their own domestic policies and cause then less environmental damage (ibid.).

Another attempt to search for a better measure of welfare and sustainability is represented by the *Index of Sustainable Economic Welfare (ISEW)* which is proposed by Daly and Cobb (1989) and it is defined as Genuine Progress Indicator (GPI). This index tries to describe the change of sustainable economic welfare over time. It measures market and non-market production, but it does not take into account those parts of production which are not available for consumption due to the need to repair damages caused by the economic system. A positive aspect of this index is that it is considered quite consistent with the idea of an environmentally sustainable economic development as well as with the concept of social justice (Stockammer, et al, 1997, p. 22). Therefore, according to Hamilton (1999, p. 14), the GPI (ISEW) sets two important tasks: 1) it measures consumption in a way which seems to be a better approximation of actual well-being than the GDP measure; 2) it accounts for the sustainability of consumption through the inclusion of measures of changes in the value of capital stocks.

Lastly, by comparing environmental adjusted GDP and ISEW, we can point out that the latter goes further than the former because it takes into consideration not only depletion and environmental costs, but also social costs, future costs, and distribution issues.

The common dissatisfaction expressed by various economists about the misuse of GDP has led to the elaboration of other indicators which centre more on human development than on economic growth. One of these indicators is *Human Development Index (HDI)*, which, however, has the weakness to attribute equal weight to its components (Kelley, 1991). It should be noted that, although HDI could be considered as a first and important step towards including broad notions of sustainability into measures of development, it has been proved that in reality two components are missing from its calculation: human freedom and environmental quality (Atkinson et al, 1997, p. 141). Indeed, “so far, the HDI has neglected links to sustainability by failing to investigate the impact on the natural system of the activities that potentially contribute to national income –and hence to HDI” (Sagar and Najam, 1998, p. 263). It is clear, that indicators such as HDI are not sufficient for the

measurability of sustainable development and have to be accompanied by complementary indicators or environmental components.

In contrast, with reference to the environmental component, the problem is that HDI should not only take into consideration the environmental component, but that this component should have the same weight as other components such as income, education and health. A way of arguing about this matter is that if environment is an important part of sustainable development and if human development is considered to be sustainable human development, then environment should have the same importance and weight as the other components (Atkinson et al, 1997)¹².

For all these reasons, we think it is appropriate to build an index of sustainability, using Sen's ideas, in order to overcome some of the weaknesses of the indices analysed so far. One of the criticisms directed to the HDI is that it cannot be a good index of sustainability because it does not take into account any environmental component. Because of this weakness, we have assumed that in Sen's index of sustainability the environmental component has to be considered and has to have the same weight as the economic/social variables. Only in this situation, the environmental component could have the same importance as the social and economic ones. Therefore, Sen's index of sustainability could be a good representation of social, economic and environmental well-being because, as we will see in the next paragraph, it takes into account a set of economic, social and environmental variables and, most importantly, since it gives the same weight to all the components considered.

4. Towards a new multidimensional index of sustainability

¹² In order to overcome some of these criticisms, few modifications of HDI, such as a *Modified Human Development Index*, (MHDI) have been proposed (Noorbakhsh, 1996a and 1996b). While, as mentioned above, HDI attributes equal weight to the three components, according to MHDI, the three components (birth rate, adult literacy, standard of living) are standardised. The standardisation eliminates the unintentional weight which is attributed to HDI. Although, according to Kelley (1991), it is not correct to attribute equal weight to the three selected components because a raise in income can increase people's choices and achieve improvements on other components with the consequence of a higher weight, the equal weighting does not seem to present serious problems. Besides, the components are not correlated with each other and the index itself is not really correlated with any of these components. The conclusion reached is "that there is a little evidence to support the suggestion that any of these indices, as compared to their component, is redundant" (Noorbakhsh, 1996b, p.24).

In order to measure and compare welfare situations it is common to use indices, such as for example, indices of inequality and poverty. Moreover, in order to measure sustainability and well-being we have built a multidimensional index based on the capabilities approach.

Using the framework adopted by Robeyns (2002, p. 12), the first step is to select some meaningful variables¹³ that are useful to this sustainability context. These are as follows: consumption, income distribution, life expectancy, health, education, employment, pollution, aesthetic and cultural value. This selection has taken into account the approach of the indicators proposed by Dasgupta (1999) and applied to the measurement of well-being in a multidimensional space. This approach, although being less refined under the theoretical profile, aims at reaching a wide dimension of economic and social welfare, able to capture its complexity and to provide a support to the evaluation process of policy making. In other words, the multidimensionality is the main feature of this approach, as only aggregating variables of different nature, meaning and different unity in one index of “quality of life” (Dasgupta and Weale, 1992), the complexity of well-being can be approximated.

At the same time, the selection has been made considering the ongoing European debate on the social indicators of national performance, since this debate represents a remarkable point of view able to address the action of the European Union. More specifically, we are referring to the *Indicators for Social inclusion in the European Union*¹⁴ (Atkinson et al, 2001) prepared for the Belgium government with the aim of defining a guide for building a set of social indicators which can be used to control and evaluate the situations of the member countries and their responses to the social policy of the European Union.

The selection of the indicators has to take also into account that the sharing of the objectives is a necessary requirement for pursuing them. For this reason, it is important that the same objectives are recognized at the institutional level. The aim is the economic and

¹³ These variables, except for consumption, represent functionings since they indicate what the individual may be able to do or to be with the resources and capability he has. In other words, functionings are the achievements an individual can pursue. For example, having enough income equi-distributed, being educated, being employed, being able to live a life in a good health, improving the environmental quality by reducing the total emissions of pollutants, such as, NO₂ or SO₂, or being able to institute protected areas for the protection of environment are all examples of functionings because they represent the achievements of a person.

¹⁴ We need a special mention of social inclusion because we are referring to the areas on which the social indicators are verified, i.e.: economic dimension, (income, its distribution and poverty) unemployment, regional differences, education, health and social participation.

social progress and the strengthening of the economic and social cohesion, while sustainability, is not considered in this report. The reason is that the purpose of the selected indicators is to measure only the current aspects of the welfare itself and not its sustainability. A current level of welfare does include any particular relevant aspects for pursuing sustainability and vice-versa and this is in contradiction with the concept of sustainability, which means a lasting level of welfare. For example, a strengthening of the social cohesion increases the current welfare, but it cannot guarantee the future welfare.

Following the above mentioned report, in Sen's sustainable development index, the indicators selected are similar to the ones of the report itself with the difference that Sen's index is based on the concept of sustainable development. In this case, the variables chosen have to measure not the current aspects of welfare, but the sustainability of the welfare itself.

However, the question, which can arise, is why these indicators have been chosen instead of others. The immediate reply is that they are in line with the principal priorities of economic/social/environmental progress of the political agenda of the European Union. But, in Sen's sustainable development index, few indicators are different from the ones proposed in the Report. This has been drawn up in order to respect Sen's idea and to satisfy the principles of sustainability.

The second step consists in exploring the possibility of how to measure the phenomenon in examination, that is the possibility of transforming these variables in indicators and, later, aggregating them¹⁵.

Taking our cue from Tsui (2002) who examines the axiomatic foundation of multidimensional poverty indices and from the axiomatic approach (Peragine, 2001) that gives an idea about the aggregation problem, we can proceed with building up Sen's index of sustainable development.

By attributing each of the above mentioned variables to each country, we assume that there is a function f which makes Sen's sustainable development (S_{sd}) depend on *consumption* (C), on *basic functionings* [L_{exb} (life expectancy for boys), L_{exg} (life expectancy for girls), H

¹⁵ It is obvious that the operation of aggregation presents some methodological difficulties which will be addressed later.

(health), Em (employment), E (education), I(income distribution)] and on *relevant functionings*¹⁶ [pollution (P) and aesthetic and cultural value, A_{cv}]:

$$S_{sd} = f [C, L_{exb}, L_{exg}, H, Em, E, I, P, A_{cv}] \quad (2)$$

In order to transform these variables in indicators so that they can be object of measurement, we have to identify the data required to measure each functioning, although due sometimes to unavailability of statistical data, as in this context, *proxies*¹⁷ may be of help. Then, the equation (2) becomes the following:

$$S_{sd} = f [I(C), (I)L_{exb}, (I)L_{exg}, (I)H; I(Em), I(E), I(I), I(P), I(A_{cv})] \quad (3)$$

where, the indicator chosen (I), for the variable consumption, is the final consumption expenditure of households and non-profit institutions, expressed in current series in million ECU/EUR adjusted for purchasing power parity (PPS); the indicator for life expectancy is life expectancy at birth calculated both for boys and girls; for health, the indicator chosen is the total number of physicians per 100.000 inhabitants; for employment, the rate of employed people aged 15-64 as a share of the total population of the same age group; for education, the number of students enrolled in tertiary education; for income distribution, the ratio of total income received by the 20% of population with the highest income on the total income received by the 20% of the population with the lowest income; for pollution, the emissions of NO₂ and SO₂; for aesthetic and cultural value, the percentage of protected areas. The equation is, therefore, composed of ten indicators with the variable pollution which consisting of two indicators.

In order to carry on the analysis, we have to address the aggregation problem. One of the simplest and most appropriate ways of aggregation in our case study, is represented by the

¹⁶ Variables such as income distribution, health, life expectancy, education, employment, can be defined as *basic functionings* because they represent necessary, although not sufficient, conditions for the preservation of the environment. While pollution, aesthetic and cultural value are *relevant functionings* because they represent “actual” (i.e. historical determined) achievements. It is worth specifying that relevant functionings are not only positive (in the sense that improve the quality of life) but also negative: pollution, is in fact, an example for its negative impact (but the same thing can be affirmed for aesthetic and cultural values). These functionings are relevant if they are able to represent satisfactorily the level of environmental well-being or in Sen’s terms, the level of “well-being freedom”. Therefore, for example, in a view of sustainable development, the relevant functionings could constitute the value-objects, which satisfy the principles of environmental sustainability, economic efficiency (such as consumption) and intergenerational equity. From what it has been said above, it should be clear that a “trend” of sustainable development cannot be identified in the promotion of each functioning, but in the promotion of the capability to function.

¹⁷ Proxies have not been used in the case of consumption and life expectancy.

purely aggregative criterion, which translates itself in summing up all the indicators considered¹⁸. Consequently, the equation (3) is transformed in the following one:

$$S_{sd} = f [I(C) + (I)L_{exb} + (I)L_{exg} + (I)H + I(Em) + I(E) + I(I) + I(P) + I(A_{cv})] \quad (4)^{19}$$

Given the multidimensionality of the approach, we have to address two issues: the aggregation of different assets in one unity of measure and the weight which has to be attributed to each indicator. In other words, the issue of the synthesis of the indicators of a different nature is composed of two aspects: 1) the identification of the procedure of synthesis which is useful to adopt in order to reduce the multiplicity of the indicators²⁰; 2) the choice of the possible criterion of weighting which has to be attributed to each indicator so as to take into account their different importance in describing the phenomenon.

Being more precise, the first aspect is a function of: a) the cognitive objective to be pursued; b) the multiplicity of the indicators; c) the homogeneity of the same indicators. The multidimensionality of the approach implies the multiplicity of the indicators. There are various ways of taking into account this aspect. However, the main reason why we have adopted the aggregative approach is that it does not represent an alternative to the multidimensional approach, but it is only another point of view which introduces a certain subjectivity in the choice of the methodology of aggregation. The resulting index may be used in order to evaluate the public decision “in short to be able to evaluate public policies we need measures of the quality of life” (Dasgupta, 1999, p. 1). From what has been mentioned so far, we can advisedly state that one of most suitable ways of solving the problem of aggregating²¹

¹⁸ The other two aggregative criteria are given by the (i) purely distributive which requires maximal equality whatever the cost is (the case of the egalitarian theories), and (ii) the intermediate one for which the requirement is the maximization of the minimum score (the “difference principle” proposed by Rawls, 1971).

¹⁹ We assume that f is a monotonic increasing function. This means that the synthetic index will raise if, *ceteris paribus*, one of the variables increases. So, an increase in consumption, life expectancy, health, education, employment will let the index increase; while the increase in pollution will let the index fall. For this reason, it is necessary to change the direction of the above mentioned negative indicators in order to have the whole set of positive increasing indicators and therefore obtain a monotonic increasing synthetic index of sustainability. Tab. 1 presents both positive and negative indicators. Negative indicators, such as income inequality and rates of NO₂ and SO₂, have to become positive through the complement respect to the unity of reference. Tab. 2 takes into account this further calculation. In particular, as regards income inequality, supposing that the relative ratio is greater than 1, in case of income equality, that ratio will be equal to 1. Therefore, 1 is the unity of reference by which every value of the indicator considered will be divided in order to achieve the income equality indicator. While, as for the negative indicators, such as emissions of NO₂ and SO₂, the positive indicators, reduced NO₂ and reduced SO₂, are obtained subtracting the highest values among the OECD countries to each observed value (we refer to the total emissions of traditional air pollutants, late 1990s in OECD Environmental Data 2002). The highest values taken as unity of reference regard Australia, which has the highest emissions of both NO₂ and SO₂ equal respectively to 135,2 and 95,8. It is clear that these are not real values, but values which were necessary to calculate in order to use the statistical method chosen.

²⁰ The above mentioned indicators are expressed in different account units and the conversion in a unique unity of measure is a necessary requirement in order to aggregate them.

²¹ One method could be the aggregation of different assets in physical terms, by using conversion factors to express different

a number of different variables in multidimensional indices may be through the arithmetic mean of the values transformed in standardised deviations which make homogeneous the indicators. This approach has been used in our empirical case study²². It is important to remark that we did not use money/market prices in order to aggregate these indicators since they represent “commodities ” which are not objects of commercial transactions.

As regards the second aspect, a critical point is the complexity of the capability approach and the consequent difficulty of weighing up the different functionings considered. To this purpose, Sen states that “individual functionings can lend themselves to easier interpersonal comparisons than comparisons of utilities.[...] However, interpersonal comparisons of *overall* advantages also require “aggregation” over heterogeneous components. The capability perspective is inescapably pluralist. First, there are different functionings, some more important than others. Second, there is the issue of what weight to attach to substantive freedom (the capability set) vis-à-vis the actual achievement (the chosen functioning vector). Finally, [...] there is the underlying issue of how much weight should be placed on the capabilities” (Sen, 1999, pp. 76-77). This issue implies the problem of valuation which, in turn recalls another one: how the weights are to be selected. Sen thinks that the problem can be resolved into a “reasoned evaluation”, that is, “there has to be some kind of a reasoned “consensus” on weights [...]. This is a “social choice” exercise, and it requires public discussion and a democratic understanding and acceptance” (ibidem, pp. 78-79).

We have referred to this important methodological matter in order to emphasize that the attribution of weights to the different components of quality of life is a necessary operation. Being this a “social-choice exercise”, the attribution of weights depends on the *evaluative judgements* that cannot be avoided when comparing states of well-being among more persons. However, in our specific case, owing, both to the impossibility of placing the chosen weights to public discussion and democratic understanding and acceptance, and the difficulty of measuring some functionings, we have thought of attributing equal weights to the different components of quality of life which have been considered by us. A disadvantage of a

physical units of measurement in “equivalent” (i.e. the energy content of various resources can be converted into coal or oil

the weighting criterion is the introduction of a further subjective component which should be better avoided as it may influence the final results. Furthermore, the choice of not having adopted a weighting system is due to the fact that each indicator is assumed to have the same weight because it contributes in equal measure to the determination of well-being and/or sustainability. It could be objected that, when we have gathered basic functionings and relevant functionings, we have distinguished between basic functionings (life expectancy, health, education, income distribution, employment) and relevant ones (pollution and aesthetic and cultural value). This means that if there are no conditions for a sustainable human development (such as, high inequality in income distribution or a low access to education institutions and health services) a sustainable development environmentally friendly may not take place. Thus, at a first sight, in terms of weighting, a higher weight may be assigned to each basic functioning and a lower one to each relevant functioning (environmental indicators). However, at a deeper analysis, it may be noted that the issue of the weighting could be applied only to developing countries, not to the industrialised EU countries of our study. It follows that the environmental component has the same relevance and thereafter the same weight of social and economic variables such as health, education, employment, income distribution, etc. Lastly, the choice of not applying any weight to each indicator is justified on the grounds of one of the criticisms of HDI.

Resuming the matter regarding the building of our index, we express, in a simplified way, each variable in symbols such as x_1^i, x_2^i, x_3^i , etc. Therefore, x_1^i stands respectively for the consumption of the country i , x_2^i stands for life expectancy at birth (boys) of the country i , x_3^i life expectancy at birth (girls) of the country i , x_4^i stands for health of the country i and so on (see, Tab.1). It follows that the equation 4 becomes:

$$S_{isd} = f \{x_1^i + x_2^i + x_3^i + x_4^i + x_5^i + x_6^i + x_7^i + x_8^i + x_9^i + x_{10}^i\} \quad (5)$$

Where S_{isd} , which substitutes S_{sd} in the equation 3, stands for Sen's sustainable development for country i since the index is calculated for each EU country. The variables z_1^i, z_2^i, z_3^i etc.,

equivalents, or contributions to global warming can be attributed to greenhouse gases in terms of CO₂ equivalents).

²² For the interpretation of the results by using the standardised deviation methodology, see Tabs. 1 and 2.

which are standardised variables referring to the country i , substitute the original ones (Tab. 2)²³. The equation 5 becomes, therefore, the following:

$$S_{isd} = f \{ z_1^i + z_2^i + z_3^i + z_4^i + z_5^i + z_6^i + z_7^i + z_8^i + z_9^i + z_{10}^i \} \quad (6)$$

The synthetic index of sustainability which is referred to the country i and calculated in the column 10_sⁱ of the Tab. 2, is the following:

$$S_{isd} I = \frac{\sum_{j=1}^{10} z_{ij}}{n} \quad (7)$$

where $S_{isd} I$ stands for Sen's index of sustainability for the country i . Z_{ij} is the ij unit of the matrix of the standardised variables, and n is the number of variables or the number of the statistical units considered²⁴.

The standardised deviation methodology allows us to identify the countries which are above the arithmetic mean (the positive ones, which have a higher standard of living and therefore a better level of well-being/sustainability) and those which are below the arithmetic mean (the negative ones, which have a lower standard of living and thus a lower level of well-being/sustainability). The last column (Tab. 2) shows the ranking in a decreasing order starting from the country with the highest positive score to the country which has the lowest one.

5. Discussion about the results

5.1. The results achieved through the standardised deviation methodology

²³All the variables from z_1^i to z_{10}^i are obtained using this formula $z_{ij} = \frac{x_{ij} - \bar{x}_{0j}}{\sigma_j}$, where z_{ij} refers to the standardisation of

the indicator j for the country i ; x_{ij} is the variable taken into account which refers to the indicator i and j , \bar{x}_{0j} is the arithmetic mean for the j indicator and σ_j is the averaged squared deviation for the indicator j . The formula of the standardised deviations is obtained through the formula of the standard deviation.

²⁴ Sen's index of sustainability derives from the following synthetic generalized index: $S_i = \frac{\sum_{j=1}^m z_{ij}}{m}$, where the matrix of the indicators $X_{n,m}$, having the same direction, will be substituted for the matrix of the standardised values Z which still have $n \times m$ dimensions. It follows that the above mentioned index, associated to the i -ma statistic unity, is given by the arithmetic mean of the elements placed in the i -ma row of the matrix of the standardised deviations $z_{n,m}$.

Focusing our attention on the synthetic index of sustainability (10_s^i), which is calculated for each country, and on the relative ranking (Tab. 2)²⁵, the results can be briefly analysed as follows.

Sweden and Austria, on the one hand; France and Germany, on the other hand, occupy the first four positions. The evidence coming from the ranking can be interpreted in the sense that these countries have followed a more sustainable/human model of development than the other EU countries. Most of the values taken into account for *basic* and *relevant functionings* are positive. With reference to Germany, one may hypothesise that the functionings values would have probably been higher before the reunification. The countries (Denmark, Netherlands, Finland, Belgium) occupy an intermediate position. It is meaningful that being similar to one other, they constitute a homogeneous group.

From a territorial and demographic point of view a similar group follows, i.e. Italy, Spain and United Kingdom. With regard to Italy, it is necessary to point out that the final positive result (0,135) is the mean between North and South. The Northern part of Italy is more industrialised, the South is more socially and economic backward. This explains why Italy, though having a final score above the mean, is quite far from the values of France and Germany; while similar economic/social conditions explain the proximity to U.K. and Spain. The position in the ranking of these three countries reveals a low level of sustainable and human development. Their situation is contradictory: some values are positive, others negative. This is, probably a consequence of their economic and social policy inspired to a more marked economic liberalism, hence to a lower supply of public services. Furthermore, we may note, with reference to consumption, that Italy and Spain have a lower cost of living than the U.K, France and Germany one's. If we look at the life expectancy indicator, we

²⁵ It should be noted that sustainability is about trends over time. In order to show this, some time series analysis applied to Italy will be carried out in section 6. Comparing this ranking with more conventional ones (such as real GDP per capita, referred to EU countries in 2001, European Union Notes: Economic Data), the situation changes especially with reference to the countries which result to have the highest positions in Sen's index ranking, i.e. Austria and Sweden. In fact, they have lower positions in GDP ranking; Sweden has the 10th position and Austria the fourth one, while Luxembourg and Ireland have the first two positions. The situation between both rankings is more or less similar with regards to Italy, Finland, Denmark, Germany, Netherlands U.K., while, France surprisingly has a lower position in GDP ranking equal to 14th than in Sen's index ranking which is on the 3rd place. Portugal, Greece and Spain confirm themselves to be at the lowest places also in the GDP ranking. Although the GDP ranking shows similar positions for some countries, it is clear and well-known that we cannot base our analysis on the sole indicator of GDP. This is surely one of the components of the development of a country which is necessary to consider but it is not sufficient. In order to reach a multidimensional development, we have to take into account not only real GDP per capita but also socio-economic and environmental variables as Sen's index ranking shows.

observe that Italy, Spain and France have values of life expectancy above the mean. This may indicate a life style and environmental conditions that are relatively better than other European countries. The health system too shows positive values for Italy.

With reference to the group of countries with intermediate values, we can infer that they have probably pursued a relatively higher level of human development as shown by the higher values of some of the social and economic indicators but, surprisingly not of development at the environmental level. Some values of the environmental indicators are negative especially with reference to Denmark and Finland. This empirical evidence is in contrast with what has been pointed out previously, at the theoretical level, i.e. that when there are conditions for a human development, it is more likely that a development at an environmental level may be achieved. Probably, although it is generally recognized that sustainable development may follow human development, the case of a lower development at an environmental level depends on the extent to which environmental issues are considered important in political choices. In other words, it is necessary to take into account the capacity of “response” of the public opinion about the environment, which reveals itself in the willingness to pay eco-taxes, to bear the expenses for the conservation of the nature and for the research, or to respect economic and fiscal instruments of regulation. Greece, Ireland and Portugal present many values below the mean and are at the bottom of the ranking. Emblematic is the case of Greece whose big effort to enter the EU needs to be recognized. It is remarkable that only three variables are above the mean: consumption, life expectancy both for boys and girls and health, which indicate a better life style, as it was stated above with reference to Italy, Spain and France. We have pointed out the anomalous situation of Luxembourg which is in 13th place. This unexpected result, is probably due either to its small territorial dimension, or to unavailability of data.

In short, the analysis of the ranking allows us to assert that the number of countries with a positive score (above the mean and therefore more sustainable²⁶) is higher than the number

²⁶ The countries with a positive score have been defined as more sustainable, from the economic/social and environmental point of view, in order to differentiate them from the less sustainable ones with a negative score. Therefore, the most sustainable country, is the one which has the highest score among all the countries which have positive values in the ranking 10_sⁱ, while, the less sustainable country is the one which has the lowest score among all the countries with negative values in the ranking 10_sⁱ.

of the countries with a negative score (below the mean and therefore less sustainable). This issue can be interpreted as a positive sign in terms of human and sustainable development.

5.2. The results achieved through factor analysis

The analysis founded on standardised deviation methodology does not allow us to reduce the influence which exists in the relation among the variables. It is important to bear in mind this weakness in analysis where there are many heterogeneous variables. Factor analysis allows us to avoid this, i.e., pollution which is negatively correlated with other variables may have a strong influence on them. It makes the analysis more interpretable due to the components extracted which make smaller the dimension of the matrix of data and to the non correlation of the transformed variables²⁷. This procedure of synthesis based on factor analysis has the big advantage to allow the estimate of the grade of reliability of the factors as representative of the dimensions of the phenomenon (Lelli, 2001, pp.170-173). Shortly, we can state that this method is considered to be an appropriate measure of well-being²⁸. In fact, these few latent components are able to express most of the original variance with minimum information loss. Thus, by extracting a small number of factors from the set of original variables, we may try to understand a latent phenomenon, such as well-being (Balestrino and Sciclone, 2001, p.8). Although this analysis does not lead to the building of another index, it will allows us to obtain another ranking and compare it with the previous one.

The first operation prior to factor analysis is to identify the variables which are strictly correlated with each other. Tab. 3 provides the coefficients of correlation for each couple of the ten indicators of the 15 EU countries²⁹. We consider as representative all values written in bold with p value³⁰.

The results of the correlation matrix show a positive correlation between consumption and income equality on the one hand, and consumption and percentage of protected areas on the other. The former positive correlation may be due to the fact that the level of consumption

²⁷ For a theoretical analysis of factor analysis, see Lelli, (2001); Balestrino and Sciclone, (2001).

²⁸ Also Sen (1990) argues that factor analysis is a suitable instrument for operationalising his approach.

²⁹ As is well known, the correlation of Pearson denoted with R always lies between -1 and 1 , which may be written as $-1 \leq r \leq 1$. Positive values of r indicate a positive correlation, while, larger positive values of r indicate perfect positive correlation i.e. $r = 1$. In contrast, negative values indicate a negative correlation (in this case, $r = 0$), while, larger negative values, i.e. $r = -1$ indicates

does not depend only on income but also on its distribution. Therefore, the lower the inequality in income distribution, the higher the level of consumption. An increase in consumption is a positive sign in terms of better standard of living and it is considered necessary (although not sufficient) and surely important in determining well-being as Dasgupta and Sen³¹ suggest. Instead, the latter correlation is only a statistical correlation whose economic meaning is too difficult to interpret. With regard to life expectancy, there is a representative positive correlation (0,680) between male life expectancy and female life expectancy and between life expectancy for girls and health and a negative one between life expectancy at birth for girls and total employment rate. The latter can be explained by the physical effects that for example a hard or an unpleasant job can have on health, such as stress or psychological frustration. Furthermore, two representative positive correlations are those between employment and income equality and between employment and percentage of protected areas. A positive representative correlation is noted between income equality and reduced emissions of SO₂

After explaining the results which derive from the matrix of correlation, we can apply factor analysis³² to our case study. Tab.5 reports the matrix of rotated components in which the factors loadings are obtained with Equamax (normalization of Kaiser). We will refer only to this matrix since it allows an easier and more interpretable identification of the common factors³³. The components extracted are three. The first component (which explains 32,2% of explained total variance) which is positively correlated with consumption, total employment rate, income equality, reduced SO₂ rate and percentage of protected areas, and negatively with health can be called “*factor of socio/economic equality*”. The second component, (which explains 26,4% of the explained total variance) which is positively correlated with life expectancy both for boys and girls, health, reduced presence of NO₂, and negatively with

perfect negative correlation.

³⁰ P value stands for the probability that exists no correlation between the variables.

³¹ Sen points out that consumption or income though not constituting a direct measure of the standard of life, they have an instrumental relevance in determining it (Sen and Anand, 1994).

³² Factor analysis, starting from the analysis of principal components, has been carried out through software packages; in this case SPSS has been used.

³³ We take into consideration and explain only this matrix, which is however the most meaningful, but it should be pointed out that factor analysis passes through the matrix of principal components (Tab. 4), in which the main factors are originally extracted before being rotated.

employment rate, can be called “*factor of health*”. The third component (which explains 15,5% of the explained total variance) which is positively correlated with reduced NO₂ rate and percentage of protected areas and negatively correlated with education and income equality can be named “*factor of environmental quality*”. Tab. 7 illustrates the factor scores³⁴ (factor 1, factor 2, factor 3) and the rankings of each factor. In order to arrive at an aggregate level of well-being, we weight the distances³⁵ by the percentage of variance of each factor. In Tab. 8 this calculation is taken into account considering the percentage of total variance³⁶. Tab. 9 shows the weighted extracted factors, the mean of variation fields standardised factors (WVFSF) and the two final rankings of well-being according to factor analysis (WVFSF ranking) and to the standardised deviation methodology (sustainable development - SD - ranking). The analysis which is carried out below, will compare both rankings.

Some representative cases, which are distinguished with the bold values, will be now explained. Considering Denmark, the correlation between factor 1 and factor 2 is negative. We can in fact, notice that, it occupies a very good position with reference to the socio/economic equality factor (1), but, it has the penultimate position (14) with regard to the factor health and the twelfth position with reference to the factor of environmental quality. (Tab.7). Both these factors have such a strong influence that Denmark is in a lower position in the WVFSF ranking (whose score is equal to 7) than in the SD ranking (whose score is equal to 5). This may be due to unavailability of data for the indicator of health. The case of Finland is quite interesting because it has the 10th position with regards to the factor health, and the last position (15th) with reference to the factor of environmental quality (Tab. 7). Both these

³⁴ Each of the extracted factors can be explained in a one-dimensional scale; indeed, it is necessary to calculate for each statistic unity, the factorial weight which is obtained by multiplying the *factor score coefficients* with the standardised values. Also with reference to total explained variance, we will refer to the weights of rotated factors which are shown below Tab. 4

³⁵ In order to sign the factors adequately, the following transformations have been carried out: $\frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}}$ for

factors 1 and 2; $\frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}}$ for factor 3, where, i indexes the regions, and j indexes the factors. The resulting

indices are expressed in distance terms in the 0-1 interval: the best performing regions are those whose score is near to one.

³⁶ Total variability is represented by the communality matrix (Tab. 6) i.e. the part of variance z_i extracted from p common factors relative to the three principal components. In other words, communality expresses how much share of it is represented in each of the extracted factors. For example, the share of the total variability (26%) has not been taken into consideration in the extraction of the components, especially with reference to the health variable only a small share with reference to education and life expectancy for boys; while income equality is highly represented in the extracted factors.

negative correlations have such a strong influence that in the WVFSF ranking, Finland has even a lower score (equal to 13th) than in the SD ranking whose score is equal to 7th. However, the cases of Denmark and Finland re-propose the analysis, which was carried out previously when dealing with the standardised deviation methodology.

The case of Spain is emblematic. It is in 2nd position with reference to factor 2 but almost the last scores with reference to factor 1 (position 13th) and it is in 10th position with regards to the factor of environmental quality. This result shows the complex situation of this country and seems to coincide with result and interpretation carried out above with regard to the standardised methodology. In fact, when comparing both final rankings, the situation between the two final rankings, with reference to Spain, is almost the same. The situation of Italy shows a better performance in the WVFSF ranking. In fact, its score is equal to 4, so revealing a higher level of well-being than in SD ranking whose score is equal to 8. The better performance may be due to the strong influence represented by factor 2 and factor 3. As it shown in Tab. 1, Italy, has the highest number of doctors per 100.000 inhabitants, equal to 574,5, while, the high negative correlation with reference to factor 1 confirms the same interpretation given about the standardised deviation methodology.

Sweden, which occupies the first position in the SD ranking is in second position in the WVFSF ranking. This may be due to the strong negative correlation with factor 3 (whose score is equal to 14).

The United Kingdom, which occupies the 10th position in SD ranking, shows a better performance in the WVFSF ranking with a score equal to 6. The two good scores of factor 1 and 3 which are equal to 5 and 3 have probably had a stronger influence than factor 2 and this could have contributed to letting the United Kingdom gain 4 scores. But the negative correlation with health (factor 2) reflects the original value for UK's health, (see, Tab 1) where, due to unavailability of data, the number of doctors per 100.000 inhabitants is indeed very small, equal to 172,5.

The country which remains the most sustainable one, using both methodologies, is Austria, which has very good scores with reference to the three factors extracted (Tab. 7). While, Ireland and Portugal confirm themselves to be on the 14th and 15th positions.

It should be pointed out that even after applying factor analysis, the problem of Luxembourg has not been solved. In fact, it is still on a low position although it gains one score. The position of Luxembourg is most probably due to the unavailability of data concentrated in the health area. At the same time it can be observed that factor analysis results show a more interpretable and better situation for some countries (see, for example, the cases of U.K. and Italy) than the ones obtained using standardised deviation methodology, but also a worst situation for some other countries (Finland and Denmark).

6. A comparison between Sen's trend of sustainable development and GDP trend index number

After explaining the results obtained through the application of the above methodologies, we think it may be useful, in order to better evaluate the phenomenon under investigation, to build Sen's trend of sustainable development and compare it with the GDP trend index number. Both trends have been referred to Italy³⁷ in a period of 14 years from 1985 to 1998. In Sen's trend of sustainable development (fig. 2), the variables taken into consideration are of course the same as those used when building our index, except for income distribution whose indicator chosen in this case is Gini index only for the receivers of income³⁸. The considered variables and the calculation in order to make positive the negative variables of income inequality and of the rates of NO₂ and SO₂ are shown in Tab. 10 (for the same reasons which we have explained in note 12)³⁹. In the same Tab. we have calculated the mean (X_0) and the standard deviation (σ). From this Tab. standardised values and the

³⁷ We have carried out the trend analysis only for Italy mainly due to data availability (in fact with reference to Italian country we have found a data set more or less homogeneous in comparison with other countries where it was impossible to find all the data which could correspond to the socio-economic and environmental variables taken into consideration). Furthermore, since the aim of building Sen's trend is to verify how Sen's theory of well-being can be useful to sustainable development and to compare it with GDP trend index number, it is necessary to refer only to one country, i.e. Italy which has indeed been chosen, among the E.U. countries, for the reasons explained above.

³⁸ As for the measurement of the inequality in individual incomes, we have referred to the Gini Index calculated in a research on an inequality in income distribution in Italy (D'Alessio and Signorini, 2000).

³⁹ In order to make income inequality positive, its values have been changed in those of income equality. This has been carried out, supposing that 1 represents income equality. Therefore, 1 becomes the unity of reference by which each value of income inequality is divided. While, reduced NO₂ and SO₂ are the positive values obtained subtracting the max values present every year

synthetic index 10_s have been obtained. The values of this last index have permitted the building of Sen's trend of sustainability possible. This can be compared with the GDP trend index number, calculated by keeping the 1995 prices constant and making the year 1985 equal to 100.

An examination deriving from comparing fig. 2 and fig. 3 reveals empirically the limitations in the evaluation of well-being founded on the only indicator of GDP. We observe a rising trend for both graphs. However, we can note that the oscillations of the trend of sustainable development are much more marked than those of GDP trend index number. The coincidence in the temporal periodization of these oscillations is meaningful. At least four temporal periods can be identified: a decreasing phase in the years 1986-1988, an increasing phase in the years 1988-1993, again a decreasing phase in the years 1994-1996 and an increasing phase in the years 1996-1998. This temporal coincidence makes even more significant the oscillations of the trend of sustainable development in comparison with the GDP trend index number. We think that these more marked oscillations are the empirical demonstration of the criticisms of GDP as the sole measure of economic growth. In short, this comparative exercise has emphasised the differences between both trends. Taking into consideration a conspicuous number of variables is indeed a necessary operation in order to measure a multidimensional phenomenon, such as well-being and/or quality of life.

7. Conclusions

The hypothesis put forward in this paper is that sustainability, well-being, and/or quality of life, are complex phenomena which require a multidimensional approach. For this reason we believe that Sen's approach constitutes one of the well-being theories most adequate to address sustainable development at the theoretical and operational level. With reference to the former, the categories of *freedom*, *functionings* and *capabilities* have allowed to identify the relationships between the components of natural capital and quality of life. In this sense, the analytical categories of *functionings* and *capabilities* have an instrumental role. In fact, the human development idea, on the basis of Sen's capability approach, seems to be

in the pollution emissions NO₂ and SO₂ rates Kg per person (Eurostat, 2002) to the observed variables (Tab.10).

the precondition for achieving sustainable human development at the environmental level as well. As regards the latter, these analytical categories have been used to evaluate social well-being according to a methodological approach which associates the concept of well-being with different economic, environmental and social conditions. On the grounds of this wider view, the environmental problem has been conceived in a new light, which includes quality of life, the intra and inter-generational equity, and the ethical aspects of human well-being. It follows that the environmental well-being is part of a wider system (the multidimensional one), which enables each individual to use their capabilities in the economic, social and environmental spheres. Moreover, not only has the environmental component to be considered, but it also has the same weight as the economic/social variables. Only in this way it will have the same importance as the other variables. We can deduce that the sustainable human development may become operational and be implemented in our societies if and only if it is inserted into a multidimensional paradigm of development. This has been the main point that has helped us to understand how Sen's theory of well-being can be useful to sustainable development.

This issue has been addressed through the building of a multidimensional index of sustainability. The problem of aggregating a set of variables expressed in different account units has been solved through the standardised deviation methodology. From the application of this method it follows that the number of European countries above the mean (more sustainable) is higher than those below it (less sustainable). This result is encouraging from the sustainability point of view, although, at the level of each country considered, some results have shown that still more needs to be done until each country, at the local level, may be able to implement more sustainable policies and thus be more careful to environment, notwithstanding the well-known economic implications. Examples are provided by Denmark and Finland, which have reached a relatively high level of economic/social development, but surprisingly not a high score at the environmental level⁴⁰. The result obtained for Austria and

⁴⁰ Anyway, it should be stated that the situations of Denmark and Finland, which have some negative values only with reference to the environmental variables considered, give us only an idea of the environmental well-being of a given country. In fact, we do not know what the situation would have been if we had taken into account other environmental variables. Consequently, a certain kind of analysis and explanation of facts, which might appear a bit too risky, is justified only on the grounds of the variables

Sweden which have been able to follow a sustainable path also at the environmental level demonstrates that the environmental well-being is a consequence of a high level of human development.

In our work, factor analysis has been also utilized in order to reduce the influence which exists in the relation among the variables. Though not leading to the building of another index, this methodology has allowed us to obtain another ranking and then compare it with the first methodology. The last empirical effort of making operational Sen's theory of well-being is made up of Sen's trend of sustainability applied to Italy and subsequently compared to the GDP index number trend.

In conclusion, we can state that the multidimensional approach may be one of the ways of addressing and, maybe, achieving sustainable development at the theoretical and operational level, although a lot has yet to be done in each country so that environmental problems enter the civic conscience. Furthermore, capabilities, freedom and functionings, are heuristic concepts which allow an extension of perspectives because they establish the links between natural capital components and the quality of life. The building of sustainability index is a clear example of this relationship.

Sen's theory of well-being constitutes a fertile area for further theoretical and empirical analyses. This approach can also be used at local level, on condition that a unique system of weights of the different indicators of well-being is not applied, but many differentiated systems referred to homogeneous areas are adopted.

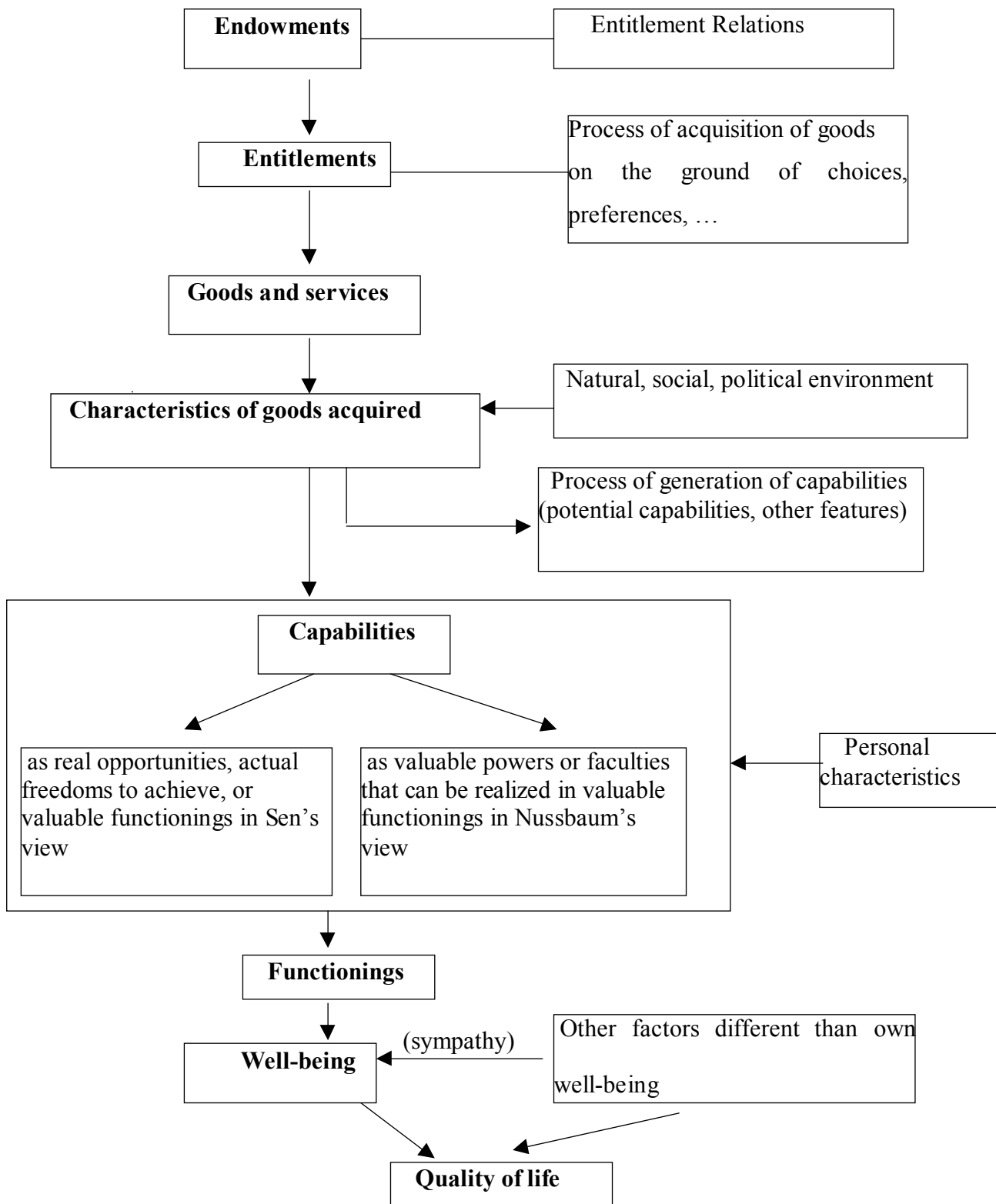
References

- Anderson, V., 1991. *Alternative Economic Indicators*. Routledge, London.
- Arrow, K., et al., 1995. Economic Growth, Carrying Capacity, and the Environment. *Science*. April, 268 (28), 520-521.
- Atkinson, G., Dubourg R., Hamilton K., Munasinghe M., Pearce D., Young C., 1997. *Measuring Sustainable Development*. Edward Elgar.
- Atkinson, A. B., Cantillon, B., Marlier, B., Nolan B., 2001. *Indicators for Social Inclusion in the European Union*, Report presented at Conference on Indicators for Social Inclusion: Making Common EU Objectives Work, Antwerp, 14-15 September.
- Balestrino A., Sciclone, N., 2001. Should we use Functionings instead of Income to measure Well-Being? Theory and some evidence from Italy. *Rivista Internazionale di Scienze Sociali*. (1), 3-22.
- Beckermann, W., 1995. *Small is Stupid*. Duckworth.
- Berlin, I., 1969. *Four Essays on Liberty*. Oxford University Press, Oxford.
- Brandolini, A., D' Alessio, G., 1998. *Measuring well-being in the functioning space*. Mimeo, Banca d'Italia, Rome.
- Casini, L., Bernetti, I., 1996. Public Project Evaluation, Environment and Sen's Theory. *Politeia*. 12, (43/44), 55-78.
- Chiappero Martinetti, E., 1996. Standard of Living Evaluation Based on Sen's Approach: Some Methodological Suggestions. *Politeia*. 12 (43/44), 37-53.
- Chiappero Martinetti, E., 2000. A Multidimensional Assessment of Well-Being based on Sen's Functionings Approach. Forthcoming in *Rivista Internazionale di Scienze Sociali*. (2), 1-34.
- Comim, F., 2001. Operationalising Sen's Capability Approach. Paper presented for the Conference Justice and Poverty: examining Sen's Capability Approach. Cambridge, pp. 1-16. Internet web site: <http://www.ct-edmunds.cam.ac.uk/vhi/sen/program1.shtml>.
- D'Alessio, G., Signorini, L. F., 2000. Disuguaglianza dei redditi individuali e ruolo della famiglia in Italia, Banca d'Italia. *Temi di discussione del Servizio Studi*. 390. Banca d'Italia, Rome, Italy.
- Daly, H. E., Cobb, J.B., 1984. *For the Common Good*. Beacom, Boston.
- Dasgupta, P., Weale, M., 1992. Measuring quality of life. *World Development*. 20 (1), 119-131.
- Dasgupta, P., 1999. *Valuation and Evaluation: Measuring the Quality of Life and Evaluation Policy*. London School of Economics and Political Sciences.
- Eurostat Yearbook, 2002. *The Statistical Guide to Europe*. Data 1990-2000.
- European Union Notes: Economic Data, 2001.
http://www.bized.ac.uk/stafsup/options/notes/eu_data.htm
- Gasper, D., 1997. Sen's Capability Approach and Nussbaum's Capabilities Ethic. *Journal of International Development*. 9 (2), 281-302.
- Grossman, G. M., 1995. Pollution and Growth: What do we know? In: Goldin, J and Winters, L.A. (editors), *The Economics of Sustainable Development*. Cambridge: Cambridge University Press. 19-46.
- Hamilton, K., 1999. *Measuring Well-Being: Responses to Some Criticisms of the Index of Sustainable Economic Welfare*. Seminar to the Department of Geography and Environment, London School of Economics and Political Science.

- Hanley, N., Shogren, J.F., White, B., 1997. Environmental Economics in Theory and Practice. T J Press, LTD.
- Hanley, N., 2000. Macroeconomics Measures of Sustainability. *Journal of Economic Surveys*. 14 (1), 1-30.
- Harris, J.M., 2000. Basic Principles of Sustainable Development. Global Development and Environment Institute, Tufts University. Working Paper 00-04.
- Istat, *Annuario Statistico Italiano*, (various years). Roma.
- Istat, *Statistiche Ambientali*, (various years). Roma.
- Kelley, A.C., 1991. The Human Development Index: Handle with Care. *Population and Development Review*. 17 (2).
- Lancaster, K., 1979. *Variety, Equity and Efficiency*. Blakwell, Oxford.
- Lelli, S., 2001. Factor Analysis VS. Fuzzy Theory: Assessing the Influence of Different Techniques on Sen's Functioning Approach. Center for Economic Studies, K.U. Leuven. <http://www.ct-edmunds.cam.ac.uk/vhi/sen/program1.shtml>.
- Mishan, E. J., 1993. *The Costs of Economic Growth*. Weidenfeld & Nicolson, London.
- Nath, V., 2001. White Collar Invasion: developed country policies leading to environmental degradation in South. <http://www.cddc.vt.edu/knownet/whitecollar-paper.doc>.
- Noorbakhsh, F., 1996a. Some Reflection on the UNDP's Human Development Index. CDS: Occasional Paper, n. 17. Centre for Development Studies, University of Glasgow.
- Noorbakhsh, F., 1996b. The Human Development Indices: Are they Redundant? CDS Occasional Paper n.20. Centre for Development Studies, University of Glasgow.
- OECD, 1999, *Environmental Data*.
- OECD, 2002. *Environmental Data*.
- Pearce, D.W., Markandya, A., Barbier, E.B., 1989. *Blueprint for a Green Economy*. Earthscan London.
- Peragine, V., 2001. *Defining Sustainability*. Department of Economics. University of Bari.
- Permann, R., Ma, Y., MC Gilvray, J., Common, M., 1999. *Natural Resource and Environmental Economics*. Longman.
- Qizilbash, M., 1996. Ethical development. *World Development*. 24, (7), 1209-1221.
- Rawls, J., 1971. *A theory of Justice*. Harvard University Press, Cambridge.
- Ray D., 1998. *Development Economics*. Princeton University Press, Princeton.
- Robeyns, I., 2000. An Unworkable Idea or a Promising Alternative? Sen's capability approach re-examined. Wolfson College, Cambridge, 1-32.
<http://www.ct-edmunds.cam.ac.uk/vhi/sen/program1.shtml>.
- Robeyns, I., 2002. Sen's Capability Approach and Gender Inequality. Conference Proceedings "Promoting Women's Capabilities: examining Nussbaum's Capabilities Approach 9-10 September 2002. Von Hugel Institute St Edmund's College, Cambridge. <http://www.ct-edmunds.cam.ac.uk/vhi/sen/program1.shtml>.
- Rothman, D.S., De Bruyn, S.M., 1998. Probing into the Environmental Kuznets Curve Hypothesis. *Ecological Economics*. (25), 143-145.
- Sagar, A. D., Najam, A., 1998. The Human Development Index: A Critical review. *Ecological Economics*. (25), 249-264.

- Saith, R., 2001. Capabilities: The Concept and its Operationalisation. QEH Working Paper. (66), Queen Elizabeth House, University of Oxford, 1-32.
- Sen, A. K., 1984. Resources, Values and Development. Basil Blackwell, Oxford.
- Sen, A. K., 1985. Commodities and Capabilities. Amsterdam: Elsevier and reprinted (1999). Oxford University Press, New Delhi.
- Sen, A. K., 1990. Welfare, Freedom and Social Choice: A reply, Recherches Economiques de Louvain. LVI, 451-486.
- Sen, A.K., 1999. Development as Freedom. Oxford University Press, Oxford.
- Sen, A.K., Anand S., 1994. Human Development Index: Methodology and Measurement. New York: Human Development Report Office. Occasional Paper, (12).
- Stockammer, E., et al., 1997. The Index of Sustainable Economic Welfare (ISEW) as an Alternative to GDP in Measuring Economic Welfare. The Results of the Austrian (revised) ISEW Calculation 1955-1992. Ecological Economics 21(1), 19-34.
- Tsui, K - Y., 2002. Multidimensional poverty indices. Social Choice and Welfare. 19 (1), 69-93. World Development Indicators database. April, 2002.

Fig. 1. Schematic representation of Sen's theoretical framework



Source: Gasper, 1997, p. 284 (modified).

Tab. 1 – Averaged data of the *basic* and *relevant* functionings in the period 1995-1998.

Countries	Household consumption adjusted for pps X_1^i	Life expectancy at birth (boys) X_2^i	Life expectancy at birth (girls) X_3^i	Health (total number of physicians per 100.000 inhabitants) X_4^i	Total employment rate X_5^i	Education X_6^i	Income inequality#	Income inequality (converted values) X_7^i	Pollution NO ₂ rate§ X_8^i	Reduced NO ₂ pollution rate X_8^i	Pollution SO ₂ rate§ X_9^i	Reduced SO ₂ pollution rate X_9^i	Percentage of protected areas X_{10}^i
Austria	61,8	74,1	80,4	359	68,1	10,1	3,7	0,27	21	114,2	6,5	89,3	28,7
Belgium	54,7	73,9	80,4	385,2	56,6	12,7	4,2	0,24	30,7	104,5	22,5	73,3	2,6
Denmark	62,2	73,3	78,3	289*	74,3	11,8	3	0,33	48,5	86,7	25	70,8	32,1
Greece	56,6	75,3	80,5	406,5	55,1	10,9	6,5	0,15	34,5	100,7	51,5	44,3	2,5
France	61,3	74,3	82,1	296	59,7	12,6	4,3	0,23	28,7	106,5	14,7	81,1	11
Finland	56,9	73,2	80,5	289,5	63,1	16,6	3,2°	0,31	50,7	84,5	19	76,8	7,5
Germany	64,3	73,8	80,1	343	64,1	9,4	4	0,25	23	112,2	19,2	76,6	26,8
Ireland	48,5	73,2	78,7	213,5	57,1	11,4	5,1	0,20	32,7	102,5	44,7	51,1	0,9
Italy	51,3	75,1	81,4	574,5	51,3	10,9	5,5	0,18	30	105,2	19,7	76,1	7,3
Luxembourg	50,7	73,5	80,1	240	59,6	8,3°°	3,9	0,26	47	88,2	16	79,8	14,1**
Netherlands	50,2	74,9	80,4	295*	67,2	11,2	3,9	0,26	30,7	104,5	8,5	87,3	9,8
Portugal	42,1	71,4	78,7	303,7	64,9	10,6	6,9	0,14	37,7	97,5	34,7	61,1	6,5
Spain	49,2	74,7	81,9	425,2	48,8	12,9	6,1	0,16	30,2	105,0	39,5	56,3	8,4
Sweden	60,0	76,6	81,6	278,7	70,3	11,4	3,2°	0,31	33,7	101,5	8	87,8	7,5
U. K.	61,1	74,4	79,5	172,5*	69,6	11,4	5	0,20	33,2	102,0	32,2	63,6	20,4
X_{10} E.U.°	55,4	74,1	80,3	324,8	62,0	11,5		0,23		101,0		71,7	
Standard deviation (σ)	6,5	1,2	1,2	97,8	7,4	1,9		0,06		8,6		13,7	

Our elaboration. Sources : Eurostat 2002; OECD, 1999, World Development Indicators database, 2002

* The values 289 and 295 are the only data available respectively for 1996 and 1998, while 172,5 is the biennial arithmetic mean obtained with the data for the years, 1995 and 1996.

° The value 3,2 (Finland) is the triennial arithmetic mean for the years 1996, 1997, 1998, while the value of Sweden is the biennial arithmetic mean for the years 1997, 1998.

°° Data for education refer to the number of students in tertiary education on the total population in age 15-34 except for Luxembourg, whose data, 8,3 is an aestimated value. This is obtained supposing a proportion to the number of pupils and students (excluding pre-primary) on the total population data for Belgium in age 5-34.

** The value is a biennial mean, while all data for 1998 are estimated through interpolation with 1997 and 1999, data available

§ Income inequality, SO₂ and NO₂ (the indicators of both pollutants taken into consideration refer to kg per person emissions) are negative indicators, whose redirection into positive indicators is essential.

Tab. 2. Matrix of the standardised elementary redirected indicators. Synthetic index 10_s^i

Countries	z_1^i	z_2^i	z_3^i	z_4^i	z_5^i	z_6^i	z_7^i	z_8^i	z_9^i	z_{10}^i	10_s	Ranking
Austria	0,989	-0,011*	0,081	0,350	0,831	-0,738	0,619	1,523	1,285	1,636	0,657	2
Belgium	-0,107	-0,179	0,081	0,618	-0,733	0,652	0,077	0,400	0,118	-0,985	-0,006	9
Denmark	1,050	-0,683	-1,739	-0,366	1,675	0,171	1,681	-1,661	-0,065	1,978	0,204	5
Greece	0,186	0,996	0,168	0,836	-0,937	-0,310	-1,342	-0,040	-1,998	-0,995	-0,344	12
France	0,911	0,157	1,554	-0,294	-0,311	0,599	-0,016	0,631	0,687	-0,141	0,378	3
Finland	0,233	-0,767	0,168	-0,361	0,151	2,738	1,330	-1,916	0,373	-0,493	0,146	7
Germany	1,374	-0,263	-0,179	0,187	0,287	-1,112	0,278	1,291	0,359	1,446	0,367	4
Ireland	-1,064	-0,767	-1,392	-1,138	-0,665	-0,043	-0,630	0,168	-1,502	-1,156	-0,819	14
Italy	-0,632	0,828	0,947	2,554	-1,454	-0,310	-0,871	0,481	0,322	-0,513	0,135	8
Luxembourg	-0,724	-0,515	-0,179	-0,867	-0,325	-1,700	0,386	-1,487	0,592	0,170	-0,465	13
Netherlands	-0,801	0,661	0,081	-0,304	0,709	-0,150	0,386	0,400	1,139	-0,262	0,186	6
Portugal	-2,051	-2,278	-1,392	-0,215	0,396	-0,471	-1,492	-0,411	-0,773	-0,593	-0,928	15
Spain	-0,956	0,493	1,381	1,027	-1,794	0,759	-1,172	0,458	-1,123	-0,402	-0,133	11
Sweden	0,711	2,088	1,121	-0,471	1,131	-0,043	1,330	0,052	1,176	-0,493	0,660	1
U. K.	0,881	0,241	-0,699	-1,557	1,036	-0,043	-0,564	0,110	-0,590	0,803	-0,038	10

*The value of -0,011 is obtained showing a two-digit approximation on Tab. 1. Also other data are approximated.

Tab. 3. Matrix of Pearson's correlation

Correlations		Consumption	M life exp.	F life exp.	Health	Empl.rate	Education.	Income equality	Reduced NO ₂ rate	Reduced SO ₂ rate	% pr.areas
Consumption	Correlation of Pearson	1	0,365	0,154	-0,130	0,467	0,053	0,575	0,173	0,361	0,640
M life exp.	Correlation of Pearson	0,365	1	0,680	0,287	-0,102	-0,025	0,120	0,345	0,224	-0,121
F life exp.	Correlation of di Pearson	0,154	0,680	1	0,480	-0,456	0,213	-0,042	0,369	0,328	-0,278
Health	Correlation of Pearson	-0,130	0,287	0,480	1	-0,602	0,014	-0,320	0,333	-0,025	-0,176
Empl.rate	Correlation of di Pearson	0,467	-0,102	-0,456	-0,602	1	-0,094	0,648	-0,196	0,447	0,625
Education.	Correlation di Pearson	0,053	-0,025	0,213	0,014	-0,094	1	0,213	-0,328	-0,068	-0,309
Income equality	Correlazione di Pearson	0,575	0,120	-0,042	-0,320	0,648	0,213	1	-0,345	0,690	0,481
Reduced NO ₂ rate	Correlation of Pearson	0,173	0,345	0,369	0,333	-0,196	-0,328	-0,345	1	0,118	0,064
Reduced SO ₂ rate	Correlation of Pearson	0,361	0,224	0,328	-0,025	0,447	-0,068	0,690	0,118	1	0,380
% pr.areas	Correlation of Pearson	0,640	-0,121	-0,278	-0,176	0,625	-0,309	0,481	0,064	0,380	1

** The correlation is representative at the level 0,01 (2-code).
 * The correlation is representative at the level 0,05 (2-code).

Tab. 4. Matrix of principal components (through the method of extraction)

Components	1	2	3
Consumption	0,659	0,496	
M life exp.		0,811	
F life exp.	-0,331	0,839	
Health	-0,553	0,495	
Total empl. rate	0,904		
Education			0,865
Income equality	0,840		0,390
Reduced NO ₂ rate		0,570	-0,599
Reduced SO ₂ rate	0,583	0,525	
% pr. Areas	0,768		-0,418

Explained total variance. Weights of non rotated factors			
Eigenvalue	3,363	2,524	1,534
% variance	33,634	25,242	15,339
% of cumulated	33,634	58,876	74,216
Variance			

Tab. 5. Matrix of rotated components

Components	1	2	3
Consumption	0,799		
M life exp.		0,777	
F life exp.		0,930	
Health	-0,314	0,660	
Total empl. rate	0,767	-0,503	
Education			-0,855
Income equality	0,870		-0,362
Reduced NO ₂ rate			0,678
Reduced SO ₂ rate	0,748	0,526	
% protected areas	0,718		0,422

Explained total variance. Weights of rotated factors			
Eigenvalue	3,226	2,640	1,556
% of variance	32,258	26,400	15,558
% of cumulated	32,258	58,658	74,216
Variance			

Tab. 6. Communality

Communality	Extraction
Consumption	0,682
M life exp.	0,671
F life exp.	0,887
Health	0,556
Empl. rate	0,842
Education	0,752
Income equality	0,898
Reduced NO ₂ rate	0,737
Reduced SO ₂ rate	0,624
% prot. areas	0,773

Tab 7. Calculation of factor scores and their rankings

COUNTRIES	FAC1_1	FAC2_1	FAC3_1	FAC1_1 Score 1	FAC2_1 Score 2	FAC3_1 Score 3
Austria	1,240	0,286	1,408	3	7	2
Belgium	-0,397	0,468	-0,479	10	6	13
Denmark	1,353	-1,575	-0,349	1	14	12
Greece	-1,172	0,538	0,273	12	5	6
France	0,430	0,949	-0,306	6	4	11
Finland	0,420	-0,268	-2,821	7	10	15
Germany	0,823	0,028	1,598	4	9	1
Ireland	-1,272	-1,065	-0,010	14	13	9
Italy	-0,803	1,529	0,423	11	1	4
Luxembourg	-0,003	-0,792	0,174	9	12	7
Netherlands	0,381	0,197	0,000	8	8	8
Portugal	-1,476	-1,689	0,400	15	15	5
Spain	-1,261	1,138	-0,236	13	2	10
Sweden	1,305	1,033	-0,363	2	3	14
United Kingdom	0,431	-0,777	0,489	5	11	3

Tab.8. Variations Field Standardised values

% Tot. Variance	32,26	26,40	15,56
COUNTRIES	FAC1_1 (distance1)	FAC2_1 (distance 2)	FAC3_1 (distance 3)
Austria	0,80	0,53	0,87
Belgium	0,33	0,60	0,13
Denmark	0,93	0,07	0,20
Greece	0,20	0,67	0,60
France	0,60	0,73	0,27
Finland	0,53	0,33	0,00
Germany	0,73	0,40	0,93
Ireland	0,07	0,13	0,40
Italy	0,27	0,93	0,73
Luxembourg	0,40	0,20	0,53
Netherlands	0,47	0,47	0,47
Portugal	0,00	0,00	0,67
Spain	0,13	0,87	0,33
Sweden	0,87	0,80	0,07
United Kingdom	0,67	0,27	0,80

Tab. 9. Weighted var.field stand.values and final rankings according to factor analysis and standardised deviation method

COUNTRIES	FAC1_1 weighted distance	FAC2_1 weighted distance	FAC3_1 Weighted Distance	WVFSF mean	WVFSF ranking	SD ranking
Austria	25,81	14,08	13,48	17,79	1	2
Belgium	10,75	15,84	2,07	9,56	11	9
Denmark	30,11	1,76	3,11	11,66	7	5
Greece	6,45	17,60	9,33	11,13	9	12
France	19,35	19,36	4,15	14,29	5	3
Finland	17,20	8,80	0,00	8,67	13	7
Germany	23,66	10,56	14,52	16,25	3	4
Ireland	2,15	3,52	6,22	3,96	14	14
Italy	8,60	24,64	11,41	14,88	4	8
Luxembourg	12,90	5,28	8,30	8,83	12	13
Netherlands	15,05	12,32	7,26	11,54	8	6
Portugal	0,00	0,00	10,37	3,46	15	15
Spain	4,30	22,88	5,19	10,79	10	11
Sweden	27,96	21,12	1,04	16,70	2	1
United Kingdom	21,51	7,04	12,45	13,66	6	10

Tab.10. Picture of the considered variables referred to Italy

Years	Consumption X ₁	Life expectancy at birth (boys) X ₂	Life expectancy at birth (girls) X ₃	Health (1) X ₄	Total Employment rate X ₅	Education X ₆	Income inequality* X ₇	Income inequality (converted values) X ₇	Pollution° NO ₂ rate X ₈	Reduced NO ₂ rate X ₈	Pollution° SO ₂ rate X ₉	Reduced SO ₂ rate X ₉	Percentage of protected areas X ₁₀
1985	61,3	72,1	78,6	548	53,7	4,4	0,355*	2,82	29	28	34	61	3,2
1986	61,0	72,4	78,9	591 #	58,0	4,5	0,347	2,88	31	27	34,5	54	3,7
1987	61,4	72,9	79,4	595 #	53,3	4,6	0,345	2,90	31	27	34,5	54	3,7
1988	61,2	73,2	79,7	625	53,7	4,8	0,328*	3,05	33	26	35	48	4,3
1989	61,8	73,5	80,0	645	53,2	4,8	0,312	3,21	33,5	27	32	43	5,9
1990	61,2	73,6	80,2	658 #	53,8	5,3	0,308*	3,25	34	27	29	38	5,9
1991	61,7	73,6	80,2	697	54,2	5,7	0,304	3,29	35	27	27	35	5,9
1992	62,7	73,8	80,4	684 #	55,0	6,2	0,326*	3,07	35	27	25	35	7,6
1993	61,7	74,1	80,5	706 #	52,2	6,5	0,349	2,87	33	30	23	31	9,5
1994	59,0	74,3	80,7	719	51,4	6,4	0,348*	2,87	31	26	22	29	9,5
1995	58,8	74,6	81,0	781 #	51,0	6,4	0,348	2,87	31	21	23	30	10,0
1996	57,7	75,0	81,3	755 #	51,4	9,8	0,344*	2,91	31	24	20	32	10,1
1997	59	75,4	81,7	737	51,6	9,9	0,344*	2,91	29	22	18	32	10,5
1998	60,0	75,5	81,8	769 #	52,2	10,0	0,341	2,93	29	20	18	33	10,5
X ₀	60,6	73,9	80,3	679,3	53,2	6,4		3,0		25,6		39,6	7,2
σ	1,4	1,0	0,9	69,1	1,8	2,0		0,1		2,7		10,5	2,7

Our elaboration on Istat data.

These data are all interpolated.

*Interpolated years.

°Eurostat, 2002.

(1) Data referred to health (numb. of physic. per 100.000 inhabit.) have been obtained summing up the physicians who work in the public and private care institutes those who exercise the profession.

Tab 11. Matrix of the standardised variables

z ₁	z ₂	z ₃	z ₄	z ₅	z ₆	z ₇	z ₈	z ₉	z ₁₀	10 _s
0,500	-1,800	-1,888	-1,900	0,278	-1,000	-1,800	0,888	2,038	-1,481	-0,617
0,286	-1,500	-1,555	-1,278	2,666	-0,950	-1,200	0,518	1,371	-1,296	-0,294
0,710	-1,000	-1,000	-1,220	0,055	-0,900	-1,00	0,518	1,371	-1,296	-0,376
0,428	-0,700	-0,666	-0,786	0,278	-0,800	0,500	0,148	0,800	-1,074	-0,187
0,857	-0,286	-0,333	-0,496	0,000	-0,800	2,100	0,518	0,324	-0,481	0,140
0,428	-0,300	-0,111	-0,308	0,333	-0,550	2,500	0,518	-0,152	-0,481	0,188
0,786	-0,300	-0,111	0,256	0,555	-0,350	2,900	0,518	-0,438	-0,481	0,333
1,500	-0,100	0,111	0,068	1,000	-0,100	0,700	0,518	-0,438	0,148	0,341
0,786	0,200	0,222	0,386	-0,555	0,050	-1,300	1,630	-0,819	0,852	0,145
-1,143	0,400	0,444	0,574	-1,000	0,000	-1,300	0,148	-1,009	0,852	-0,203
-1,286	0,700	0,777	1,472	-1,222	0,000	-1,300	-1,704	-0,914	1,037	-0,244
-2,071	1,100	1,111	1,095	-1,000	1,700	-0,900	-0,592	-0,724	1,074	0,079
-1,143	1,500	1,555	0,835	-0,888	1,750	-0,900	-1,333	-0,724	1,222	0,187
-0,428	1,600	1,666	1,298	-0,555	1,800	-0,700	-2,074	-0,628	1,222	0,320

Fig. 2. Sen's trend of sustainability

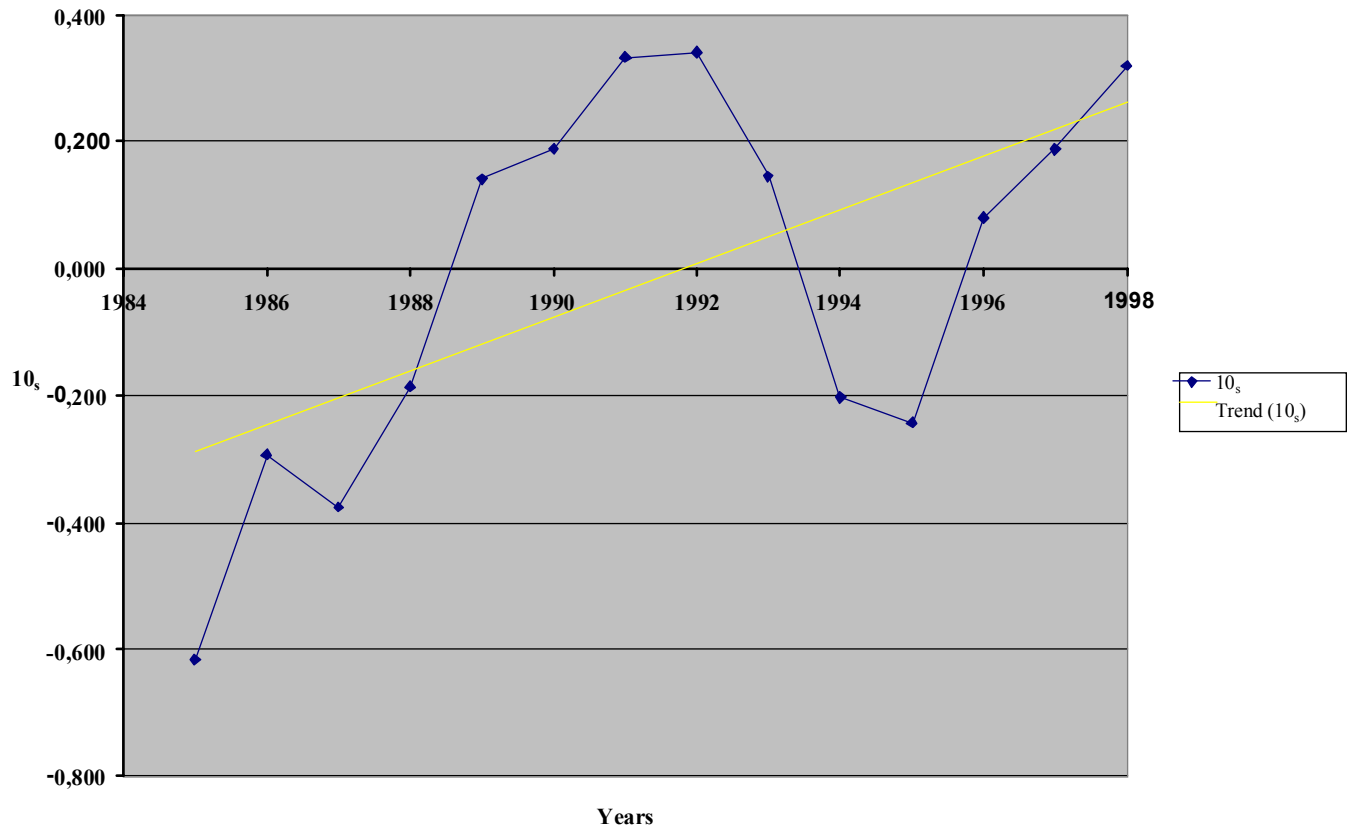


Fig. 3. Trend Index number

