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ON SYNTHETIC INDICES OF MULTIDIMENSIONAL WELL-BEING: HEALTH AND INCOME INEQUALITIES IN FRANCE, GERMANY, ITALY AND THE UNITED KINGDOM

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Abstract

The multidimensional view of well-being is receiving growing attention, both in academic research and policy-oriented analysis. This paper examines empirical strategies to measure poverty and inequality in multiple domains, concentrating on two problems in the use of synthetic multidimensional indices: the weighting structure of different functionings and the functional form of the index. These problems are illustrated by comparing inequality and deprivation in income and health in the four largest countries of the EU: France, Germany, Italy and the United Kingdom.

1. Introduction[1]

The multidimensional view of human well-being has a growing influence on research on inequality and poverty. This development owes much to the conceptualisation of the "capability approach" by Sen (1985, 1987), but the shift has not been confined to academic circles and has extended to policy-oriented analysis. The United Nations Development Programme has challenged since 1990 the primacy of GDP per capita as the measure of progress by proposing the Human Development Index (HDI), which combines income with life expectancy and educational achievement (e.g. UNDP, 2005). The *World Development Report 2000/2001: Attacking Poverty* opened with the statement that: "This report accepts the now traditional view of poverty … as encompassing not only material deprivation

[1] Revised version of a paper presented at the conference "Ethics, Economics and Law: Against Injustice", Ritsumeikan University, Kyoto, 28-30 October 2005. I thank participants in the conference and, in particular, Sabine Alkire and Prasanta Pattanaik for very useful comments. In this paper I draw extensively on earlier joint work with Giovanni D'Alessio. The views expressed here are solely those of the author and do not necessarily reflect those of the Bank of Italy.

(measured by an appropriate concept of income or consumption), but also low achievements in education and health. … This report also broadens the notion of poverty to include vulnerability and exposure to risk – and voicelessness and powerlessness" (World Bank, 2001, p. 15). The European Commission has long favoured the concept of social exclusion since "… more clearly than the concept of poverty, understood far too often as referring exclusively to income, it also states out the multidimensional nature of the mechanisms whereby individuals and groups are excluded from taking part in the social exchanges" (1992, p. 8).[2] The multifaceted nature of social development is implicit in the set of indicators agreed by the European Union (EU) at Laeken in December 2001 to monitor the performance of member countries: the indicators cover regional cohesion, joblessness, school dropouts, literacy, life expectancy and health status besides income poverty and inequality (see Atkinson et al., 2002; Atkinson, 2002).

These are only few significant examples of the shift to a multidimensional view of human well-being in recent years. The intuitive appeal of this view can explain its popularity, but offers little guidance on its practical implementation, whether for statistical analysis or policy design. The central problem is how to translate intuition into measurement. The lack of a certain durable good or housing amenity need not be a sign of material deprivation, for it may depend on personal preferences or social habits – hence the attempt of separating "lack because one does not want" from "lack because one cannot afford" (see, for instance, Guio, 2005). "Meeting friends or relatives less than once a month or never" – an indicator used by Eurostat (2000) following on a tradition going back to Townsend (1979) – may denote weak social ties, but also the preference for quietness of somebody living a hectic working life or the passion for web-exchanges of a blogger. These two examples only illustrate the difficulties in defining non-monetary indicators, but many are the conceptual and empirical questions that arise in a multidimensional context: the identification of the relevant dimensions of well-being, the construction of the corresponding indicators and the understanding of their own metric, the methods to handle the different dimensions, the weighting of the selected indicators.

[2] Accordingly, Eurostat defined social exclusion as "… the link between low income, activity status and a number of indicators which relate to means, perceptions and satisfaction of the groups under study with respect to their standard of living and quality of life" (Mejer, 2000, p. 1).

In this paper, I concentrate on a specific issue in multidimensional measurement: the requirements and the implications of using synthetic multivariate indices of inequality and poverty. The complexity of the problems suggests that empirical measurement in multiple domains needs to be grounded in a theory of multidimensional well-being. Here, I take the perspective of the capability approach, which has the distinctive merit, as noted by Robeyns, to stress "…to a far greater extent [than other approaches] the need to integrate theory and practice, and to pay due attention to the philosophical foundations" (2006, p. 371).[3] After outlining alternative approaches to study multidimensionality (Section 2), I review the arguments for and against using synthetic measures of the distribution of well-being and explore their analytical structure (Section 3). I then investigate these issues empirically by taking a specific case study: the distribution of income and health among the adult population in the four largest EU countries (Section 4). Household incomes are distributed differently within each country: Germany shows the lowest inequality and poverty, France comes next, Italy and the United Kingdom are much higher up in the ranking (Brandolini and Smeeding, 2006). As we shall see, considering people's health conditions together with their incomes changes this picture and, in many cases, leads to reverse the conclusion about the German ranking. The main lesson, drawn in the last Section, is that broadening the informational basis to include non-monetary variables, such as the health status, may affect our knowledge of inequalities, though proper attention has to be paid to the underlying methodological choices.

2. Strategies to study multiple dimensions

The alternative strategies to deal with the multiple dimensions of well-being basically differ for the extent of manipulation of raw data: the heavier the structure we impose on data, the closer we arrive at a complete cardinal measure of well-being. A broad classification of possible strategies is given in Figure 1, where the main distinctions relate to whether the functionings are investigated singly or comprehensively, and whether multidimensionality is retained or collapsed into a synthetic well-being indicator at the personal level.

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[3] The operationalisation of the capability approach is examined by Brandolini and D'Alessio (1998), Alkire (2002) and Kuklys (2005), among others. Empirical applications are surveyed by Robeyns (2006).

Indicators of standard of living can simply be considered in conjunction with the information on the distribution of income, or other indicators of monetary resources. This is the *supplementation strategy* followed by Sen in his analyses of gender discrimination in the allocation of food within Indian families (1985, Appendix B) and of mortality figures as indicators of social inequality and racial disparity (1998). Another recent example is the study by Fahey, Whelan and Maître (2005) on the relationship between income inequalities and quality of life in the enlarged European Union. No attempt is made to reduce complexity, and the constituents of well-being are examined one by one. The attention is directed not only at their univariate features, but also at the pattern of cross-correlation: the latter may reveal whether income poverty compounds with other deprivations, or is instead associated with better achievements in other domains. The advantage of this strategy rests on its simplicity: it imposes little structure on the phenomena under examination and its measurement requirements are less demanding. The disadvantage, especially in the presence of a rich information set about people's standard of living, is the lack of synthesis and the difficulty of drawing a well-defined unitary picture.

The task of the alternative *comprehensive non-aggregative strategies* is to make comparisons on the basis of the entire vector of functionings. Analyses based on strict *vector dominance* impose little restrictions on the data, but their information may be limited, especially when the set of indicators is large. For instance, examining some basic average functionings (GNP per capita, death rate, life expectancy, number of inhabitants per medical doctor, illiteracy rate, consumption of calories) for about 130 countries, Gaertner (1993) reported that vector dominance held in at most a quarter of the comparisons between any two countries chosen from politically or economically homogenous groups, though it held in roughly 90 per cent of the comparisons between a country in the richest group and one in the poorest group.

Standard *multivariate statistical techniques* (e.g. Kendall, 1975; Sharma, 1996) may help in managing the multiple dimensions of the problem. For example, Schokkaert and Van Ootegem (1990) employed factor analysis to identify the functionings of a group of Belgian unemployed from their answers to a number of qualitative questions. They were very careful to stress that their application of factor analysis was "a mere data reduction technique", which did not guarantee that the list of functionings was complete, nor did it provide any indication about the relative valuation of the functionings; in particular, the estimated weights represented only the importance of each factor (functioning) in explaining the pattern of responses to the 46 survey questions, not their importance in the valuation function (see pp. 439–40). Factor analysis was similarly used by Nolan and Whelan (1996a, b) in their study of deprivation in Ireland.

An alternative route is to specify *dominance criteria* which extend the notion of Lorenz dominance to multivariate distributions, along the lines of the seminal papers by Kolm (1977) and Atkinson and Bourguignon (1982). Dominance conditions for multidimensional poverty comparisons are developed by Bourguignon and Chakravarty (2002) and Duclos, Sahn and Younger (2006). The applications discussed by Atkinson and Bourguignon (1987), Atkinson (1992) and Jenkins and Lambert (1993) relate to the comparison of income distributions when family needs differ. By adopting the standard practice of transforming income by means of an equivalence scale one is specifying *how much* a family type is more needy than another. By contrast, dominance criteria only requires to *rank* family types in terms of needs, and may easily allow for some disagreement about the ranking itself. The cost of this weaker informational requirement is that the ordering tends to be incomplete. In order to achieve complete ordering, one needs to specify a *multidimensional index* of inequality or poverty, which associates a real number to each multivariate distribution. Research in this area is rapidly growing.[4]

The last and most structured strategy in applying the capability approach is to pursue a fully *aggregative strategy* and to construct a summary composite indicator of well-being to which standard univariate techniques can be applied. This approach was advocated by Maasoumi (1986) who used information theory to specify functional forms for the well-being aggregator (see Bourguignon, 1999, for a critique and an alternative formulation). Single aggregate measure can be derived also using multivariate techniques, such as principal components (Maasoumi and Nickelsburg, 1988) and cluster analysis (Hirschberg et al., 1991), or methods developed in efficiency analysis (Lovell et al., 1994; Deutsch and Silber, 2005;

[4] See Bradburd and Ross (1988), Fluckiger and Silber (1994), Tsui (1995, 1999), List (1999), Gajdos and Weymark (2005) and the surveys by Maasoumi (1999), Lugo (2005) and Weymark (2006) for inequality; Tsui (2002), Atkinson (2003), Bourguignon and Chakravarty (2003) and the survey by Bibi (2005) for poverty.

Ramos and Silber, 2005). Alternatively, the summary indicator can be expressed in monetary units, rather than in some "well-being unit", by estimating "functioning-equivalent income", that is income adjusted for differences in functionings (Kuklys, 2005, Chapter 5; Lelli, 2005). In many contexts, the estimation of functioning equivalence scales might reveal a powerful and appealing alternative. The monetisation of differences in achieved functionings should not, however, conceal that well-being is a combination of valuable states of life, nor should it lead to conclude that an appropriate money transfer can compensate for every disadvantage.

As for a multidimensional index, the outcome of an aggregative strategy is a complete ordering. Conceptually, there is however an important difference. The aggregative strategy requires to specify a well-being indicator which summarises all functionings for each person: inequality or deprivation are then evaluated in a unidimensional space. The multidimensional index does not entail the aggregation of functionings at the individual level and therefore avoids specifying a functional form for the well-being indicator. In practice, such an indicator may be *implicitly* defined when the index is additively separable across persons, as for the inequality measures proposed by Tsui (1995, 1999); but it should be borne in mind that "the function U [that enters into the additive social evaluation function] is a utility function that the social evaluator uses to aggregate any individual's allocation of the q attributes into a summary statistic. The function U need not coincide with any individual's actual utility function" (Weymark, 2006, p. 314). The difference between the two approaches emerges in the analysis of deprivation: whereas a multidimensional poverty index implies a separate threshold for each functioning, a fully aggregative strategy sets a single threshold in the space of the well-being indicator.

3. Pros and cons of using synthetic measures of the distribution of well-being

As just seen, a crucial decision in studying a multidimensional concept of well-being is whether to collapse all information into one number, or to keep separate the different dimensions of well-being. Both options have their own merits (see also Micklewright, 2001). On the one hand, a loss of information and a sensitivity to arbitrary choices are inherent in the process of aggregation. As put by Sen, "the passion for aggregation makes good sense in many contexts, but it can be futile or pointless in others. ... When we hear of variety, we need not invariably reach for our aggregator" (1987, p. 33). On the same vein, Erikson (1993, p. 75) expressed a strong reservation against constructing a "simple ordered indicator of level of living", Schokkaert and Van Ootegem (1990) avoided aggregating the functionings identified with factor analysis, and Nolan and Whelan (1996a, b) used factor analysis solely to merge elementary components into three separate indicators of deprivation termed "basic-life style", "secondary life-style" and "housing". On the other hand, a single number is very effective in summarising complex problems in a simple and comprehensible way for the general public. This communicational advantage is important, as a single complete ranking is more likely to capture newspaper headlines – and people's imagination – than a comparison of multidimensional scorecards and a complex reasoning on the relations among multiple indicators. This "eye-catching property", as labelled by Streeten (1994), has been crucial for the HDI to successfully challenge per capita income as the sole measure of development.

The HDI is a good case in point to illustrate the problems with complete aggregation. The HDI measures the average achievement in human developments in a country by taking a simple arithmetic mean of three indicators: the logarithm of GDP per capita (*Y*), life expectancy at birth (*L*) and education. The indicator for education is itself a composite index combining adult literacy (*A*), with a two-third weight, and gross enrolment in primary, secondary and tertiary school (*G*), with a one-third weight. Income is taken in logarithms "… in order to reflect diminishing returns to transforming income into human capabilities" (Anand and Sen, 1994, p. 10). All four elementary indices are normalised by taking the proportional country's achievement over a prefixed scale. More formally, for country *i*, it is

$$\mathrm{HDI}_i = \frac{1}{3}\left(\frac{L_i - \underline{L}}{\overline{L} - \underline{L}}\right) + \frac{1}{3}\left[\frac{2}{3}\left(\frac{A_i - \underline{A}}{\overline{A} - \underline{A}}\right) + \frac{1}{3}\left(\frac{G_i - \underline{G}}{\overline{G} - \underline{G}}\right)\right] + \frac{1}{3}\left(\frac{\ln Y_i - \ln \underline{Y}}{\ln \overline{Y} - \ln \underline{Y}}\right), \qquad (1)$$

where the upper and lower bars indicate the maximum and minimum values, respectively. It is clear that HDI varies between 0 and 1. If we replace the prefixed minima and maxima and simplify, we obtain the following expression:

$$\mathrm{HDI}_i = 0.0056 L_i + 0.0022 A_i + 0.0011 G_i + 0.0556 \ln Y_i - 0.3951. \qquad (2)$$

The iso-HDI contours in the bivariate space spanned by GDP per capita (in current PPP U.S. dollars) and life expectancy at birth (in years) are plotted in Figure 2. These curves are drawn taking a value for the education index of 0.94 (the value of Japan), and all countries shown have values comprised between 0.93 and 0.96. Data are drawn from UNDP (2005, Table 1, pp. 219–22) and refer to 2002–03. Two comments are in order. First, a similar value of the HDI may correspond to different situations. Argentina and Hungary, for instance, achieve virtually the same level of human development (0.863 and 0.862, respectively), but Argentineans are expected to live 1.8 years longer than Hungarians, even if their average per capita income is 17 per cent lower. Had life expectancy been valued more than GDP per capita, say 3:1 rather than 1:1, then the Argentinean HDI would have surpassed the Hungarian one (0.867 vs. 0.856). This example shows the importance of weighting, but it also highlights the loss of valuable information in identifying the areas needing policy action. Second, an expression like (2) sets a very definite rate of substitution between the different constituents of well-being. For a given value of the education index, the HDI is unchanged if life expectancy *falls* by one year at the same time as the other human capabilities that can be achieved with income *rise* by about 0.1 units, that is as GDP per capita *rises* by almost a tenth ($\Delta \ln Y = -(0.0056/0.0556)\Delta L \cong -0.1\Delta L$). According to this substitution rate, the richer is a country, the higher the implicit value of extending human life: an additional year is equivalent, in HDI terms, to a reduction of per capita income by 2,658 U.S. dollars in Japan but only 166 U.S. dollars in Kyrgyzstan. This difference reflects the fact that income is a proxy for human capabilities that are not captured by education and life expectancy, and that at higher income levels more income is necessary to achieve these capabilities due to the assumption of diminishing returns. However, we might question the hypothesis that the marginal rate of substitution between life expectancy and income rises with income. The issue is not only which functional form but also whether a definite rate of substitution between the various constituents of well-being should be imposed.

It should be noted that constructing a synthetic indicator at the country level, like the HDI, is conceptually different from combining elementary indicators at the personal level, in spite of the similarities of the aggregation procedure. One thing is to integrate multiple indicators to gauge a person's well-being; quite another is to measure mean well-being in a country by taking the average of mean achievements in each dimension, regardless of how these achievements combine at the personal level. In their discussion of EU social indicators, Atkinson et al. (2002, pp. 72–3) suggest that aggregation is worth pursuing at the individual level, but should be avoided at the country level, on the grounds that "the whole thrust of the European social agenda is to emphasise the multidimensionality of social disadvantage. Politically, the process will not encourage Member States to learn from each other if attention is focused on a single rank order". The focus of this paper is on aggregation at the individual level. With this in mind, in the remaining of this Section I further examine the two issues just exposed with the HDI example, the role of the weighting structure and the functional form of the synthetic indicator.

Weighting structure

The simplest multivariate index of living standard can be written as

$$S_i = \sum_j w_j x_{ij} , \qquad (3)$$

where x_{ij} is non-negative and represents the level of the jth attribute (functioning), j=1,…,J, enjoyed by the ith person (family), i=1,…,n, and w_j is the corresponding weight, equal across persons. Expression (3) would become an index of deprivation if x_{ij} measured hardship. Weights are normalised to sum to unity.

Weights determine the extent to which distinct functionings contribute to well-being, and diverse weighting structures reflect different views. As suggested by Sen (1987, p. 30; see also Foster and Sen, 1997, p. 205), one way to account for this difference is to specify "ranges" of weights rather than a single set of weights, although this approach is likely to lead to a partial ordering. The practical relevance of the issue depends on the tension among different functionings: if their achievements were strongly correlated, the structure of relative weights would be less important.

The first possibility is to treat all attributes equally. *Equal weighting* may result either from an "agnostic" attitude and a wish to reduce interference to a minimum, or from the lack of information about some kind of "consensus" view. For instance, Mayer and Jencks (1989, p. 96) opted for equal weighting, after remarking that: "ideally, we would have liked to weight [the] ten hardships according to their relative importance in the eyes of legislators and the general public, but we have no reliable basis for doing this". (In fact, there may be disagreement among the legislators and the general public, let alone the general public itself.) Equal weighting has the obvious drawbacks of not discriminating among constituents that are reputed to play different roles, and of double-counting whenever the informational content of two distinct attributes partly overlaps.

A second route is "to let the data speak for themselves". With a *frequency-based weighting*, the weights are computed as some function of the relative frequencies of the attributes. For instance, several authors seem to agree with Desai and Shah (1988) and Cerioli and Zani (1990) that the smaller is the proportion of people with a certain deprivation, the highest is the weight that deprivation should be assigned, on the grounds that a hardship shared by few is more important than one shared by many. However, this criterion may lead to a questionable and unbalanced structure of weights. As observed by Brandolini and D'Alessio (1998, p. 39), in 1995 the shares of Italians with low achievement in health and in education were estimated at 19.5 and 8.6 per cent, respectively. With these proportions, education insufficiency would be valued more than health insufficiency: a tenth more according to Desai and Shah's formula, over a half more according to Cerioli and Zani's one. Whether education should be given a weight so much higher than health is certainly a matter of disagreement. An alternative procedure is to use the output of *multivariate techniques*, such as factor analysis (Nolan and Whelan, 1996a, b), principal components (Maasoumi and Nickelsburg, 1988), or cluster analysis (Hirschberg et al., 1991), but we should be cautious in entrusting a mathematical algorithm with a fundamentally normative task. The same observation applies to methods developed in efficiency analysis (Lovell et al., 1994; Cherchye et al., 2004; Deutsch and Silber, 2005; Ramos and Silber, 2005).[5]

A third alternative is to use *market prices* as weights. When x_{ij} denotes the quantity purchased by the ith family of the jth commodity and the weight w_j equals the market price p_j of the same commodity, the index S_i coincides with the family's total expenditure. Sugden (1993) and Srinivasan (1994) argued that the availability of such "operational metric for

[5] Cherchye et al. (2004) use production frontier techniques to aggregate the EU social indicators into a synthetic indicator where weights are variable and such as to maximise the value of the indicator in each country: "the endogenously defined weights can be interpreted as implicitly revealed policy priorities" (p. 948). There are two objections to this weighting procedure. First, many factors beyond the control of policy-makers could lead to different outcomes from those aimed at, and the deduced national priorities could differ from those that motivated policy action. Second, the judgemental relativism implicit in country-specific weights is inherently in contradiction to a joint assessment process: weights might perhaps be chosen to vary within some range, but they should still be common to all nations.

weighting commodities" makes traditional real-income comparison in practice superior to the capability approach. However, market prices do not exist for functionings; even if they did, they would be inappropriate for well-being comparisons, a task for which they have not been devised, as stressed by Foster and Sen (1997).

Functional form of the synthetic indicator

A single measure of inequality or poverty in multiple domains can be obtained either by specifying a well-being function and then computing a standard univariate index, or by directly defining a multidimensional index. In the first approach, it is natural to relax the hypothesis of additive separability used in (3), because it rules out that attributes are other than perfect substitutes. As suggested by Maasoumi (1986), a straightforward generalisation of S_i is offered by the class of functions showing constant elasticity of substitution (CES)

$$S_{\beta i} = \begin{cases} \left[\sum_j w_j x_{ij}^{-\beta}\right]^{-1/\beta} & \beta \neq 0 \\ \prod_j x_{ij}^{w_j} & \beta = 0 \end{cases}, \tag{4}$$

where the weights sum to unity and β is a parameter governing the degree of substitution between the attributes: they are perfect complements as β goes to infinity and perfect substitutes for β=—1. The second approach is to derive multivariate indices of inequality and poverty that satisfy some desirable properties and can be applied directly to the vectors of attributes. I consider here two of these indices, one for inequality proposed by Tsui (1995) and one for deprivation derived by Bourguignon and Chakravarty (2003).

Tsui (1995) follows the approach pioneered by Kolm (1969) and Atkinson (1970) and identifies inequality with the social welfare loss (see Sen, 1978, 1992, for a critique of ethical inequality indices). After restricting the class of social evaluation functions to be continuous, strictly increasing, anonymous, strictly quasi-concave, separable and scale invariant, he derives the two following multidimensional (relative) inequality indices:

$$I_1 = 1 - \left[\frac{1}{n}\sum_i \prod_j \left(\frac{x_{ij}}{\mu_j}\right)^{r_j}\right]^{1/\Sigma_k r_k} \tag{5a}$$

$$I_2 = 1 - \prod_i \left[\prod_j \left(\frac{x_{ij}}{\mu_j} \right)^{r_j / \Sigma_k r_k} \right]^{1/n} \tag{5b}$$

where μ_j is the mean of attribute j over all persons and parameters r_j's must satisfy certain restrictions. The separability condition implies that the attributes can be aggregated for every person i into an indicator of well-being $S_i = \Pi_j x_{ij}^{w_j}$, where $w_j = r_j / \Sigma_k r_k$ can be seen as a normalised weight on attribute j. By replacing ε for $\Sigma_k r_k$, (5a) and (5b) can be rewritten as

$$I = \begin{cases} 1 - \left[\frac{1}{n} \sum_i \left(\frac{S_i}{S} \right)^{1-\varepsilon} \right]^{1/(1-\varepsilon)} & \varepsilon \neq 1 \\ 1 - \prod_i \left(\frac{S_i}{S} \right)^{1/n} & \varepsilon = 1 \end{cases} \tag{6}$$

where $S = \Pi_j \mu_j^{w_j}$ is the "representative" well-being of the society, that is the well-being of a person showing the mean achievement for each attribute. The restrictions on r_j transfer to w_j and ε; in the bivariate case, it is sufficient that $\varepsilon > 0$ and $0 < w_1 = 1 - w_2 < 1$.

This reformulation has three advantages. First, it shows the close link of the Tsui multivariate index with the Atkinson univariate index applied to the S_i's, from which it differs only for the replacement of *mean* well-being with *representative* well-being. This is indeed the appropriate normalisation since "… maximizing social welfare under the constraint of fixed total resources of attributes … requires to give to each individual the average available quantity of attributes …" (Bourguignon, 1999, p. 478). This observation exposes the conceptual diversity between using a multidimensional index and applying a univariate index to an indicator of multidimensional well-being. (Of course, the two indices coincide in the univariate case.) Second, expression (6) brings out the role of ε, i.e. $\Sigma_k r_k$ in the original formulation, as the parameter that governs the degree of concavity, and hence of inequality aversion, of the social evaluation function. In the univariate income space, the range of economically sensible values for ε can be restricted on the basis of considerations on the preference for redistribution. A similar analysis has not been conducted in the multivariate space of well-being, but "… there is not necessarily any reason to change our views about the value of [ε] simply because we have moved to a higher dimensionality" (Atkinson, 2003, p.

59). In the empirical analysis of the next Section, I take ε to vary between 0.3 and 3, the same interval identified by Atkinson and Brandolini (2004) in the analysis of income inequality. This range includes the values used by Lugo (2005) in her application to Argentinean data. Third, expression (6) shows that the Tsui index allows for different weightings of the attributes (through the w_j's), but makes no allowance for a variation in the degree of substitution between the attributes: the Cobb-Douglas functional form of the underlying well-being indicator implies that the elasticity of substitution between two attributes is uniformly equal to unity. In the bivariate case, a straightforward generalisation is represented by the index derived by Bourguignon (1999) by assuming a CES functional form for the indicator of well-being, which has the Tsui index as a special case (see Lugo, 2005).

Allowing for different patterns of substitution among well-being constituents is an explicit aim of Bourguignon and Chakravarty (2003). They characterise several families of multidimensional poverty indices, that differ in the way in which the Pigou-Dalton transfer principle is generalised to the multidimensional framework. I consider here the case where the transfer principle is supposed to hold for all attributes. A possible specification, in the bivariate case, is

$$P = \frac{1}{n}\sum_i \left\{ w_1 \left[\max\left(1 - \frac{x_{i1}}{z_1}, 0\right) \right]^{\theta} + w_2 \left[\max\left(1 - \frac{x_{i2}}{z_2}, 0\right) \right]^{\theta} \right\}^{\frac{\alpha}{\theta}}, \qquad (7)$$

where $\theta \geq 1$ and $\alpha > 0$, and z_j is the poverty threshold for attribute j.[6] This measure has isopoverty contours of the type shown in Figure 3, which are convex to the origin in the orthant where a person is poor relative to both attributes, i.e. $x_{ij} < z_j$ for $j=1,2$, and vertical or horizontal in the orthants where a person is poor relative to one attribute only. If θ tends to infinity, the substitutability between the two attributes tends to 0 and the isopoverty contours become right angles: the poverty level associated to a person who is poor in both dimensions is determined by the attribute which is farthest away from its poverty line. At the other extreme, if $\theta = \alpha = 1$ the two attributes are perfect substitutes and the convex part of the

[6] This family of indices may be generalised to any number of attributes, but only at the cost of assuming the same elasticity of substitution between each pair of them (Bourguignon and Chakravarty, 2003, p. 40).

isopoverty contours becomes a straight line. If an attribute is redistributed from a poor person to another less poor person so as to increase the correlation of the two attributes in the population, the index P is non-increasing for $0<\alpha<\theta$ and non-decreasing for $\alpha>\theta$. In other words, the higher α relative to θ, the more the two attributes are substitutes. Thus, the extent of deprivation as measured by (7) depends on the interaction of three types of parameters: the degree of concavity α, that was already present in the univariate case, and the weights w_j's and the shape of the contours governed by θ, that are new in the multidimensional case (see the insightful discussion by Atkinson, 2003). In their empirical example on Brazilian data, Bourguignon and Chakravarty (2003) consider five values for α (0, 1, 2, 3, 5) and three values for θ (1, 2, 5); in an application to data for Egypt and Tunisia, Bibi (2005) takes two values for α (3, 15) and three values for θ (2, 4, ∞).

As underlined by Atkinson (2003, p. 60), the empirical literature on multidimensional deprivation has largely concentrated on counting deprivations rather than taking a weighted mean of shortfalls from the poverty line as in the Bourguignon and Chakravarty index. The emphasis may be different, however, as regards the weight given to multiple deprivations. For bivariate distributions, Atkinson (2003) proposes the following deprivation indicator

$$D = 2^{-\kappa}(H_1 + H_2) + (1 - 2^{1-\kappa})H_{1,2}, \qquad (8)$$

where H_j, with j=1,2, is the proportion of persons deprived on the jth dimension, $H_{1,2}$ is the proportion of those deprived on both dimensions and κ varies from 0 to infinity. (Expression (8) differs from Atkinson's original formula for dividing through by 2^{κ}.) When κ equals 0, the indicator counts all people with at least one deprivation ($D=H_1+H_2-H_{1,2}$), regardless of the number of failures. As κ rises, the weight on multiple deprivations increases: for $\kappa=1$ those with two deprivations are counted twice and D gives the simple mean of the headcount rates in the two dimensions; as κ goes to infinity, D tends to coincide with the proportion of people deprived on both dimensions $H_{1,2}$.

4. Income and health inequalities in France, Germany, Italy and the United Kingdom

Do the methodological problems discussed in the previous Section really matter? How sensitive are the results of multidimensional analyses of well-being to different assumptions?

In order to answer these questions, I assume that a person's well-being can be represented by two functionings: health status and command over resources.[7] I then examine its distribution among the adult population of the four largest EU countries.

Data sources and definitions

Data are drawn from the European Community Household Panel (ECHP), a multidimensional longitudinal household survey sponsored by Eurostat in the 1990s and discontinued in 2001. The ECHP aimed at collecting information on personal income and living standards in the EU by means of standardised national annual surveys elaborated under the co-ordination by Eurostat. I ignore the longitudinal nature of the database and focus on the last wave conducted in 2001. The sample includes all persons aged 16 or more, since no information on health status is collected for younger persons. Each observation is weighted by the cross-sectional weight (variable PG002).

The first functioning is the person's perception of her health condition. Indicators of self-perceived health are widely used but are not without problems because "... it is often hard to know exactly what they mean" (Wilkinson, 1996, p. 55). For instance, it is unclear whether respondents have in mind an absolute notion, or rather one adjusted for age or other factors. On the other hand, according to Currie and Mandrian, "several studies suggest that self-reported measures are good indicators of health in the sense that they are highly correlated with medically determined health status" (1999, p. 3315). As being in good health is a fundamental constituent of human well-being, I choose to use this indicator, despite its ambiguities. Health status is measured on a scale from 1 (very good) to 5 (very bad) and is based on the respondent's self-perception at the time of the interview (variable PH001). The variable is recoded so that 1 corresponds to the worst status and 5 to the best one. All persons who declared their health conditions to be bad or very bad (i.e. recoded values 1 or 2) are classified as health-poor.

The second functioning is represented by command over resources, as measured by income. Having an income is not itself a functioning, but many functionings, like being well-

[7] This choice is open to Volkert's criticism that "income-related aspects still play a disproportionately important role" in multidimensional analysis (2006, p. 379).

nourished or having a decent home, depend crucially on it. This is a sufficient reason for including income. As observed by Anand and Sen, "in an indirect way – both as a proxy and as a causal antecedent – the income of a person can tell us a good deal about her ability to do things that she has reason to value. As a crucial means to a number of important ends, income has, thus, much significance even in the accounting of human development" (2000, p. 100). Consistently with this interpretation and the assumption made in the construction of the HDI, it may be reasonable to take some concave transformation of the income variable, as there is likely to be diminishing returns in the conversion of income into human capabilities. To assess the impact of this hypothesis, I consider two alternative formulations, one using income and the other using its logarithmic transformation. Total household income is obtained by adding all monetary incomes received by household members, net of income taxes and social security contributions, in the year preceding the interview (variable HI100). This total is adjusted for household composition (including children) with the modified OECD equivalence scale, and then attributed to each adult household member. The different economic conditions, welfare states and social structures of the four countries suggest that a relative standard is better suited than an absolute one to capture the minimum necessary level of economic resources. A person is hence defined as income-poor if his/her household's equivalent income is below the median of the distribution of equivalent incomes among adult persons in each country; for consistency, the logarithm of this value is taken to be the threshold when the logarithmic transformation is used. This definition follows the methodology used by Eurostat except for considering only the adult population.

Inequality

As regards the degree of inequality of the household income distribution, the ranking of the four largest EU countries is well-known: Germany shows the least unequal distribution, followed by France, while Italy and the United Kingdom exhibit far higher levels of inequality (Brandolini and Smeeding, 2006). The same ranking obtains for the adult population: the Gini index goes from 26 per cent in Germany and 27 per cent in France to 29 and 31 per cent in Italy and the United Kingdom, respectively (Table 1). Taking the logarithmic transformation, income concentration appears to be much lower, as predictable, and Italy and the United Kingdom reverse their relative positions. The evidence is rather different for the health distribution: the highest Gini index is found in Germany (16 per cent) and the lowest in France (12 per cent), with Italy and the United Kingdom in intermediate position (over 13 per cent). This diverse picture of income and health inequalities gives rise to mixed results when the two dimensions are considered jointly.

The values of the Tsui multidimensional index of inequality are plotted in Figure 4. The six panels corresponds to the two definitions of income (logarithm of income on the left, income on the right) and to three values of the parameter ε representing inequality aversion (0.3, 1 and 3, from the top to the bottom). In each panel, the values on the horizontal axis represent the weight w given to income, moving rightwards from 0 to 1, or to health, moving leftwards from 1 to 0; in the two endpoints, all weight is given to one attribute and the value of the index coincides with that of the Atkinson (univariate) index. When the logarithm of income is taken, the consideration of people's health condition leads to a rather consistent picture: multidimensional inequality is higher in Germany than in the other three countries, unless very little weight is put on the health indicator. Differences between France, Italy and the United Kingdom are small, except for high levels of inequality aversion ($\varepsilon=3$): in such a case Italy is the country with the lowest inequality. The pattern is completely different when income, and not its logarithm, is considered, provided that sufficient weight is put on income ($w\geq0.2$): Germany exhibits now the least unequal distribution of well-being, while the United Kingdom and, immediately next, Italy show the most unequal distributions for $\varepsilon\leq1$, and France for $\varepsilon>1$.

The pattern of health and income inequalities in the four largest EU countries is complex. Contrary to the income-based evidence, Germany appears to be the most unequal country when well-being is represented by the health status and the logarithm of income; this result tends to reverse when command over resources is measured by income. Attention has to be paid to the assumptions made in the calculation, but the greatest differences relate to the use of income or its logarithmic transform and to the degree of inequality aversion: these alternative choices are not specific to multidimensional analysis and equally arise in the univariate context. The weighting of the two attributes, the only factor that reflects here the multiple dimensions, plays a relatively minor role, except when it is very unbalanced. As noted above, the degree of substitution, the other factor specific to multidimensionality, is assumed away, since the Tsui index has by construction a unitary elasticity of substitution.

Poverty

The pattern of deprivation is similar to that of inequality in both the health and the income domains (Table 1).[8] The income headcount poverty rate ranges from 11 per cent in Germany to 20 per cent in Italy; the health poverty rate varies between 8 per cent in France and 19 per cent in Germany. A first way to assess the extent of multivariate deprivation is to apply Atkinson's counting approach. The curves in Figure 5 trace the indicator D in the four countries for different values of κ. The proportion of people who are poor in at least one dimension (κ=0) ranges from 21 per cent in France to 28 per cent in Italy. This proportion gradually decreases as κ rises, and converges to the proportion of persons who are poor in both dimensions (κ=10): 2 per cent in France and around 3 per cent in the other three countries. The curve for France lies uniformly below that for the United Kingdom, which in turn lies uniformly below that for Germany: as these curves do not cross, the ranking of the three countries does not depend on the weight assigned to the occurrence of multiple deprivations. The curve for Italy starts higher than the others, then crosses that for Germany at κ=2 and that for the United Kingdom at κ=4.5. Thus, Italy fares badly when the focus is on the proportion of deprived people but is better positioned when the attention is shifted to those who are deprived on both functionings. This result may reflect the low correlation of the health and income indicators (Table 1).

The Bourguignon and Chakravarty index tends to replicate this pattern, but there are notable exceptions. Assume, for the moment, that the two functionings are equally weighted and that the poverty threshold for the health status is set at 3 (deprivation occurs when the variable is strictly lower than this threshold). Figure 6 reports the results of the estimation for the two definitions of income (logarithm of income on the left, income on the right), three values of the parameters α which represents poverty aversion (0.5, 1 and 5, from the top to the bottom), and six values of the parameter θ that governs the degree of substitution between the two functionings (1.1, 2, 5, 10, 100 and 500; along the horizontal axis in

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[8] The identification of the poor in the income space is unaffected by the logarithmic transformation, due to the assumption that the threshold for income taken in logarithms coincides with the logarithm of the threshold for income. However, the transformation makes a difference in the estimates of the Bourguignon and Chakravarty index, which is a function of the proportional shortfall of the variable from the respective poverty line.

logarithmic scale). As θ rises, the two functionings become less and less substitutable and the individual poverty indicator tends to reflect the worst performing dimension. When α is below or equal to 1, the income definition is relatively unimportant: multidimensional deprivation is higher in Germany, followed by Italy, and then the United Kingdom and France (Germany and Italy appear to differ only when income is taken in logarithms). For $\alpha=5$, i.e. for higher aversion to poverty, there is a clear deterioration of the relative position of France. Germany fares unequivocally better than Italy, regardless of the value of θ, using income, but the opposite is true taking the logarithm of income. Despite the differences, the conclusion based on the index *P* is qualitative similar to that based on the counting approach, provided that poverty aversion is not high: deprivation is highest in Germany and lowest in France. This ranking changes, however, when poverty aversion is high.

How is this conclusion affected by the weighting of the two functionings? This is shown in Figure 7, which is like Figure 6 except for replacing the weights for the substitution parameter θ (assumed equal to 2) on the horizontal axis. When all weight is assigned to one functioning, at either extreme of the horizontal axis, the index *P* becomes the univariate poverty index proposed by Foster, Greer and Thorbecke (1984). When command over resources is measured by the logarithm of income (panels on the left), the ranking is as described before, with Germany showing more health ($w=0$) and multidimensional ($0<w<1$) deprivation than the other three countries; the relative position of Germany only improves for income poverty ($w=1$). The picture is somewhat more intricate when income, and not its logarithm, is the variable under consideration (panels on the right). Consider Germany and Italy: when no weight is given to income ($w=0$), Germany looks worse than Italy; as the weight is shifted from health to income, the gap between the two countries narrows and disappears for w around 0.5; as w further rises towards 1, Italy becomes increasingly more deprived than Germany. In the case where poverty aversion is high ($\alpha=5$), there is a full reversal of the ranking of all four countries according to whether w is below or above 0.5. This example shows that weighting can matter and need to be given proper attention. The mere reliance on some mathematical or statistical algorithm, however cleverly justified, does not seem advisable.

A final point concerns the definition of the health poverty threshold. The criterion to identify the poor with those persons with (recoded) score equal to 1 or 2 is consistent with setting the threshold at any number between 2 and 3. This choice does not matter for the Atkinson indicator, but has a bearing on the Bourguignon and Chakravarty index: with the threshold equal to 3 used above, the possible values of the relative shortfalls are 1/3 and 2/3; with a threshold set at $2+\xi$, with ξ small, they are approximately 0 and 1/2 (more precisely, $\xi/(2+\xi)$ and $(1+\xi)/(2+\xi)$). It is obvious from the inspection of (7) that the contribution of health to deprivation would be rather different had we chosen this second value. For instance, setting the threshold at 2.01 and using income, the value of P for $\theta=\alpha=2$ would be 53 per cent lower for Germany (0.0110 instead of 0.0232) and 31 per cent lower for France (0.0134 instead of 0.0195): in general, this change would reverse the relative position of the two countries. Agreement on the identification of persons with a poor health status does not lead to an unambiguous definition of the poverty threshold and is consistent with rather different values of the index P. This is a rather serious shortcoming, since the problem arises for any discrete variable – unfortunately the large majority of non-monetary indicators. Note, however, that the problem relates to the characteristics of the indicator, not to the choice of a multidimensional evaluative space.

5. Conclusions

The multidimensional view of well-being is receiving growing attention, both in academic research and policy-oriented analysis. In this paper, I examined empirical strategies to measure poverty and inequality in multiple domains, concentrating on two questions in the use of synthetic multidimensional indices: the weighting structure of different functionings and the functional form of the index. These problems are illustrated by comparing inequality and deprivation in income and health in the four largest countries of the EU: France, Germany, Italy and the United Kingdom. Two conclusions can be drawn.

On the methodological side, the theoretical discussion suggests that measurement assumptions may considerably influence the results – especially so for synthetic indices that are more structured than other multivariate approaches. The empirical findings confirm this observation and point to the need of a thorough analysis of sensitivity. It is important to asses the impact of alternative weighting structures and of different hypotheses on the degree of substitutability between the functionings. Yet the difficulties of multivariate measures should not be overstated: the choice of the degree of poverty or inequality aversion, or the proper definition of an indicator such as command over resources also arise in univariate contexts. Synthetic indices can provide valuable insights, if used "… more as a dominance instrument than a strictly cardinal rule of comparison", as suggested by Bourguignon (1999, p. 483).

On the substantive side, the empirical results show that broadening the evaluative space to include people's perception of their own health condition modifies the picture drawn on the basis of income alone. Germany is the country with the lowest income poverty and inequality, but it appears to have the most unequal distribution of well-being, as proxied by income and health, for the majority of parameter configurations studied in this paper. The least unequal distribution of well-being is found in France, although this is no longer true when the degree of poverty and inequality aversion in the social evaluation function is high. There is a distinct informative value in adopting a multidimensional perspective.

Table 1

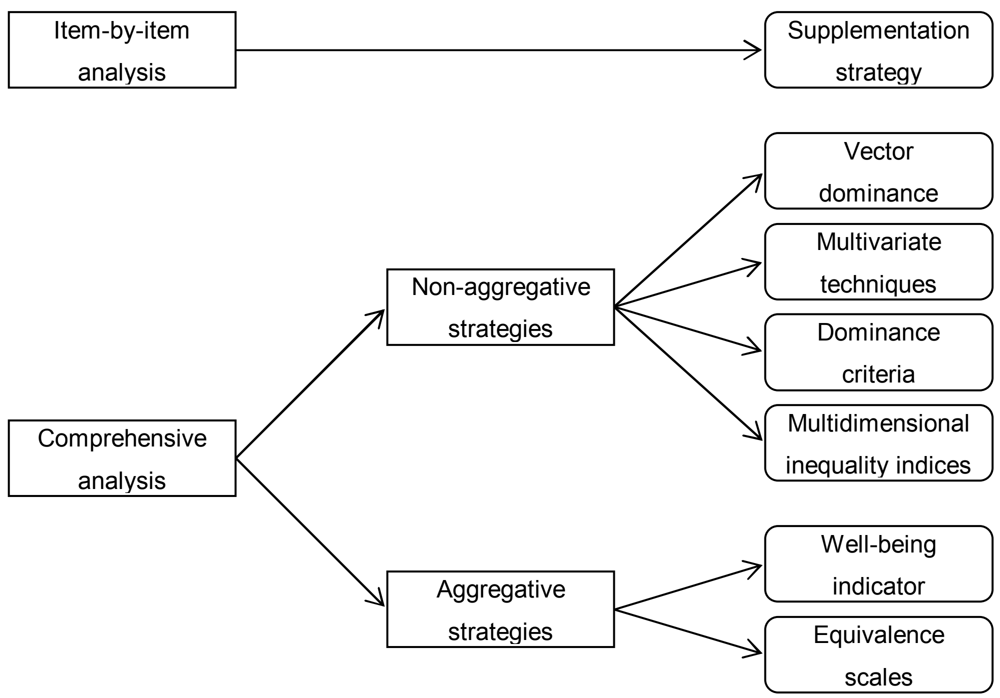
HEALTH AND INCOME DISTRIBUTION STATISTICS
(percentage values)

Country	Gini index			Headcount poverty rate				Correlation coefficient	
	Income	Log (income)	Health	Income	Health	Health and income	Health or income	Health and income	Health and log (income)
France	27.2	3.0	12.4	15.2	8.0	2.0	21.2	0.11	0.11
Germany	25.8	2.7	15.5	11.2	19.0	3.1	27.1	0.07	0.08
Italy	29.1	3.5	13.5	19.5	11.5	2.7	28.3	0.04	0.03
United Kingdom	30.6	3.3	13.1	17.4	9.5	2.9	24.0	0.13	0.16

Source: author's elaboration on ECHP data, Wave 8.

Figure 1

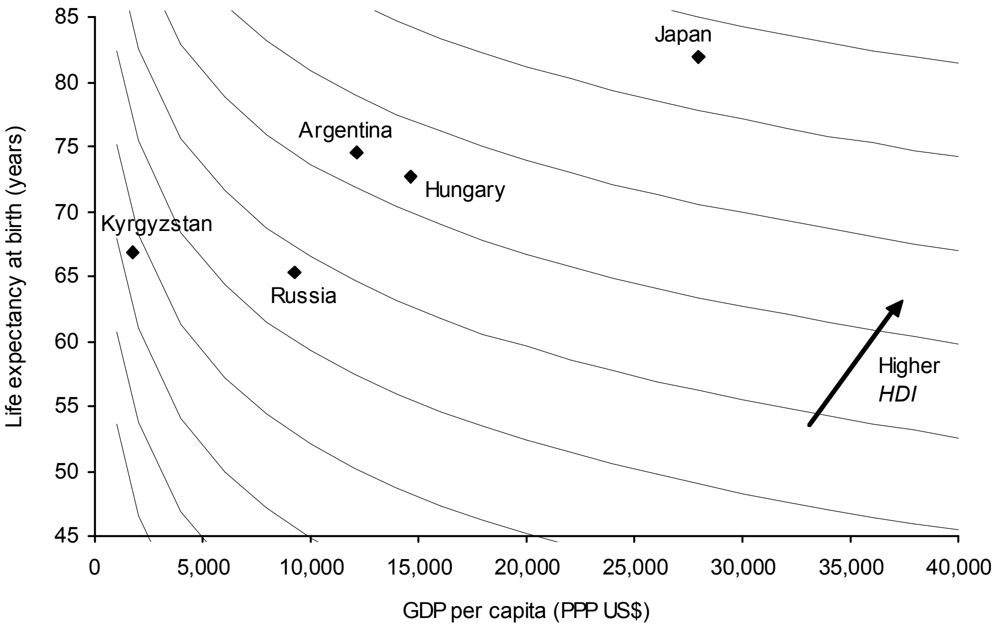
STRATEGIES FOR MULTIDIMENSIONAL ANALYSIS OF WELL-BEING



Source: Brandolini and D'Alessio (1998), Table 3.

Figure 2

ISO-HDI CONTOURS



Source: author's elaboration on data drawn from UNDP (2005), Table 1, pp. 219–22. All countries shown in the figure have similar values of the education index, comprised between 0.93 and 0.96.

Figure 3

ISOPOVERTY CONTOURS FOR THE BOURGUIGNON-CHAKRAVARTY MULTIDIMENSIONAL POVERTY INDEX

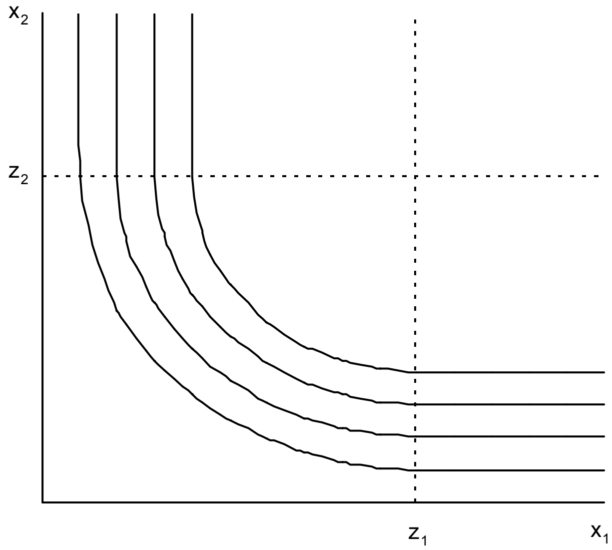
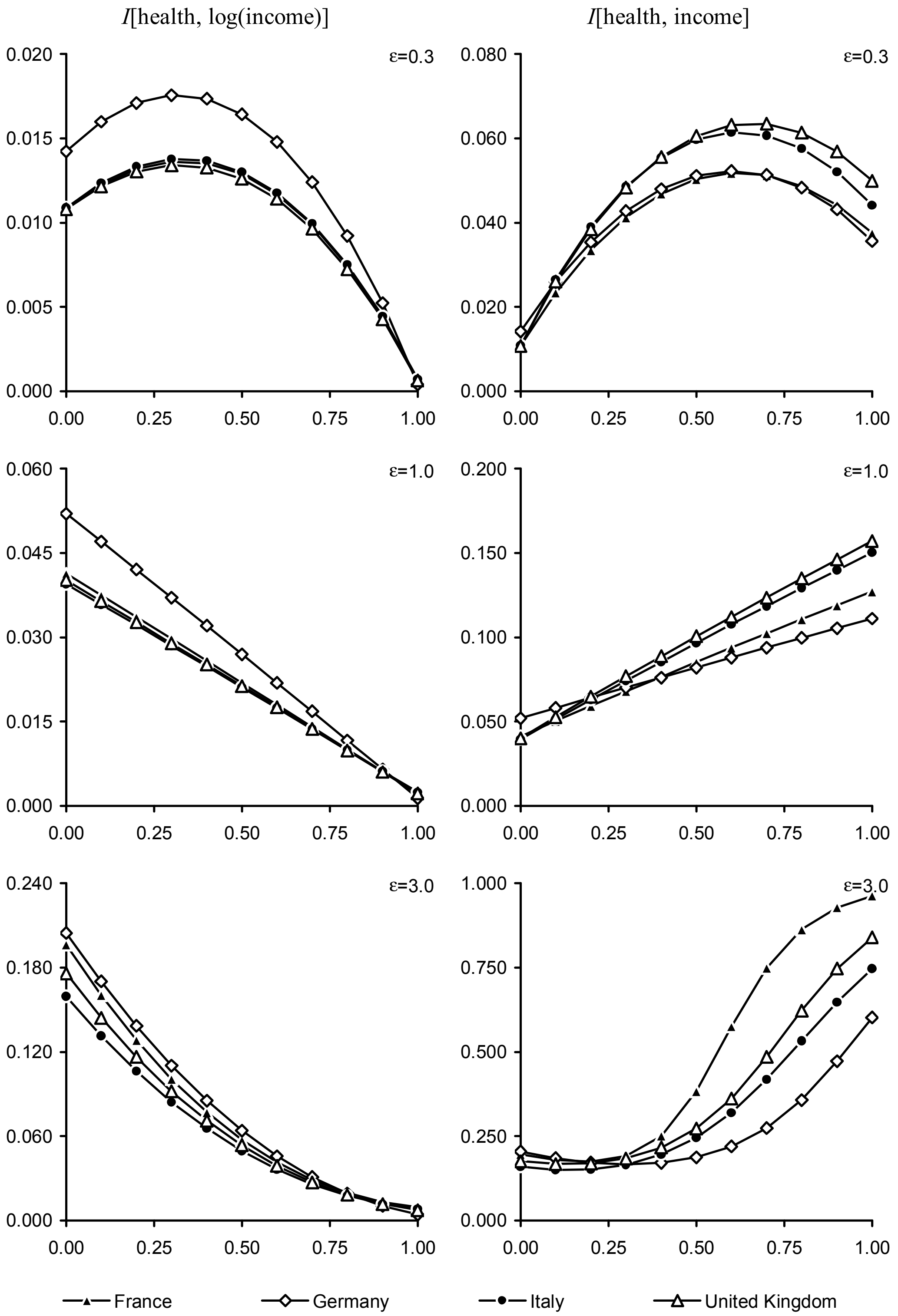


Figure 4

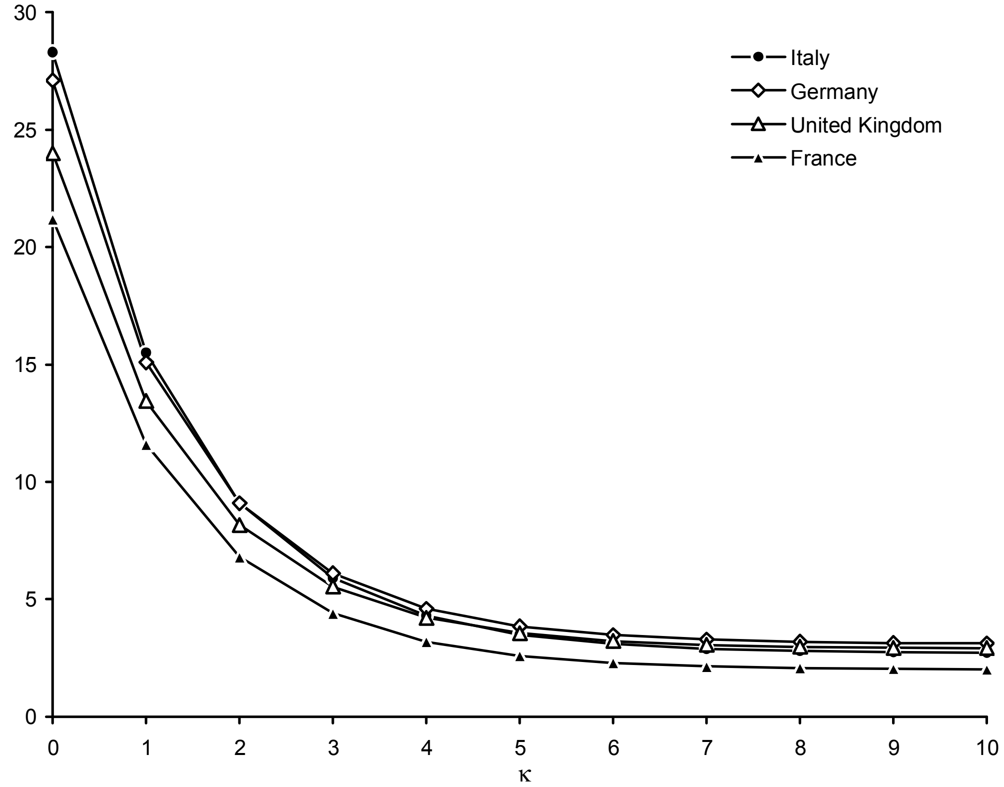
TSUI MULTIDIMENSIONAL INEQUALITY INDEX



Source: author's elaboration on ECHP data, Wave 8. Moving rightwards on horizontal axis amounts to gradually shifting the weight from health only (w=0) to log(income) or income only (w=1).

Figure 5

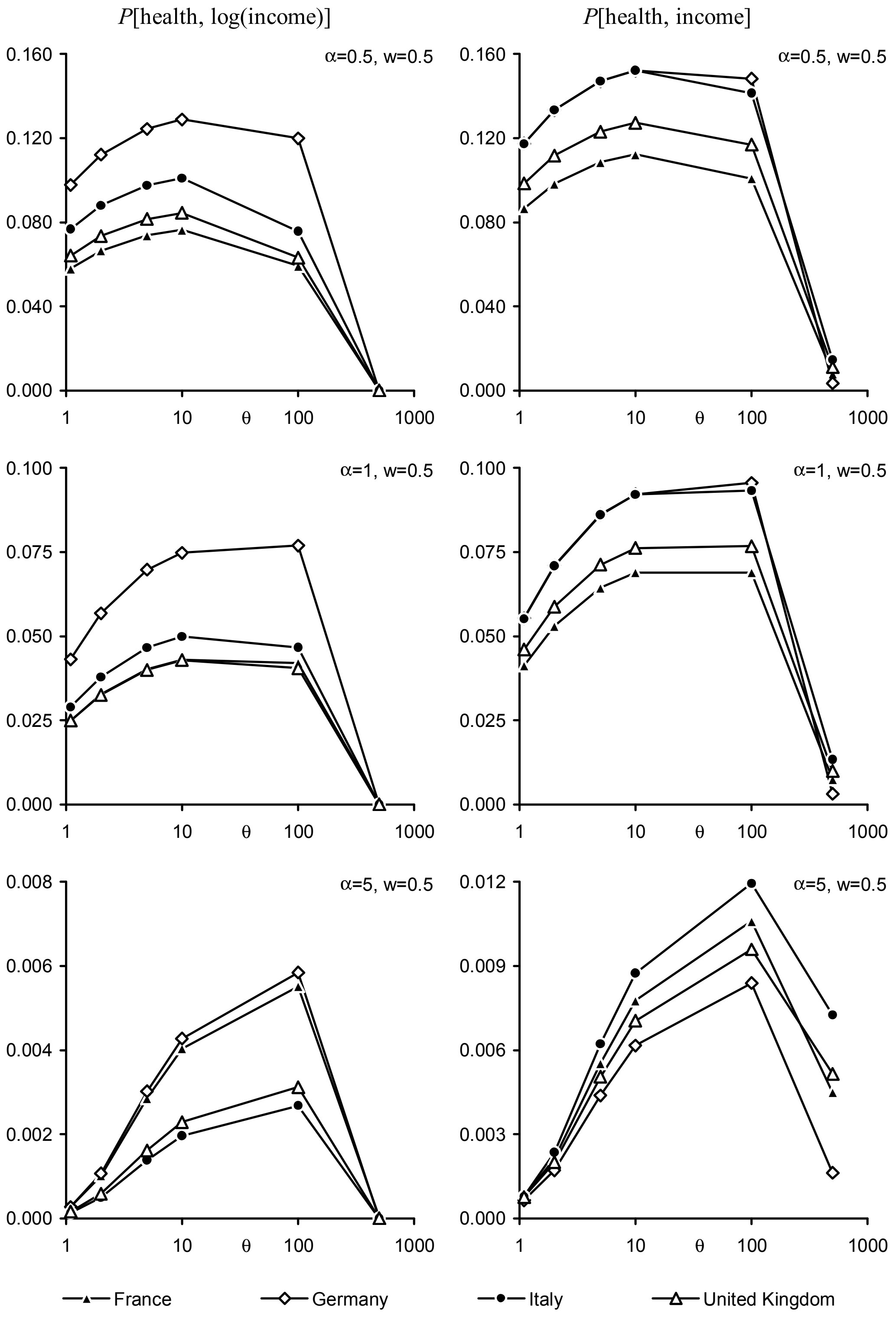
ATKINSON MULTIDIMENSIONAL DEPRIVATION INDICATOR



Source: author's elaboration on ECHP data, Wave 8.

Figure 6

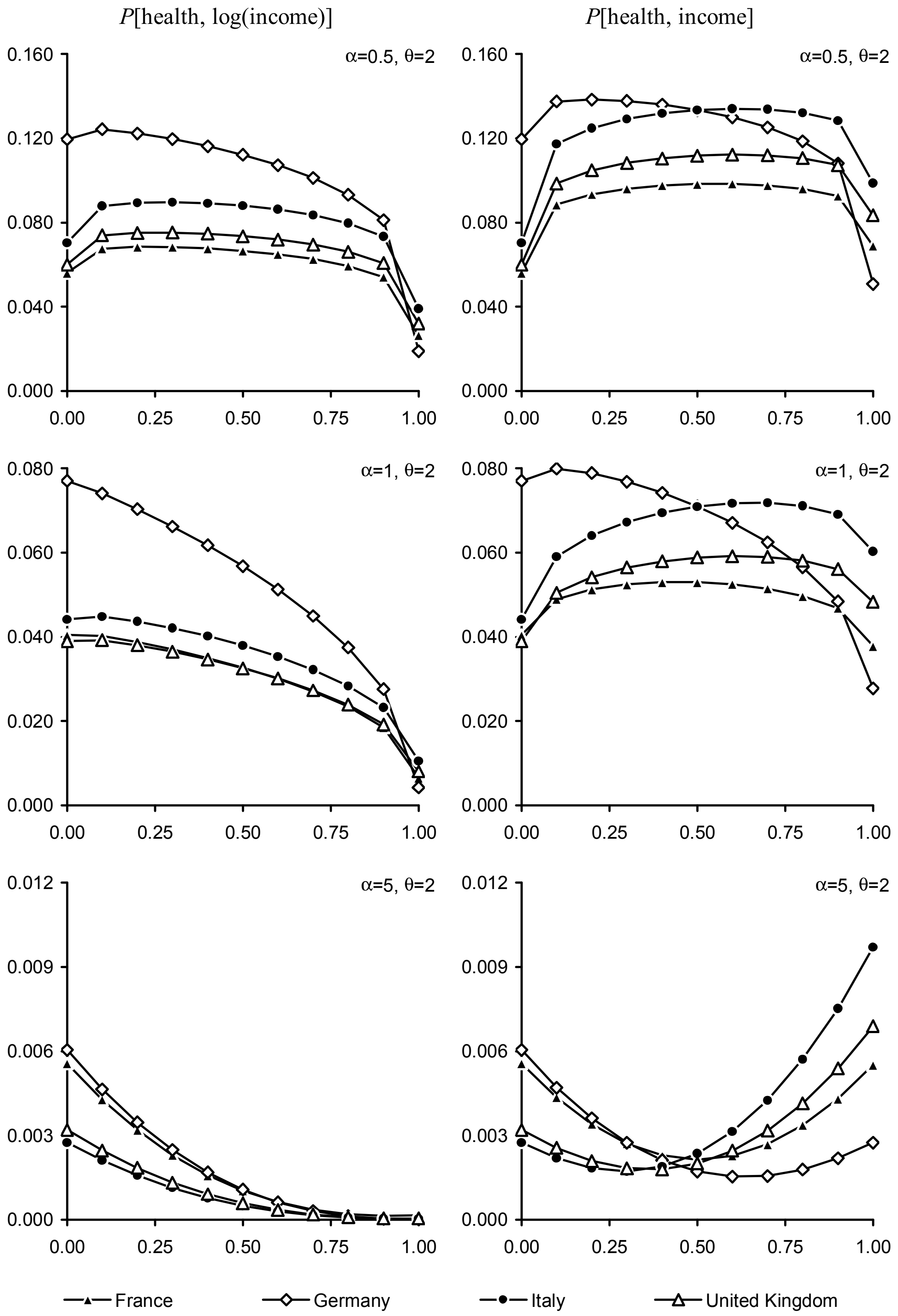
BOURGUIGNON-CHAKRAVARTY MULTIDIMENSIONAL DEPRIVATION INDEX – I



Source: author's elaboration on ECHP data, Wave 8. Logarithmic scale for the horizontal axis reporting the values of θ.

Figure 7

BOURGUIGNON-CHAKRAVARTY MULTIDIMENSIONAL DEPRIVATION INDEX – II



Source: author's elaboration on ECHP data, Wave 8. Moving rightwards on horizontal axis amounts to gradually shifting the weight from health only (w=0) to log(income) or income only (w=1).

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