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Abstract

This working paper refers to the evaluation of health states when equity matters. We propose an evaluation formula that incorporates equity concerns from an equality of opportunity viewpoint and is applicable to categorical data, such as self-reported qualitative health states. An empirical illustration using Spanish data is provided.

Key words

Evaluation of health states, equality of opportunity, categorical data.

Resumen

Este documento de trabajo se ocupa de la evaluación de estados de salud incorporando aspectos distributivos desde el enfoque de igualdad de oportunidades. Se propone una fórmula de evaluación que es aplicable al caso de variables categóricas, como las valoraciones subjetivas de estados de salud. Se realiza una ilustración del método propuesto usando datos de las comunidades autónomas españolas.

Palabras clave

Evaluación de estados de salud, igualdad de oportunidades, variables categóricas.

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1. Introduction

THE need to introduce distributive considerations in the analysis of health is already well established. Wagstaff (1991), Bleichrodt (1997), Dolan (1998), Østerdal (2003), and Bleichrodt and van Doorslaer (2006), deal with this question in the context of the evaluation of health programs following the QALYs approach. More generally, there is a number of contributions dealing with inequalities in the distribution of health, much in line with the studies on income inequality (see for instance Allison and Foster [2004], Herrero and Pinto [2008], Rosa Dias [2009], Trannoy et al. [2010], Almas et al. [2011]). There is also a recent literature taking into account the socioeconomic dimension of the problem, linking inequality in health with a more general form of socioeconomic inequality (see Wagstaff et al. [1991], Bommier and Stecklov [2002]). The issue is complex and has generated a large body of literature (see the reviews in Wagstaff and van Doorslaer [2000] and Williams [2001]).

A more difficult case is that in which we aim at assessing health inequality from categorical data. This happens, in particular, when the health variables correspond to *Self Assessed Health* (SAH). These types of health surveys, which are fairly common and usually contain very rich data, provide subjective evaluations of people's health. The standard format is one in which people have to choose the best description of their health status out of four or five alternative categories. In order to evaluate the health situation of a society from such data, the analyst usually attaches some cardinal values to those health categories, either by a naive procedure (a "1 to 4" or "1 to 5" scale) or by means of more sophisticated procedures (see van Doorslaer and Jones [2003], Lecluyse and Cleemput [2006], Cubí-Mollá [2010]). The results so obtained are obviously dependent on the chosen cardinalization, such that the analysis is conditioned by the weights attached to health states. Needless to say, this problem translates to the associated inequality measurement.

Several authors have dealt with those difficulties. Let us mention the work of Abu-Naga and Yalcin (2008), who apply a family of inequality indices due to Allison and Foster (2004) that have suitable invariant properties with respect to cardinalization. Zheng (2011) deals with the same problem from a different perspective, using socioeconomic variables to order distributions (Lorenz dominance criteria applied on an income-health matrix). Our contribution here follows that literature in that we approach the evaluation of health inequality using categorical data associated with SAH surveys. Yet we depart from previous works in that we focus on *equality of opportunity*.

Equality of opportunity is nowadays one of the most relevant concepts of distributive justice[1]. The bottom line behind this principle is that people who are relatively disadvantaged due to external circumstances deserve some kind of compensation. And, complementarily, that we should not be concerned for outcome differences that derive from people's other characteristics that could be deemed irrelevant for the problem under consideration. Some of these ideas are implicit in the World Health Organization (WHO) programme (see Whitehead [1990]), in which it is claimed that "equity is [...] concerned with creating equal opportunities for health and with bringing health differentials down to the lowest possible".

We propose here to translate that approach to the evaluation of health states. To do so we start by grouping people according to their circumstances so that so that society is partitioned into a finite number of *types*, each of which gathers individuals with similar opportunity. To fix ideas, we can think of a type as a set of agents living in the same region and having similar wealth. People are also classified in terms of a given set of *health states*. The key idea is that the differences in the distribution of health states across types can be regarded as differences in people's opportunities.

The paper is structured as follows. Section 2 presents the reference model. This model includes an evaluation function for the assessment of health and an index of inequality of opportunity. Section 3 presents an empirical application out of the last Spanish SAH in order to illustrate the extent of the modelling. A few final words in Section 4 close the paper.

2. The Model

CONSIDER the problem of providing a welfare assessment of the overall health of a society with m agents, $M = \{1, 2, \ldots, m\}$, out of categorical data on individual health states. Such a

[1] There is a wide spectrum of views with respect to what is required for equality of opportunity, from the non-discrimination view to the view that social provision should compensate for all forms of disadvantage. Common to all these views is that individuals are accountable, to some extent, for the achievement of the advantage in question, whether this refers to health, education, income, utility or welfare. The issue of *responsibility* has become prominent in some of the recent developments within the areas of political philosophy and welfare economics (e.g. Fleurbaey (2007) and the literature cited therein).

welfare assessment will be represented by a *social evaluation function, η(.)*, a mapping from the set of individual realizations to the real numbers, that is to be interpreted as an index of social welfare regarding health. A specific feature of our way of modelling the problem is that it incorporates equality of opportunity as an intrinsic part of the evaluation.

Our approach is based on the idea that individual health status is a function of different variables such as gender, age, wealth, life-style (including sporting and eating habits, social interactions, or risky activities), personal preferences, parental characteristics, … Some of those variables can be regarded as part of the agents' autonomous choices (e.g. life-style or preferences), whereas others are to be interpreted as part of their external circumstances. We assume that all those variables can be clearly divided into *effort variables* (those corresponding to autonomous choices) and *opportunity variables* (those regarding circumstances). Note that the decision on how to classify those variables into effort and opportunity determines the nature and extent of our evaluation, as it selects those aspects for which inequality is relevant and those for which it is not.

Two remarks are worth considering at this point:

1) External circumstances, in the sense used here, will typically depend on the problem under consideration. Take the case of wealth, for instance. It may well be that wealth derives from people's effort in many cases. Yet, when evaluating health, one usually assumes that wealth is part of the external circumstances, in the sense that it is a variable that should not affect people's health (or, put differently, that health differences due to wealth are socially unfair).
2) When applying the equity of opportunity principle to specific cases one may find that not all variables that affect agents' outcomes can be classified either as effort or opportunity. That may happen with some "natural causes" (e.g. age) or "structural traits" (e.g. social conventions). When comparing societies with different patterns for those types of variables, one has to find a way of neutralizing that type of differences. Age is a case particularly relevant in the evaluation of health because the distribution of health states gets systematically worse with age[2].

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[2] It is not clear, from a conceptual viewpoint, whether differences in age are to be considered as "personal decisions" or as "circumstances", when evaluating health. In the first case (ageing as the consequence of the decision of keep living), differences due to age would be ignored, so that the evaluation would disregard that feature. In the second case (ageing as an opportunity variable), we would be assuming that

Suppose that we have already solved the question of which variables are effort variables and which ones are opportunity variables. Let $T = \{1, 2, \ldots, \tau\}$ denote the resulting set of *types* in which the population is partitioned, according to the agents' external circumstances. That is, all agents within a type have similar opportunity. There is a finite set **S** of relevant health states, $\mathbf{S} = \{s_1, s_2, \ldots, s_S\}$ that summarize all possible individual health conditions. We can think of the standard four or five categories classification of health status, from excellent to very poor.

We shall assume initially that the demographic structure is the same for all types, in order to simplify the discussion. The case of heterogeneous demographic structures is taken up later in this section.

2.1. The evaluation of health prospects

We want to assess the welfare content of social health for a society made of m individuals that are of τ different types (with a homogeneous demographic structure) and may exhibit one of S different health states. The main idea behind our approach is that observed differences in the distribution of individual health status across types reflect the different opportunities that people enjoy.

Let $m(t,s)$ be the number of agents of type t with health state s, $m(s) = \sum_{t=1}^{\tau} m(t,s)$ the total number of agents of with health state s in society, and $m(t) = \sum_{s=1}^{S} m(t,s)$ the total number of agents of type t. Call α_{ts} the probability that an individual of type $t = 1, 2, \ldots, \tau$, will have health state $s = 1, 2, \ldots, S$. That is, $\alpha_{ts} = \frac{m(t,s)}{m(t)}$. Let $\pi = (\pi_1, \pi_2, \ldots, \pi_\tau)$ be the vector of population shares of the different types; that is, $\pi_t = \frac{m(t)}{m}$, with $\pi_t > 0, \ \forall\, t$ and $\sum_{t=1}^{\tau} \pi_t = 1$.

Consider now the following matrix:

$$\mathbf{A} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \ldots & \alpha_{1S} \\ \alpha_{21} & \alpha_{22} & \ldots & \alpha_{2S} \\ \ldots & \ldots & \ldots & \ldots \\ \alpha_{\tau 1} & \alpha_{\tau 2} & \ldots & \alpha_{\tau S} \end{bmatrix}$$

differences in health due to age deserve some compensation. Clearly neither of those alternatives fits well with our primary intuitions on the evaluation of health states. It seems more appropriate to look for a way of standardizing demographic structures when comparing different societies, which amounts to treat age neither as an effort variable or as an opportunity variable.

Row t of matrix **A**, denoted by $\alpha(t)$, represents the health prospect for type t. That is, it gives us the probability distribution of health faced by agents of type t. The sth column of matrix **A**, denoted by $\alpha(s)$, describes the distribution of health state s across types. The differences in the probabilities within a column correspond in our framework to differences among types due to their differential circumstances or traits[3].

The product $\boldsymbol{\pi}\mathbf{A} = \mathbf{b}$ yields a row vector of S terms, $\mathbf{b} = (b_1, b_2, ..., b_S)$, each of which describes the share of agents with health state s in the population. That is,

$$b_s = \boldsymbol{\pi}\alpha(s) = \frac{m(s)}{m},\ s = 1,2,...,S$$

Now let $\mathbf{q} = (q_1, q_2, ..., q_S)$ denote the vector of cardinal values associated with the different health states. Those values correspond to the weight attached to the different health states in our evaluation. That is, each term q_s can be interpreted as the unitary contribution of an agent with health state $s = 1, 2, \ldots, S$ to total health[4]. Then, the column vector **c**, given by $\mathbf{Aq} = \mathbf{c}$, provides an evaluation of the average health state of the different types, conditional on the cardinalization scheme **q**. That is,

$$c_t = \alpha(t)\mathbf{q} = \sum_{s=1}^{S} \frac{m(t,s)}{m} q_s,\ t = 1,2,...,\tau$$

The overall welfare of society derived from a health states matrix **A** and an evaluation criterion $\mathbf{q}$, will be given by:

$$\eta(\mathbf{A},\mathbf{q}) = \boldsymbol{\pi}\mathbf{Aq} \tag{1}$$

[3] Think, for the sake of illustration, of the case of two types, rich and poor, and two health states, good or bad. The rows of the corresponding matrix describe the distribution of health states for rich and poor people, respectively. The columns describe how good and bad health states are distributed between rich and poor. Is this type of difference the one that we associate with the inequality of opportunity in society (here due to income factors).

[4] In many cases, in particular when dealing with categorical data, those values correspond to a particular cardinalization introduced by the analyst out of some external source.

That is,

$$\eta(\mathbf{A},\mathbf{q}) = \sum\nolimits_{s=1}^{S} \frac{m(s)}{m} q_s$$
$$= \sum\nolimits_{t=1}^{\tau} c_t \pi_t$$

The last expression says that our evaluation criterion is embedded in a *health evaluation function,* a mapping $\eta : R_{++}^{\tau S} \times R_{++}^{S} \to R_{+}$, that associates real numbers to reported health states, taking into account their distribution across the different types. That criterion consists of a weighted average of the values of the health states, with weights given by the corresponding population shares. Or, alternatively, it consists of the weighted sum of the evaluation of the types' average health, with weights equal to the shares of the population types. We can therefore identify $q_s \frac{m(s)}{m}$ as the implicit evaluation of health state *s*, and $c_t \pi_t$ as the contribution of type *t* to total welfare health.

2.2. Inequality of opportunity

Our target here is to define a measure that captures the inequality of opportunity in health associated with a matrix **A** of relative frequencies of health states among a population consisting of τ different types (with a homogeneous demographic structure).

Recall that the *s*th column of matrix **A** describes the distribution of health state *s* among the τ different types. Ideally, the distribution of every health state across types should be uniform. That is, differences in people's external circumstances should not affect their health states. As a consequence, the observed differences in the distribution of health states across types derive from characteristics that involve diverse health opportunities for the members of this society.

The inequality that is relevant for our purposes is, therefore, that *within* the columns of matrix **A**, which describe the agents' chances of having a given health state depending upon their type. Clearly, there is no point in fostering an egalitarian distribution of health states *within* a type, as those internal differences are, by construction, ethically irrelevant.

Given the distribution of health state *s* across types, $\alpha(s) = (\alpha_{1s}, \alpha_{2s}, \ldots, \alpha_{\tau s})$, we denote by $i(s)$ the associated inequality measure, where $i(.)$ is a *relative inequality index* applied to such a distribution. The inequality of opportunity associated with matrix **A** can be obtained as the weighted sum of the inequality across health states, with weights equal to the corresponding population shares. That is,

$$I_{opp}(\mathbf{A},\mathbf{i}) = \boldsymbol{\pi}\mathbf{A}\mathbf{i} = \sum_{s=1}^{S} \frac{m(s)}{m} i(s) \tag{2}$$

where **i** = [$i(1)$, $i(2)$, …, $i(S)$] is a vector of dispersion measures among the types by health states. This inequality of opportunity index can also be interpreted as a summary measure of the differences between the rows of matrix A, that describe the distribution of health states across types.

Note that equation (2) turns out to be independent on the cardinalization assumed but it is sensitive to the inequality measure adopted. Concerning this point it is worth noting that standard inequality measures, such as Gini or the family indices of Atkinson and Theil, give relatively more weight to smaller values (see Goerlich and Villar [2009] for a discussion). That is a convenient property when dealing with income distribution because it shows a higher concern for those who are more in need (smaller values in this context correspond to “the poor”). This is not the case here because deviations above or below the mean can be good or bad depending on the health state under consideration. Therefore, it is preferable to use a scale independent inequality measure that weights equally deviations above and below the mean. The *coefficient of variation* (*cv*) (or its squared version) turns out to be the natural candidate to assess dispersion in this context.

The coefficient of variation is defined as follows:

$$cv(s) = \frac{\sigma(s)}{\mu(s)}$$

where $\sigma(s)$ is the standard deviation and $\mu(s)$ is the mean value.

2.3. Inequality adjusted values

We can combine the evaluation of health states and the assessment of the equality of opportunity in a single measure, $H(.)$, that describes the *inequality adjusted health evaluation function.* This measure can be defined as follows:

$$H(\mathbf{A},\mathbf{q},\mathbf{i}) = \eta(\mathbf{A},\mathbf{q})\left[1 - I_{opp}(\mathbf{A},\mathbf{i})\right] \tag{3}$$

That is, function $H(.)$ applies a discount to the overall evaluation of health states, $\eta(.)$, equal to the weighted inequality of health states across regions (the inequality of opportunity index). The term $\eta(\mathbf{A},\mathbf{q})I_{opp}(\mathbf{A},\mathbf{i})$ describes the total amount of such a reduction.

From that expression we can estimate the *relative welfare loss* due to the inequality of opportunity, $RWL_{opp}(\mathbf{A},\mathbf{i})$, as:

$$RWL_{opp}(\mathbf{A},\mathbf{i}) = \frac{\eta(\mathbf{A},\mathbf{q})I_{opp}(\mathbf{A},\mathbf{i})}{H(\mathbf{A},\mathbf{q},\mathbf{i})} = \frac{I_{opp}(\mathbf{A},\mathbf{i})}{1-I_{opp}(\mathbf{A},\mathbf{i})} \tag{4}$$

This expression (multiplied by 100) gives us the percentage of welfare that is lost due to the inequality of opportunity.

Note that equation (4) turns out to be independent on the cardinalization assumed.

2.4. Differences in age structures

It is well established that perceived health states depend on the age of the respondents. Most empirical studies show that perceived health status get systematically worse with age, even though people declared health incorporates an adjustment to their actual conditions. Therefore, some of the differences observed in the distribution of health states among types may reflect differences in their demographic structures. Our assessment of the inequality of opportunity should therefore discount that part of inequality due to "natural causes" (the differential age structure of the types).

Consider now that the population of each type is partitioned into P different age intervals, identified by the sub-index p. Type t is now made of P different population subgroups, for t = 1, 2, …, τ. There are several ways of dealing with the evaluation of health states in this context. The one we propose here is that of *demographic standardization*, which consists of normalizing the types' demographic structures by that of the whole society. This can be done as follows. For each type we build a matrix $\mathbf{R}(t)$, with P rows (one for each age interval) and S columns (one for each health state), whose generic entry, $\alpha_s^p(t)$, is the share of population within age interval p and health state s. That is,

$$\alpha_s^p(t) = \frac{m_s^p(t)}{m(t)}$$

Let now $\mathbf{v}(t) = \left(m^1(t), m^2(t), \ldots, m^P(t)\right)$ denote type t vector of population by age intervals, with $m^p(t) = \sum_{s=1}^{S} m_s^p(t)$. Then,

$$\mathbf{v}(t)\mathbf{R}(t) = \left(m_1(t), m_2(t), \ldots, m_S(t)\right)$$

gives us the distribution of health states of type t.

Let $\mathbf{v} = \left(v^1, v^2, \ldots, v^P\right)$ stand for the vector of population age intervals in the whole country. For each type t we calculate:

$$\mathbf{vR}(t) = \left(\hat{m}_1(t), \hat{m}_2(t), \ldots, \hat{m}_S(t)\right)$$

where $\hat{m}_s(t)$ represents the population in t with health state s under the assumption that the age structure of this type coincides with that of the whole society. We control in this way for the effect of the differences in population structures.

Finally, we construct a matrix $\hat{\mathbf{A}}$ with τ rows (one for each type) and S columns (one for each health state) whose typical entry, $\hat{\alpha}_{is}$, is given by:

$$\hat{\alpha}_{is} = \frac{\hat{m}_s(t)}{\sum_{s=1}^{S} \hat{m}_s(t)}$$

This is the matrix that describes the distribution of health states net of the influence of the differences in the types' population structures. The analysis goes along the lines in former sections, with respect to this new matrix. That is, we shall use the following formulae:

$$\eta\left(\hat{\mathbf{A}}, \mathbf{q}\right) = \boldsymbol{\pi}\hat{\mathbf{A}}\mathbf{q} = \sum_{s=1}^{S} \frac{\hat{m}(s)}{m} q_s \qquad (1')$$

$$I_{opp}(\hat{\mathbf{A}}, \mathbf{i}) = \boldsymbol{\pi}\hat{\mathbf{A}}\mathbf{i} = \sum_{s=1}^{S} \frac{\hat{m}(s)}{m} i(s) \qquad (2')$$

where $\hat{m}(s) = \sum_{t=1}^{\tau} \hat{\alpha}_{ts}$ and the inequality measures refers to the columns of matrix $\hat{\mathbf{A}}$.

And, obviously,

$$H\left(\hat{\mathbf{A}},\mathbf{q},\mathbf{i}\right)=\boldsymbol{\pi}\hat{\mathbf{A}}\mathbf{q}\left[1-I_{opp}\left(\hat{\mathbf{A}},\mathbf{i}\right)\right] \tag{3'}$$

$$RWL_{opp}\left(\hat{\mathbf{A}},\mathbf{i}\right)=\frac{I_{opp}\left(\hat{\mathbf{A}},\mathbf{i}\right)}{1-I_{opp}\left(\hat{\mathbf{A}},\mathbf{i}\right)} \tag{4'}$$

3. An Empirical Illustration

WE present here an illustration of the model described above, using the Spanish data on health states corresponding to 2003 and 2006 (*Encuestas Nacionales de Salud 2003, 2006,* INE 2005 and 2008, respectively). Those data come from a survey in which people report their perceived health states, selecting one of the four possible states: very good, good, not so good, and bad[5]. In this application types correspond to the different Spanish regions so that inequality of opportunity refers to the diverse health opportunities faced by people living in different regions.

Tables A.1, A.2 and A.3 in the annexe present the three matrices $\hat{\mathbf{A}}$ we take as reference for our analysis. Each matrix contains the frequency of each health state in the 17 Spanish regions, once their population has been re-scaled in order to cancel out the differences due to their diverse age structures[6]. The first two matrices correspond to the data of 2003 and 2006. The third one provides the data for 2006 with the average population structure of 2003. The reason is than in those 3 years the Spanish population had experienced enormous changes due to the massive arrival of immigrants (more than two million people in that short period, which corresponds to a 5% increase over the Spanish population in 2003). Table A.4

[5] We have reduced the original five health states into four, by aggregating the states "bad" and "very bad" into a single one. We do so in order to apply a suitable cardinalization for the health states (see below).

[6] We define 10 age intervals of ten years each (except the first one that consists of 11 years and the last one that is open) and use the Spanish population structure for all regions and assign to each age the declared health status of the region for that age, according to the procedure described in section 2.3.

provides a summary of the changes in the population structure. It shows that those changes are basically explained by two different elements: ageing and immigration. Ageing reduces the share of the young and increases that of people over 65 (here the improvement of life expectancy also plays a role). Immigration increases the share of working age population, on the one hand, and the infant population, on the other.

Table 1 provides an estimate of the health sates in the Spanish regions in 2003, 2006 and 2006 with the average population structure of 2003, denoted by 2006(03). The tables in the annexe present the distribution of health statuses in the different Spanish regions. Table 1 has been obtained by using the cardinal estimates in Cubí-Mollá (2010)[7]. That is,

- Very good: $q_1 = 0.926$
- Good: $q_2 = 0.899$
- Not so good: $q_3 = 0.643$
- Bad: $q_4 = 0.195$

Note that the weights for the different health states are highly non-linear. The worth of "good" health is some 97% of that of "very good", whereas "not so good" health is valued as 71.5% of the value of "good" health, and "bad" represents 30.3% of that of "not so good" health.

In summary, the cells of table 1 provide the values $\eta_g(\mathbf{A},\mathbf{q})$ presented in equation [1], for the case of the Spanish regions and the aforementioned years.

[7] Cubí-Mollá (2010), estimates the cardinal values for the SAH in Spain by applying a suitable modification of the interval-regression approach in van Doorslaer and Jones (2003), considering the skewness in the distribution of the health variable, outperforming the approach in Wagstaff and van Doorslaer (1994), introducing continuity by using as a reference for the Spanish population the Catalonia Health Survey (ESCA 2006), Generalitat de Catalunya (2007), that offers both categorical and numerical data on the SAH.

TABLE 1: **Evaluation of the Spanish regions' health in 2003, 2006 and 2006(03)**

	2003	2006	2006(03)	% var. 2006/2003	% var. 2006(03)/2003
Andalusia	0.7801	0.7880	0.7897	1.01	1.24
Aragon	0.7966	0.8111	0.8124	1.83	1.99
Asturias	0.7791	0.7881	0.7897	1.15	1.36
Balearic Islands	0.7668	0.8004	0.8016	4.38	4.54
Canary Islands	0.7484	0.7738	0.7758	3.39	3.66
Cantabria	0.7849	0.8080	0.8093	2.94	3.10
Castile and León	0.8170	0.8208	0.8221	0.46	0.63
C. La Mancha	0.7787	0.8002	0.8014	2.75	2.90
Catalonia	0.7986	0.7959	0.7971	-0.35	-0.19
Valencian. C	0.8030	0.7707	0.7725	-4.03	-3.80
Extremadura	0.7826	0.7806	0.7827	-0.25	0.01
Galicia	0.7599	0.7539	0.7552	-0.79	-0.63
Madrid	0.8069	0.8028	0.8041	-0.50	-0.35
Murcia	0.7837	0.7620	0.7639	-2.78	-2.54
Navarre	0.8181	0.7980	0.7987	-2.46	-2.36
Basque Country	0.8161	0.8071	0.8077	-1.11	-1.04
Rioja	0.8234	0.8247	0.8265	0.15	0.37
Spain	0.7970	0.7914	0.7927	-0.70	-0.53

Those data convey three key messages. First, that it has been a small reduction in the average health status in the whole country, a reduction that is not explained by the changes in the population structure (compare the data corresponding to 2003 with those to 2006[03], i.e. the reported health in 2006 with the population structure of 2003). Second, that the regions have evolved rather differently (a range of variation that goes from above 4% increase in the Balearic Island to a decrease of around 4% in the Valencian Region). And third, that the flow of immigrants has not compensated the reduction of perceived health due to population ageing (compare the data corresponding to 2006 and to 2006[03]).

Table 2 provides the values of the coefficient of variation among the regions, by health state. It shows that inequality is higher in the extreme health states and quite uniform for the case of "good" health. Indeed, the inequality of the best health state is between 5 and 7 times that of the good health state, whereas the bad states was 8 times higher in 2003 and dropped to some 4 times higher in 2006. It also shows an increase in the dispersion of the top health states.

TABLE 2: **Inequality across regions by health states, 2003, 2006 and 2006(03), with average age distribution**
(coefficient of variation)

	Very Good	Good	Not so good	Bad
2003	0.2222	0.0920	0.1644	0.2756
2006	0.2597	0.1039	0.1511	0.2123
2006(03)	0.2607	0.1044	0.1525	0.2124

As for the overall inequality of opportunity (see equation [2']), table 3 shows that it has increased by some 11.5%. This increment would have been larger with a constant average population structure. The data point out a pattern of increasing diversity in the distribution of health states across regions.

The same message derives from the relative welfare loss. The data show that it increased from around 16% to 18% during the period, with a larger increase with a constant population structure.

The inequality adjusted health index, H(.), shows a reduction of some 2.5% (of which 2% derives from the increase in the inequality of opportunity and 0.5% to the decline in the overall perceived health status).

TABLE 3: **Inequality of opportunity, welfare loss and inequality adjusted evaluation of health states in the Spanish regions, 2003, 2006 and 2006(03), with average age population**

	2003	2006	2006(03)	% var. 2006/2003	% var. 2006(03)/2003
Iopp	0.1372	0.1530	0.1539	11.46	12.14
RWL (%)	15.90	18.06	18.19	13.53	14.35
H(.)	0.6876	0.6703	0.6707	-2.52	-2.45

4. Final Remarks

EQUALITY of opportunity is a powerful evaluation principle most pertinent when dealing with such essential aspects of life as health or education. Applying this principle usually requires a number of compromises and case-specific adaptations that determine the extent and relevance of the analysis. Those difficulties increase when the original data are categorical.

We have presented here a model for the evaluation of equality of opportunity in health for categorical data (focussing on self-reported health status). The key idea is that of partitioning society in a finite set of types that collect agents with the same relevant circumstances and then compare the frequency distribution of the realizations across types.

When health states can be given a cardinal evaluation, we can also provide an overall measure of welfare health for a society, taking into account both average levels and inequality of opportunity. This model has been illustrated by means of a particular example dealing with self-reported health status in Spain, identifying types with the different regions.

One may reasonably argue that welfare evaluation becomes fully dependent on the weighting system of health states we adopt, which may derive from different sources or admit a number of alternatives (as it is the case here). Yet it is worth noting that the analysis of equality of opportunity is independent on any cardinal valuation of health states, which makes this part of the analysis very robust.

In a complementary line of research the authors have developed a model for the analysis of categorical data with an endogenous weighting system (see Herrero and Villar [2012]), which permits one to address this problem from a slightly different viewpoint (see Herrero, Méndez and Villar [2012]). The key difference is that in the model presented here provides a summary measure of inequality of opportunity for the whole society, as an aggregate of inequality of opportunity in the different categories, whereas in those papers equality of opportunity only allows comparing the relative opportunity values of the different types. Both lines of research are, therefore, complementary.

5. Appendix

TABLE A.1: **Health states 2003 with average population structure**

	Very good	Good	Not so good	Bad
Andalusia	0.1396	0.5443	0.2240	0.0896
Aragon	0.0791	0.5902	0.2865	0.0436
Asturias	0.1747	0.5048	0.2264	0.0919
Balearic Islands	0.1662	0.4947	0.2294	0.1060
Canary Islands	0.1270	0.4937	0.2545	0.1196
Cantabria	0.1381	0.5580	0.2181	0.0777
Castile and León	0.0916	0.6684	0.1887	0.0510
C. La Mancha	0.1259	0.5311	0.2635	0.0783
Catalonia	0.1790	0.5457	0.1986	0.0748
Valencian C.	0.0937	0.6682	0.1559	0.0783
Extremadura	0.1098	0.5647	0.2463	0.0762
Galicia	0.1157	0.5150	0.2641	0.1025
Madrid	0.1436	0.5932	0.2008	0.0589
Murcia	0.1436	0.5546	0.2100	0.0880
Navarre	0.1646	0.6087	0.1676	0.0546
Basque Country	0.1574	0.6019	0.1850	0.0529
Rioja	0.1053	0.6814	0.1620	0.0471
Spain	0.1265	0.5855	0.2172	0.0708

Source: Encuestas Nacionales de Salud 2003, 2006 (INE 2005 and 2008).

TABLE A.2: **Health states 2006 with average population structure**

	Very good	Good	Not so good	Bad
Andalusia	0.2467	0.4477	0.2178	0.0871
Aragon	0.1913	0.5523	0.1953	0.0609
Asturias	0.1664	0.5218	0.2327	0.0782
Balearic Islands	0.2241	0.498	0.2041	0.0714
Canary Islands	0.0883	0.5845	0.233	0.0859
Cantabria	0.1161	0.6347	0.1821	0.0655
Castile and León	0.2505	0.5161	0.1773	0.0556
C. La Mancha	0.2252	0.4776	0.2335	0.0622
Catalonia	0.2341	0.4612	0.2346	0.0698
Valencian C.	0.2171	0.4419	0.237	0.1024
Extremadura	0.1692	0.5039	0.2414	0.0804
Galicia	0.1174	0.4809	0.3004	0.1011
Madrid	0.2535	0.4671	0.2099	0.0675
Murcia	0.1398	0.4921	0.2649	0.1014
Navarre	0.2196	0.5013	0.2002	0.078
Basque Country	0.1985	0.5307	0.2099	0.0575
Rioja	0.1807	0.6085	0.1565	0.0498
Spain	0.1922	0.5036	0.2262	0.0779

Source: Encuestas Nacionales de Salud 2003, 2006 (INE 2005 and 2008).

TABLE A.3: **Health states 2006 with average population structure of 2003**

	Very good	Good	Not so good	Bad
Andalusia	0.2502	0.4480	0.2156	0.0855
Aragon	0.1939	0.5527	0.1933	0.0599
Asturias	0.1679	0.5236	0.2311	0.0765
Balearic Islands	0.2261	0.4987	0.2025	0.0704
Canary Islands	0.0887	0.5875	0.2317	0.0846
Cantabria	0.1163	0.6374	0.1804	0.0644
Castile and León	0.2555	0.5144	0.1748	0.0547
C. La Mancha	0.2273	0.4777	0.2325	0.0612
Catalonia	0.2369	0.4611	0.2330	0.0687
Valencian C.	0.2204	0.4420	0.2355	0.1005
Extremadura	0.1712	0.5069	0.2380	0.0790
Galicia	0.1182	0.4832	0.2983	0.1001
Madrid	0.2551	0.4683	0.2082	0.0665
Murcia	0.1424	0.4938	0.2622	0.0999
Navarre	0.2216	0.5010	0.1991	0.0774
Basque Country	0.2000	0.5299	0.2099	0.0570
Rioja	0.1850	0.6084	0.1534	0.0490
Spain	0.1945	0.5043	0.2244	0.0767

Source: Encuestas Nacionales de Salud 2003, 2006 (INE 2005 and 2008).

TABLE A.4: **The Spanish population by age (2003, 2006)**

Age intervals	2006	2003	Difference
0 - 10	4721690	4400421	321269
11 - 20	4467304	4636582	-169278
21 - 30	6813204	6858179	-44975
31 - 40	7479028	6915744	563284
41 - 50	6440922	5824824	616098
51 - 60	5061518	4747624	313894
61 - 70	3969623	3908059	61564
71 - 80	3412338	3230404	181934
81 - 90	1485801	1288453	197348
> 90	216816	194285	22531
Total	44068244	42004575	2063669

Source: Estimaciones de la Población Actual de España (INE).

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