A Resource-Sensitive Framework for Defining and Measuring Equality of Opportunity in Health Care*

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Abstract

We offer a new framework for defining and measuring disparities in the distribution of health care opportunities. These are conceived as inversely related to the *cost of a specified bundle of health services of given quality*. In the ex-ante perspective we adopt, what is salient is the distribution of costs across *cells*, where each cell is defined by a set of characteristics determining access barriers to care. Differently from the existing health literature, our approach allows to disentangle the opportunities individuals enjoy - assessed by jointly considering chances of access and disparities in access conditions - from the mere utilization of health services. A general index for the measurement of equality of opportunity in health care is then developed and resource-conditional policy suggestions are deducted. A simple exercise based on real data shows that the methodology we provide can be easily applied.

Keywords: *Health care*, *Equality of opportunity*, *Access costs*.
JEL codes: I14, I18

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1 Introduction

Motivated by the search for financial sustainability, many governments have recently contemplated radical reforms of the national health systems that exacerbate the public health effect of economic crises (Karanikolos et al. 2013). A recent study, using data on self-reported perception of access to health care across and within 29 European countries, identifies many individual characteristics (e.g. poor health, unemployment) systematically associated with perceived access barriers (Cylus 2015). The problem is how to conjugate access to care with the objective difficulties governments meet in financing health systems.

The present paper tries to contribute to the ongoing debate by offering a normative framework for defining and measuring equality of opportunity in health care. Within this framework, clear-cut, resource-conditional policy suggestions are deducted.

The literature on the distribution of health care provides a wide choice set from which a normative criterion, the *equalizandum*, can be drawn. At a very general level, such a set can be partitioned along the line marking a key distinction between an approach inspired by the so-called outcome egalitarianism and an approach supporting the view that egalitarianism should instead be concerned with opportunities. As health depends on many factors varying from genetic propensities to lifestyles (Sen 2002), any attempt to equalize outcomes (e.g. Quality-Adjusted Life Years) would inevitably imply a too intrusive intervention in people's life. For these reasons, equality of opportunity is generally considered a more defensible perspective.

The most common way to understand egalitarianism of opportunities in health care is based on a notion of horizontal equity, for, it is said, the end goal consists of *equal health care (or, equal access to health care) for those in equal need of health care* (Wagstaff and van Doorslaer 2000, Allin et al. 2007). Within the latter perspective, utilization of health treatments is taken as the basic information for assessing disparities in opportunities. However, as utilization depends on both access conditions and individual preferences, it follows that, even if access conditions were equalized across the entire population, equal health care for those in equal need would probably not.

Egalitarianism of opportunity in health care has also been explored within the tradition of *welfarist-consequentialism*, in that disparities of opportunities are inferred ex-post from the assessment of outcome inequalities, once needs as well as preferences have been revealed. This aspect is clearly emphasized in Fleurbaey and Schokkaert (2009), where a distinction is made between problematic (legitimate) and unproblematic (illegitimate) outcome inequalities depending on their origins; e.g., whether they originate from different needs or lifestyle choices respectively.

In contrast with the views presented so far, in this paper we disentangle opportunities from utilization. Our proposal is deeply grounded in the

Rawlsian principle of fair equality of opportunity, by which the equalizandum is to be determined in terms of access to health care independently from both health needs and individuals' preferences.

In the *ex-ante* perspective we propose, what is salient is how the size of access barriers, i.e. *the monetary cost of a bundle of health services of given quality*, is distributed across *cells*, where each cell is defined by a set of characteristics which are relevant in determining barriers (age, geographic location, presence of a disability, etc.). In this perspective, perfect equality of opportunity in health care is said to be obtained if and only if both the following are satisfied: i) access is granted to any cell (what is termed *universal access*); ii) the cost of the affordable bundle is the same for any cell (what is termed *equal universal access*). In our view, reducing aggregate inequality of opportunity in health care first requires granting universal access, and then equalizing the cost barriers individuals face. In this sense, the design of the health system is required "to close gaps in access and incrementally to approach equality of access" (Daniels 2013).

With these distinctions in mind, we develop a general index for the measurement of equality of opportunity in health care, as well as resource-contingent policy suggestions. The index we propose can be easily managed for empirical comparisons across areas and over time.

In a policy perspective, resources are to be allocated first to grant access to the cells with the smallest resource gap from the minimum amount necessary to gain access. A counter-intuitive consequence of this, is that, to enhance the distribution of health opportunities, resources are not employed to ameliorate first the condition of whom may be considered more at a disadvantage. Diversely, when resources are sufficient to grant universal access, all the costs must be reduced starting from the highest ones.

The paper is organized as follows. Section 2 discusses the philosophical underpinnings of our notion of equality of opportunity in health care, and the main literature in the field of equal access. Section 3 sketches the normative framework by which a partial ordering of equality of opportunity in health care is defined. Accordingly, the immediate policy implications for the design of health policies are derived. In Section 4, the index for the measurement of equality of health opportunities is derived, and tested on by means of a simple exercise based on Italian data. Section 5 concludes.

2 Equality in Health Care

2.1 Equality of Opportunity in Health Care: an Ex-Ante Perspective

The aforementioned idea that health care is necessary to protect individuals' fair shares of opportunity, is key to prominent egalitarian perspectives; it can be seen as innervating Rawls' (1999, 1971) appeal to a principle of *fair*

equality of opportunity (Daniels 1981, 1985, 2008), as well as Sen's (1980, 1992) work on *capabilities*.

Rawls appeals to the principle of *fair equality of opportunity*, by which, it is said, those who are at the same level of talent and ability, and have the same willingness to use them, should have the same prospects of success regardless of their initial place in the social system. In this sense, as emphasized by Sugden (1993), "*individuals have equal opportunities ... if they have equal command over resources*", independently from outcome prospects.

Notably, Rawls' theory of justice is silent on the distribution of health status, not of health care. According to Sugden (1993), this is consistent with Rawls' understanding of any human society as a *system of fair cooperation*. In any such system, what has to be distributed justly - or fairly - are the benefits and burdens of *social cooperation*; this requires fairness in the distribution of the so-called *social primary goods*, and not in the distribution of *natural primary goods* (e.g., congenital handicaps). Disparities in health status are not then relevant in Rawls' theory, but access to health care is fundamental in order to construct a *well-ordered society*, ensuring *fair equality of opportunity ex-ante*, i.e., when needs and preferences have not been revealed yet. In this sense, the "*provision for medical care, as with primary goods generally, is to meet the needs and requirements of citizens as free and equal*" (Rawls 2001, p.174). This, as emphasized by Daniels (1985) while reinterpreting Rawls' theory of justice, would clearly imply a social obligation to grant access to health care to everyone.

The social commitment to protect and promote health for all people is shared by Sen's capability approach, where health is something that has *special moral importance* in itself. In Sen's perspective, the distinction between health achievements and the capability to achieve good health (which may or may not be exercized) is crucial. Specifically, justice in health requires that all individuals share *ex ante* the same *health prospects*, whose realization, ex post, depends inevitably on individual choices as well as on the amount of resources available to the individual.

In this paper we borrow from Sen the idea that equal opportunities for health is valuable *per se*, but, in our view, the relevant variable is not given by the *health prospect* any individual is able to enjoy (whose equalization would be a very demanding objective), but by the concrete impediments (measured by monetary costs) individuals face in obtaining access to health care. In this sense, our notion is closer to Rawls' ideal of *equal command over resources*, and, as a result, strictly anchored to the idea of access to health care, whose foundations trace back to the health literature on 'access' and 'equal access'.

The problem of what should be meant by access, and, consequently, by equal access, is not a trivial one (Mooney 1983; Aday and Andersen 1974; Andersen 1995). The strand of literature focusing on the role played by demand factors does not allow to properly disentangle *potential* from

effective use of health services. This is particularly relevant, for, in assessing opportunities ex-ante, what really matters are the objective possibilities of access as influenced by factors like *availability and accommodation* (levesque et al. 2013).

Given the notion of (potential) access we opted for, the literature on health inequality provides some interesting definitions of 'equal (potential) access' to health care (Le Grand 1982, 1987; Olsen and Rogers 1991). However, we do not consider any of these definitions as fully satisfactory for either they define equal access as equal price of access without taking resources into consideration, or define equal access as equality of budget sets.

2.2 Equality of opportunity as *equal universal access*

Following the Rawlsian tradition of fair equality of opportunity by which the attention is focused on '*equal command over resources*', in this Section we propose a definition of equality of opportunity in health care as equal universal access. By access, given the focus on supply factors, we denote the chance to benefit of bundle of health related services of given quality. By equal access, we mean the equality in the cost to be faced in order to get access to the same bundle above, where, by cost of access, we refer to the monetization of all concrete impediments that have to be overcome.

According to an ex-ante perspective, we refer to the distribution of the cost of access across *cells*, and not - as it is commonly understood - across individuals, where each cell is defined by a set of *characteristics* determining the objective impediments (e.g., distance from the nearest place where a treatment of given quality is delivered, health services fees, presence of disabilities and so on).

Remarkably, we focus on health treatments of given (fixed) quality. Specifying the quality of the health treatments under consideration is necessary, given the presumably strong heterogeneity characterizing treatments across geographic locations or over time.

Given the notion we opted for, we claim that perfect equality of opportunity in health care is obtained if, and only if, *equal universal access* is granted. Remarkably, to the extent that any metric of inequality of opportunity is to be referred to the population as a whole (and not to a part of it), any notion of inequality is meaningless whenever opportunities are not given to someone; indeed, the definition of inequality orderings strictly relies on the quantification of gaps, but the 'opportunity gap' between two individuals - one of the two having no access to the health treatment - is to be taken as a non-sense because *cardinality* is hardly defensible in this framework.

Hence, in our view, equality of access can be only achieved by first granting universal access, and then by equalizing the monetary costs individuals face. As such, if access is granted to an additional cell, then equality is

improved. On the contrary, any cost equalization is ineffective if universal access is not granted yet. In this sense, the design of the health system is required "to close gaps in access and incrementally to approach equality of access" (Daniels 2013).

Notably, the priority to access we opted for is not defined in a purely lexicographic fashion, as equality of access cannot be evoked to rank alternative schemes which do not differ from each other in terms of access (unless universal access is granted first). This aspect clearly emphasizes the peculiarities of health care as compared to the literature on income inequality and poverty; e.g., increasing the income of a poor income unit inevitably reduces poverty, whereas stretching in any direction the cost of access associated to a given cell does not stretch opportunities until access is not granted to the cell. Most importantly, pairwise income gaps between poor income units (e.g., Foster et al. 1984), as well as poor and non-poor income units, are undeniably meaningful, whereas this is not the case when access and equal access are considered in health care.

3 Formal Analysis

3.1 Basic definitions

In this Section we introduce formal notation and definitions.

Let $\Theta = \times\Theta_{k=1}^{m}$ be the space of characteristics affecting the direct cost of access to health care (e.g., distance, transport facilities, accommodation needs, fees...), that is, the cost borne by a cell to get access to a bundle of health treatments of given quality, which may be intended as either a composite good, or a single health treatment. A vector $\theta_i \in \Theta$ is a point in the Θ-space fully characterizing the i^{th} cell. Let $\theta = \{\theta_i\}_{i=1}^{n}$ be the set of such cells.

We write $C(\theta) := \{c(\theta_1), ..., c(\theta_n)\}$ to denote the initial cost distribution, i.e. the cost that the i^{th} cell has to bear in order to obtain the health treatment of pre-determined quality.

Let $r : \Re^n \to \Re^n$ be a *leveling function*, i.e. a function associating to any initial vector of costs, a vector of non-negative transfers $r(\theta) = [r(\theta_1), \ldots, r(\theta_n)]$ such that $\sum_{i=1}^{n} r(\theta_i) \leq B$, where B is the total amount of resources allocated to the Health sector. In what follows, $C(\theta, r(\theta))$ will denote the policy-induced cost distribution where $c(\theta_i, r(\theta)) = c(\theta_i) - r(\theta_i)$. Remarkably, both the budget B and the initial cost distribution $C(\theta)$ are taken as given, and the policy-maker is assumed to define the leveling function in such a way as to improve equality of opportunity.

We indicate by Y, with supports $[\underline{y}, \overline{y}]$, the distribution of accessible financial resources (e.g., income, wealth, loans, public and private transfers) that can be employed to obtain a treatment of given quality. In an ex-ante perspective, it is not known the endowment of resources enjoyed by

each cell, so it is as if each cell confronted with the whole distribution of resources; access is therefore granted only to those cells bearing a cost of access not greater than the *minor pocket* $\underline{y}$. Universal access is then realized when all the policy-induced costs are not greater than the minor pocket, i.e. $c(\theta_i, r(\theta)) \leq \underline{y} \; \forall \; i$. In what follows, we denote by $I_{C(\theta,r(\theta))} \equiv \{\theta_i : c(\theta_i, r(\theta)) \leq \underline{y}\}$ the set of cells having access to the health treatment.

3.2 Equality in health care: a normative framework

As observed above, as far as the distribution of opportunities for health is concerned, *equal command over resources* can be interpreted as equal cost of access to a given (bundle of) health treatment(s) of predetermined quality.

In formal terms, let Γ be the criterion used to measure individuals' dis-opportunities; that is, Γ maps the cost associated to a given cell (i.e., *cell-specific* monetary cost) into a point on the dis-opportunity curve $\Omega_i = \Gamma(c(\theta_i, r(\theta)))$ with $r(\theta) \geq 0$. As Γ is independent of the characteristics of each cell, it must be the case that the sole distribution of costs matters.

More specifically, we write $\Gamma(c(\theta_i, r(\theta))) = c(\theta_i, r(\theta))$ to quantify dis-opportunities for each cell having access to the health treatment; we write $\Gamma(c(\theta_i, r(\theta))) = +\infty$ when $c(\theta_i, r(\theta)) > \underline{y}$. In other words, if a treatment is not affordable, dis-opportunities are at the maximum, whatever the gap to the minor pocket; to the extent that opportunities are enjoyed if and only if access is obtained, any policy-induced reduction of the cost of access is worthless unless access is granted first.

In what follows, we write $C(\theta, r(\theta)) \succeq C'(\theta, r'(\theta))$ to indicate that $C(\theta, r(\theta))$ is at least as good than $C'(\theta, r'(\theta))$ in terms of equality of opportunity, with $\succ$ and $\sim$ indicating the asymmetric and symmetric component of the *opportunity equality ordering* respectively.

Here we formalize the basic normative background for the construction of opportunity equality orderings.

Axiom 1. *(Anonymity). Let $C(\theta, r(\theta))$ be the cost vector and let $C'(\theta, r'(\theta)) = P \times C(\theta, r(\theta))$ be any cost vector obtained through a permutation of $C(\theta, r(\theta))$. Then $C'(\theta, r'(\theta)) \sim C(\theta, r(\theta))$.*

Evidently, the anonymity requirement properly characterizes the equality perspective where $\Gamma(.)$ is assumed to be the same for all i.

Axiom 2. *(Transfer). Let $C'(\theta, r'(\theta))$ be a cost vector obtained by $C(\theta, r(\theta))$ by reducing the cost of the j^{th} cell. Provided that $I_{C(\theta,r(\theta))} \neq \theta$, $C'(\theta, r'(\theta)) \succ C(\theta, r(\theta))$ if and only if $c(\theta_j, r'(\theta)) < \underline{y} < c(\theta_j, r(\theta))$.*

By Axiom 2 a cost reduction is worth whenever access is allowed for some cell having no access otherwise. Conversely, recalling that $\Gamma(c(\theta_i, r(\theta))) = +\infty$ whenever $c(\theta_i, r(\theta)) > \underline{y}$, if the cost reduction does not allow access, then this is ineffective in terms of opportunities whatever the gap to the

minor pocket. Remarkably, if universal access is not granted, then equality of opportunity can be exclusively promoted by increasing the frequency of access. As such, any improvement in statistical equality in the cost distribution might be ineffective, for statistical equality is not capturing equality of opportunity unless universal access is granted.

Axiom 3. *(Lorenz Dominance). Let* $C(\theta, r(\theta))$ *and* $C'(\theta, r'(\theta))$ *be two cost vectors, and let* $L\{F[c(\theta_i, r(\theta))]\}$ *and* $L\{F[c(\theta_i, r'(\theta))]\}$ *be the corresponding Lorenz curves with* $F[\cdot]$ *indicating the distribution function. Provided that* $I_{C(\theta,r(\theta))} = I_{C'(\theta,r'(\theta))} = \theta$*, if* $L\{F[c(\theta_i, r(\theta))]\} \geq L\{F[c(\theta_i, r'(\theta))]\}\ \forall\ i$*, then* $C(\theta, r(\theta)) \succeq C'(\theta, r'(\theta))$*.*

Axiom 3 introduces an additional norm where opportunity equality orderings are defined in terms of Lorenz dominance, which is known to be formally equivalent to imposing the Pigou-Dalton principle of transfer in the presence of scale invariance (Muirhead 1903, Hardy et al. 1929). Remarkably, meanwhile Axiom 2 states that equality of health opportunities is improved when the chance of access is extended to more cells, Axiom 3 implies that any statistical inequality reduction in the cost distribution enhances equality of health opportunities when universal access has been granted first.

All in all, Axioms 1-3 characterize a *partial*, not complete, opportunity equality ordering in health care. More precisely, Axiom 1 and 2 are compatible with a complete ordering, but the opportunity equality ordering becomes inevitably partial when universal access is granted, i.e. when Lorenz dominance conditions apply. As such, Axioms 1-3 may not be able to rank alternative cost distributions but, importantly, this is not fully jeopardizing the possibility to gather policy implications which are discussed in the next section.

3.3 Egalitarian health policy

Let B indicate the amount of resources allocated to the Health Sector and let $F = \sum_{i=1}^{n} max\left\{0, \left[c(\theta_i) - \underline{y}\right]\right\}$ be the amount of resources necessary to reduce the cost associated to any cell up to the minor pocket $\underline{y}$; given $\underline{c} = min\{C(\theta)\}$, $M = \sum_{i=1}^{n}\left[c(\theta_i) - min\left\{\underline{c}, \underline{y}\right\}\right]$ is the amount of resources necessary to reduce the cost of any cell up to the minimum between $\underline{c}$ and $\underline{y}$.

As we show in the following Proposition, if the opportunity equality ordering $\succeq$ is defined by Axioms 1-3, then the design of the leveling function strictly depends on the amount of resources allocated to the Health sector.

Proposition 3.1. *Let* $C(\theta, r(\theta))$ *be the policy-induced cost distribution originating from* $C(\theta)$ *by means of* $r(\theta)$*. Depending on the availability of resources,* B*, a necessary and sufficient condition for minimizing inequality of opportunity, is that*

i) if $B \leq F$, B must be allocated to equalize costs to the minor pocket, giving priority to cells whose cost is closer to it;

ii) if $F < B < M$, B must be allocated in such a way as to grant universal access first, and then to reduce the highest costs, avoiding re-ranking;

iii) if $B = M$, B must be allocated in such a way as to obtain $c(\theta_i, r(\theta)) = min\{c(\theta_i)\} \; \forall \; i$.

Proof. Appendix. □

Proposition 3.1 maintains that, whenever the amount of resources is not sufficient to grant access to all cells, the leveling function must be designed in such a way as to maximize the number of accesses. This implies that available resources must be first allocated to grant access to the cells with the smallest gap from the minor pocket, i.e. to cells with the lowest costs among those having no access. Apparently this may increase statistical inequality among those cells. Actually such an increase in inequality is irrelevant because the size of the gap to the minor pocket is not something that impinges on opportunities when access is not granted. In other words, a policy that made all the costs closer to the minor pocket without pushing any cost below it, would be ineffective.

When resources are sufficient to grant access to any cell, the leveling function is instead to be designed in such a way as to minimize statistical inequality. This implies that B is allocated to reduce all the costs starting from the highest one. Indeed, in a way that resembles the well known Rawlsian *maximin principle*, inequality improvements - as defined in terms of Lorenz dominance (Axiom 3) - can be obtained in this case through a non-reranking and non-negative resource transfer if and only if the recipient is the worst-off cell (see Proof of Proposition 3.1). Finally, if $c(\theta_i, r(\theta)) = \underline{c} < \underline{y}$, then equality of opportunity cannot be ulteriorly increased, so that any additional available resource that is equally shared among cells, i.e. preserving perfect equality, would be ineffective in terms of equality of opportunity.

Notice that, to the extent that the socially desirable *design* of health policies is determined by the amount of resources made available to the health sector, Proposition 3.1 clearly highlights that equalizing opportunities crucially depends on the overall allocation of resources to health (Sen 2002).

4 Measuring Equality of Opportunity in Health Care

4.1 A measurement proposal

Given the normative framework discussed above, we propose an index for the measurement of equality in health care, which can be empirically implemented for comparisons across countries and/or over time. This index is

able to determine a *complete* opportunity equality ordering which is normatively consistent with the axiomatic framework set above.

We propose the following index of equality of opportunity in health care.

$$HG = \left(\frac{q}{n}\right) \max\left\{1; [1 + (1 - G)]^{1+q-n}\right\} \tag{1}$$

where $q = \sharp I_{C(\theta,r(\theta))}$ is the number of cells having access.

Proposition 4.1. *index HG satisfies Axioms 1-3.*

Proof. Appendix. □

Even if this is not the only metric ensuring normative consistency, in our view, it is particularly appealing as it is defined up to well known indexes in the field of poverty and inequality measurement, i.e. the Headcount Ratio and the Gini index. Specifically, the general formulation in eq. (1) accounts for each of the two conditions below (i-ii). Indeed,

i) if $q < n$, as the term in square brackets cannot be lower than one and the corresponding exponent $(1 + q - n)$ is no greater than zero, then $\max\{.\} = 1$ and, as a result, $HG = HG_1 = \frac{q}{n}$ with $HG \in [0, 1[$;

ii) if $q = n$, $HG = HG_2 = 2 - G$ with $HG \in [1, 2]$.

Moreover, to the extent that HG is a sort of composite index accounting for both the Headcount ratio and Gini index, it must be the case that two additional properties hold.

First, HG is *scale invariant* as it can be shown that, given two populations such that $\underline{y}' = \lambda \underline{y}$ and $C'(\theta, r'(\theta)) = \lambda C(\theta, r(\theta))$ with $\lambda > 0$, it must be the case that $HG' = HG$. This implies, for example, that HG is independent of the currency one is considering for the analysis.

Second, HG is *replication invariant* as it can be shown that if $C'(\theta, r'(\theta))$ is obtained from $C(\theta, r(\theta))$ through a k-fold replication of the population with $k \in \mathbb{N}$, then it must be the case that $HG' = HG$. As such, HG is said to be independent of the size of the population.

It is worth observing that, once *universal equal access* has been achieved $(HG = 2)$, the only possibility to preserve perfect equality of opportunity is to equally share additional resources among all cells.

4.2 A simple example

In this Section we run a simple test using real data. The only aim is to show that our methodology can be easily applied to measure disparities in health care opportunities both across areas and over time. For our purposes we assume that the only relevant characteristic, distinguishing any cell from the others, is geographic location. In particular, each cell is characterized by being situated in one of the Italian provinces.

As for the health treatment of given quality, we use data on Heart Valve Replacement (Italian Ministry of Health, 2016). We consider the cost borne

by any cell to get access to a surgical treatment entailing a 30-day mortality rate no greater than 1.5 percent (details in Appendix B). Only 19 Italian hospitals respect this quality standard. According to Section 3.1, access is granted to a given cell when the cost of access is not greater than the money threshold referred to as the 'minor pocket'. As the present exercise is only run for illustrative purposes, to compute the minimum of accessible resources we employ the generalized mean (or, Hölder mean) from the distribution of annual provincial disposable incomes at the net value of subsistence.

As explained in Appendix B, the advantage of using the generalized mean is that by varying the relevant parameter, it is possible to inflate the minor pocket as resulting from income and wealth surveys, in such a way as to take into account the additional resources individuals can have access to in case of need. Although this remains an approximate procedure to meet the problems deriving from the lack of adequate data, it might however be usefully employed, for, what is important in our perspective, is the relative (not the absolute) value of the index we propose. Once the parameter value is set,, comparisons across areas or over time are indeed meaningful.

For our purposes, we consider two different values of the parameter, $\rho = 1$ and $\rho = 0$ that give rise to two different scenarios: with and without universal access. Specifically, for $\rho = 1$ the minor pocket is $4,467.01$€, so that universal access is granted and $HG = 1.71$. Instead, as shown in Fig. 1, for $\rho = 0$ the minor pocket is 277.16€, so that universal access is not granted, and $HG = 0.25$.

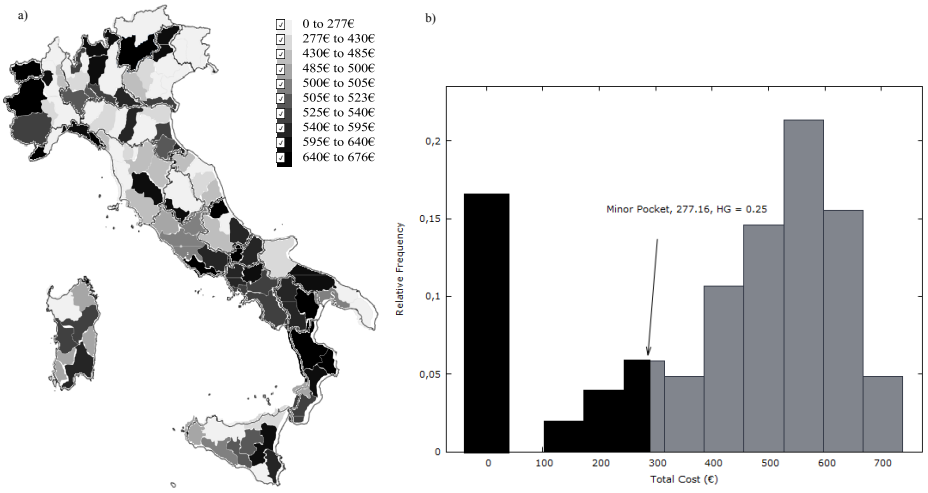

Figure 1: a) Cost of access to Heart Valve Replacement for each of the 103 Italian provinces; b) proportion of provinces having access ($\rho = 0$).

5 Concluding Remarks

A dramatic increase in the cost of provision of health services coupled with the need to cut public deficits are currently downplaying the expectation of adequate health care opportunities in Western countries. This is happening with perhaps greater strength in Europe, where an aspiration to an adequate level of justice in access to care is still present. We believe that in such *hard times* this aspiration requires to re-define the general principles informing the national health policies. The present paper wishes to contribute to this effort by offering a new framework for defining and measuring equality of opportunity in health care.

It is evident that the exercise of measuring equality of opportunity may have different meanings in different contexts, for it is very sensitive to the treatments included in the bundle whose cost is relevant. Access can be assessed at different standards. Treatments that individuals can easily get in Western countries may be very hard to get in some other regions of the world. In Sub-Saharan Africa, for example, very basic treatments are those which are probably suitable to consider key to assess opportunities. Movements in the direction of fostering equality of opportunity cannot but be movements towards guaranteeing access to presumably basic treatments to a greater part of the population. As a consequence, depending on what the bundle

of (e.g. decent minimum of) specified quality contains, our methodology can require to apply the standard methods of income inequality (Lorenz Dominance) or not. We believe that our methodology is sufficiently elastic to adapt to these different circumstances.

Appendix A

Proof. **(Proposition 3.1)**. To prove i), given two different leveling functions $r(\theta)$ and $r'(\theta)$, by Axioms 1 and 2, necessary condition for $C(\theta, r(\theta)) \succeq C'(\theta, r'(\theta))$ is $I_{C(\theta,r(\theta))} \geq I_{C'(\theta,r'(\theta))}$, which requires $r(\theta_i) = (c(\theta_i) - \underline{y}) > 0$ and $r(\theta_j) = 0$ whenever $\underline{y} < c(\theta_i) < c(\theta_j)$. By contradiction, suppose that $r'(\theta_i) = 0$ and $r'(\theta_j) = (c(\theta_j) - \underline{y}) > 0$. Then, to obtain $I_{C'(\theta,r'(\theta))} = I_{C(\theta,r(\theta))}$, additional resources $[c(\theta_j) - c(\theta_i)]$ are necessary. In addition, suppose that $r''(\theta_i) > 0$ and $r''(\theta_j) = 0$ such that $c(\theta_i, r''(\theta_i)) < \underline{y}$, then to obtain $I_{C''(\theta,r''(.))} = I_{C(\theta,r(\theta))}$, additional resources $[\underline{y} - c(\theta_i, r''(\theta_i))]$ are necessary. Sufficient condition for $C(\theta, r(\theta)) \succeq C'(\theta, r'(\theta))$ is that the two previous conditions must hold $\forall\ i, j : \underline{y} < c(\theta_i) < c(\theta_j)$. To prove ii), given the initial cost distribution $C(\theta)$, let $\overline{C}(\theta, r(\theta))$ be the increasingly ordered (policy-induced) cost distribution with $c(\theta_i, r(\theta)) \leq \underline{y}\ \forall\ i$, and $L\{F[c(\theta_i, r(\theta))]\}$ the corresponding Lorenz curve. If $C(\theta, r'(\theta))$ is obtained from $C(\theta, r(\theta))$ so that $r'(\theta_i) = r(\theta_i)\ \forall\ i \neq j$ and $r'(\theta_j) = r(\theta_j) + \Delta_j$ with $\Delta > 0$ and non-reranking, then, by construction of the Lorenz curve, it must be the case that, for all $j \neq 1$ and $j \neq n$, $L\{F[c(\theta_i, r(\theta))]\}$ and $> L'\{F[c(\theta_i, r'(\theta))]\}$ cross to each other. For $j = 1$, $L\{F[c(\theta_i, r(\theta))]\} > L'\{F[c(\theta_i, r'(\theta))]\}\ \forall\ i$, whereas for $j = n$, $L\{F[c(\theta_i, r(\theta))]\} < L'\{F[c(\theta_i, r'(\theta))]\}\ \forall\ i$. Thus, a non-reranking transfer (Δ) generates a Lorenz majorization (i.e., inequality improvement) if and only if the recipient is the worst-off. The proof of iii) follows immediately from proof ii). □

Proof. **(Proposition 4.1)**. Axiom 1 holds as q, n, G, and μ are all invariant with respect to any permutation of the monetary cost vector. To prove that Axiom 2 holds we proceed as follows. For all $q < (n-1)$, HG_1 is lower than one and increasing in q. When $q = (n-1)$, if access is given to the n^{th} cell also, then HG_2 becomes relevant with $H_2 \geq 1$. To prove that HG satisfies Axiom 3, notice that when $q = n$ and $G > 0$, any Lorenz majorization which reduces G up to $G = \varepsilon > 0$ increases index HG_2 with $HG_2 < 2$. □

Appendix B: Details of the empirical exercise

Under the Italian National Health System, Heart Valve Replacement is granted to anyone in need; there are no patient's fees. We only consider then: the cost borne to get to the nearest hospital providing a treatment of the specified quality level; the accommodation costs. Travel costs are computed using the Michelin Guide, once all the distances separating any given province from the nearest hospital *suitable for care* are determined. Accommodation costs - incurred by whoever provides assistance to the patient during the three weeks, on average, he/she is hospitalized - are calculated using information on the accommodation prices required by the B&Bs advertized on the Hospitals' websites, in the area dedicated to inform patients about accommodation opportunities. To compute the minor pocket it is necessary to know the ex-ante distribution of accessible resources: whoever in need, may indeed receive additional resources from other members of the social networks he belongs to (his family, his friends, and so on). Not always this information is available, although suitable estimates can be carried out. Whenever the overall distribution of accessible resources, taking into account *potential* resources accruing in case of need, is unknown, a possible empirical strategy — that we employ here for illustrative purposes — is to inflate the minimum resources as resulting from income and wealth surveys, in such a way as to achieve higher resource levels to be employed as bases for comparisons. This is why we employ here the generalized mean (or, Hölder mean) from the distribution of annual disposable incomes. Data come from the Survey on Household Income and Wealth (SHIW) carried on by the Bank of Italy. Incomes are obtained from the 2015 wave (which refers to the 2014 chronological year) at the net value of subsistence (the absolute poverty line set by the Italian National Institute for Statistics: Istat 2014). As income information for each province is not made available by the Bank of Italy for privacy reasons, we have imputed to each province belonging to the same region, the same endowment. Formally, let y_{ij} be the annual disposable income at the net value of subsistence of the i^{th} individual in province j, with $i = 1 \dots n(j)$. According to Section 3, the minor pocket is to be computed as $\underline{y} = min\{y_j\}$, where $y_j = \left(\sum_{i=1}^{n(j)} y_{ij}^{\rho}\right)^{\frac{1}{\rho}}$, $j = 1, \dots, 103$. The advantage of using the generalized mean is that by varying the parameter ρ, it is possible to inflate the minor pocket as resulting from income and wealth surveys, in such a way as to take into account the additional resources individuals can have access to in case of need. Specifically, the financial endowment of each province, y_j would be: (i) the maximum value in the income distribution at the provincial level, for $\rho \to +\infty$; (ii) the arithmetic mean for $\rho \to 1$; (iii) the geometric mean for $\rho \to 0$; (iv) the harmonic mean for $\rho \to -1$; the minimum value in the j^{th} distribution of resources for $\rho \to -\infty$. The generalized mean — with ad hoc parameter restrictions — is widely used in economics, especially in the field of risk and inequality measurement (Markowitz 1951,

Atkinson 1970). Although this remains an approximate procedure to meet the problems deriving from the lack of adequate data on the distribution of accessible resources, it might however be usefully employed, for, once the parameter value ρ is set, comparisons across areas or over time are indeed meaningful.

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