Measuring Disparities in Access to Health Care.
A Proposal Based on an ex-ante Perspective

Abstract. The dominant perspective on fair access to health care, based on the use-per-need principle, is grounded in the idea that the utilization of health services reflects actual needs for care. However, as utilization also depends on individuals' preferences, the dominant perspective is not well equipped to measure *objective* opportunities of access to health care. In this paper we provide an alternative approach to evaluate access to health care that avoids reference to utilization. This approach focuses on the monetization of access barriers to a bundle of health services of appropriate quality, for any set of relevant characteristics an individual may happen to have and given the distribution of potential financial resources. We apply our methodology to Italian data on heart valve replacement. Our results suggest that in this case unequal access to care is mainly due to the unequal distribution of accessible financial resources. We also show how commonly adopted normatively based inequality indices can be easily amended to cope with the framework we provide.

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

1. Introduction

The most common way to understand egalitarianism in health care agrees with a principle of horizontal equity promoting *equal access to health care for those in equal need of health care* (Culyer and Wagstaff 1993, Wagstaff and van Doorslaer 2000). In practical terms, to assess the extent to which this principle is satisfied, utilization of health treatments is commonly taken as the basic information (e.g., Oliver and Mossialos 2004, Allin et al. 2007, Frenz and Vega 2010). However, as utilization depends *inter alia* on individual attitudes and preferences, it follows that, even if access conditions were equalized across the entire population, equal access to health care for those in equal need would probably not.

To see why this is relevant for policy assessment, let us suppose that some individuals - because of mistaken beliefs or atypical preferences - are reluctant to take advantage of freely available health services, appropriate for a given disease (vaccination is the obvious example). This does not imply that their *objective* possibilities of obtaining the appropriate treatments are scarce; hence, this should not affect one's judgement about the overall organization of health care resources in the society, as well as one's concerns about the distribution of health care opportunities.

In this paper we provide an alternative approach to analyse opportunities of access to health care, that, avoiding reference to utilization, allows to disentangle the chances individuals enjoy from the effective utilization of health services. This approach is grounded in an *ex-ante perspective*, that is, it considers a world in which health needs, socio-economic statuses and preferences are not yet revealed, and computes the barriers that must be overcome for any vector of relevant characteristics an individual might potentially have.

A specific list or vector of characteristics is what, in our terminology, constitutes a *cell*. A cell can be defined in such a way as to represent any individual with specific characteristics in terms of geographical location, age, disability, need for personal assistance, and so on. These characteristics are relevant because they affect the cost of access to health care, hence the size of the barriers an individual with these characteristics has to overcome.

In the ex-ante perspective we propose, the use-per-need principle is thus disregarded in favour of a criterion that focuses on the monetization of access barriers to a bundle of health services of appropriate quality for any possible set of relevant characteristics, i.e. any cell. Access opportunities are then computed by considering that, ex-ante, any individual has an equal chance to fall in each cell, bearing a given access cost, as well as, conditional on being in that cell, a given chance to get a particular level of financial resources, determined by a draw from the *cell-specific* distribution of resources.

For empirical applications, the methodology we propose require information on: 1. the cell-specific cost of access to a bundle of health treatments of appropriate quality, i.e. *the cost of access to appropriate health care* for any realization of relevant characteristics an individual may potentially have; 2. the cell-specific distribution of accessible financial resources (net of subsistence level). Access is then guaranteed only when the cost associated to a given cell is lower than the financial resources the individual occupying that cell may have access to (e.g., income, wealth, loans, private and public transfers).

Notice that by cost of access to care we mean the total amount of *out-of-pocket* payments made by the individuals to get the health treatments they need[1]. Due to out-of-pocket payments, the notion of universal access is different from the one of universal coverage; the former might not be granted to everyone although the latter is (Cylus and Papanicolas 2015). This happens whenever - despite

[1] Traditionally, the economic literature sees access as depending on supply as well as demand factors (e.g. Mooney 1983). Supply factors affecting access to health care relate to the spatial distribution of providers, the production technology as well as other factors influencing the cost and the appropriateness of health services. Demand factors are generally related to the individual capacity of obtaining and processing the necessary information; the burden of disease; the individual's skills and attitudes; the diffusion of self-care practices (Andersen 1995). Levesque et al. (2013) outline five dimensions capturing supply as well as demand-side determinants of access to care: approachability, acceptability, availability and accommodation, affordability and appropriateness.

universal coverage - the cost of access is higher than what an individual can afford. Indeed, the lack of access in the presence of universal health coverage has been widely documented for both European (ExPH 2018) and non-European countries (e.g. Kwon 2003).

In light of the discussion above two issues are worth discussing. The first is related to whether there are cells to which access is certainly ex-ante granted. This can be, but only if for each of such cells the cost of access is below the lower support of the cell-specific distribution of accessible resources. The second issue of interest is related to the distribution of the probability of access across cells, whose characteristics are influenced by both the cell-specific distribution of accessible resources and the cell-specific cost of access to a health treatment of appropriate quality.

As we shall see, our approach allows to quantify the number of cells to which access is ex-ante precluded, the key determinants of denied access (either the cost of access or the distribution of accessible financial resources) and, most importantly, the possibility of a double disadvantage – given the value taken by relevant characteristics – related to both low accessible financial resources and high cost of access to health treatments.

The article is organized as follows. In Section 2, we set up the methodology. In Section 3, we apply our methodology to Italian data by considering disparities in the opportunity of access to a specific health treatment, i.e. heart valve substitution. As emphasized by Fattore et al. (2014), mobility for cardiovascular diseases in Italy is significant; in particular, within major diagnostic category of cardiovascular diseases, health valve replacement accounts for about 20% of all admissions of non-resident patients. As receiving care in locations that are distant from home requires adequate resources, relevant equity issues are clearly involved. Our results suggest that the probability of access is unequally distributed across Italian provinces, and, not surprisingly, such a disparity is found to be mostly, if not entirely, driven by the unequal distribution of accessible financial resources. Most importantly, we have observed that for a bunch of provinces, mostly placed in the South of Italy, a double disadvantage materializes, due to the simultaneous presence of higher cost of access and lower amount of accessible financial resources. In Section 4, an extension of our methodological proposal is discussed, by which comparisons across different societies can be implemented through the application of a general class of indexes embedding the social preferences of the policy-maker. Section 5 concludes.

2. Methodology

As clarified in the Introduction, our notion of equality of access to health care refers to *potential*, not *effective* access; for effective access (i.e. utilization of health services) also depends on individuals' attitudes and preferences.

To operationalize our notion, three ingredients are necessary: 1. a list of individual characteristics potentially affecting the cost of access; 2. a bundle of health treatments of appropriate quality; 3. the cell-specific distributions of financial resources that can be employed to get the treatment(s) under consideration. With these ingredients it is possible to compute the access cost and the probability of access for any possible realization of characteristics, i.e. the cost the individual occupying a given cell will incur in to gain access to an appropriate treatment, once a need for that treatment emerges.

We restrict the analysis to the supply of health treatments of appropriate quality. The focus on appropriate health treatments allows to assess the chance of access of any individual *given* the quality standard that is considered suitable; the reference is therefore not to a generic health treatment of any quality. Setting the quality standard allows, among other things, to get rid of disparities between health care providers related for example to limited availability of medical staff or other resources.

Once costs are computed for any possible combination of individuals' relevant characteristics, it is possible to verify whether access to a health treatment of appropriate quality is granted to a given cell for any amount of financial resources it may happen to be endowed with, or, rather, what is the ex-ante chance that a given cell will gain access. Moreover, disparities in access conditions reflecting differences among cells can be easily detected.

In formal terms, let $\Theta = \times\ \Theta_{k=1}^{m}$ be the space of characteristics (e.g., place of residence, age, handicaps and so on) affecting the direct cost of access to health care, that is, the cost borne by an individual in the i^{th} cell to get access to a (bundle of) health treatment(s) of appropriate quality, B, which may be intended as either a bundle of health services, or as a single health treatment. We neglect indirect costs of access (e.g., work loss, worker replacement, and reduced productivity from illness and disease) since these costs would depend upon personal characteristics, whose knowledge is not available in the ex-ante perspective we opt for. A vector $\theta_i \in \Theta$ is a point in the Θ-space fully characterizing the i^{th} cell, $i \in I = \{1, \dots, n\}$. Let $\theta = \{\theta_1 \times \dots \times \theta_n\}$ be the set of such cells. We write $C(\theta) = \{c(\theta_1) \times \dots \times c(\theta_n)\}$ to denote the cost distribution, *i.e.* the cost that the individual occupying the i^{th} cell has to bear in order to obtain the health treatment(s) of appropriate quality. We indicate by Y, with density $f_i(Y)$ and supports $[\underline{y}_i,\ \bar{y}_i]$ the distribution of cell-specific accessible financial resources (e.g., income, wealth, loans, public and private transfers); these are the resources potentially employable by the individual in the i^{th} cell to obtain B.

In an ex-ante perspective, the endowment of resources that will be enjoyed by an individual occupying a given cell is not known; what is known, instead, is the cell-specific distribution of employable resources with which the individual occupying that cell confronts. Access is surely granted to the i^{th} cell if the i^{th} cost of access is not greater than the lower support of the cell-specific distribution of accessible financial resources, i.e. if $c(\theta_i) < \underline{y}_i$.

Our methodology makes it easy to compute both the *effective* probability that an individual in cell θ_i gets access to care, ρ_i,

$$\rho_i = 1 - [prob_i(Y < c(\theta_i)] = 1 - \int_{\underline{y}_i}^{c(\theta_i)} f_i(Y)dY \tag{1}$$

and the *virtual* probabilities of access an individual in cell θ_i would have if either the distribution of accessible financial resources were not cell-specific, or the cost of access were equal for all cells. Formally, let $f(Y)$ be the distribution of accessible financial resources whose supports are $[\underline{y}, \bar{y}]$, and $c(\theta) = n^{-1} \sum_{i=1}^{n} c(\theta_i)$ the average cost of access in the whole population, we define:

$$\rho_i^f = 1 - [prob(Y < c(\theta_i)] = 1 - \int_{\underline{y}}^{c(\theta_i)} f(Y)dY \tag{2}$$

$$\rho_i^c = 1 - [prob_i(Y < c(\theta)] = 1 - \int_{\underline{y}_i}^{c(\theta)} f_i(Y)dY \tag{3}$$

where: ρ_i^f is the virtual probability of access for the i^{th} cell, would the distribution of accessible financial resources be the one of the whole population for all cells; and ρ_i^c is the virtual probability of access for the i^{th} cell, would its cost of access be equal to the average cost of access.

By considering the effective probability of access, ρ_i, and the two virtual probabilities of access, ρ_i^f and ρ_i^c, four different policy-relevant scenarios can be disentangled.

- If $\rho_i \geq \rho_i^f, \rho_i^c$, then the i^{th} cell over-performs in terms of access with respect to the entire population.
- If $\rho_i^f < \rho_i < \rho_i^c$, then the i^{th} cell over-performs in terms of accessible financial resources, but under-performs with respect to cell-specific cost of access, meaning that, the organization of the health system is inadequate and jeopardizing access to health treatments for individuals belonging to this cell.
- If $\rho_i^c < \rho_i < \rho_i^f$, then the i^{th} cell over-performs in terms of cell-specific cost of access, while under-performing with respect to accessible financial resources, meaning that the distribution

of accessible financial resources in this cell is disadvantageous and limiting access to health care.

- If $\rho_i \leq \rho_i^f, \rho_i^c$, then the i^{th} cell under-performs in terms of both accessible financial resources and cost of access; access to the health treatment is limited for individuals in this cell due to both inadequate organization of the health system and disadvantageous distribution of accessible financial resources.

3. An application to Heart Valve Replacement

In the remainder of the paper we illustrate how our methodology can be applied by considering the case of Heart Valve Replacement in Italy. As emphasized by Fattore et al. (2014), mobility for cardiovascular diseases in Italy is significant; in particular, within major diagnostic category of cardiovascular diseases, health valve replacement accounts for about 20% of all admissions of non-resident patients. As receiving care in locations that are distant from home requires adequate resources, relevant equity issues are clearly involved.

Under the Italian NHS, patients can get the treatment anywhere in Italy, but the quality is of course not homogeneous. Data provided by the Italian NHS – Programma Nazionale Esiti (2016) – allow to rank hospitals and clinics providing the treatment, on the basis of the quality of the treatment provided

We consider the cost borne by different cells to get access to a surgical treatment of appropriate quality, where appropriateness is here defined as a *30-day mortality rate no greater than 1.5 percent*. Only 19 Italian hospitals respect this quality standard according to the Italian Ministry of Health.

3.1. Computing costs

To the extent that access depends on the total cost of a given treatment of appropriate quality, it is necessary to clarify that we define the monetary cost of access as the sum of all the direct costs (user-fee, specific contribution for health-care financing, transportation costs, private accommodation, …) that an individual has to bear in order to obtain the treatment. This definition carries with it the big advantage of neglecting some aspects linked to nonmonetary costs. Moreover, as far as the sole hospitals supplying a health treatment of appropriate quality are considered, the impact of waiting time on the cost of access is clearly considered.

Thus, we only focus on direct costs, usually represented by (a) co-payment fees, (b) travel costs, (c) accommodation costs, (d) personal assistance needs, (e) informal payments.

For illustrative 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. In the particular case of Hearth Valve Replacement such assumption is appropriate, for access costs are very much related with transportation and accommodation costs (although these costs can vary according to some other relevant characteristics not considered here - such as, for example, the presence of disabilities). In other applications things go differently. For example, the acute management of stroke does not imply appreciable costs for the patient, who receives free emergency cares. However, rehabilitation, which is essential for recovery after stroke, implies that costs other than those related to mobility must be borne by the individuals, whose size - estimated in Italy in about 6370 euro on average - varies with, among other things, the severity of disabilities caused by the stroke itself (Alice 2011).

Under the Italian National Health System, Heart Valve Replacement is granted to anyone in need; there are no patient's fees. We can only consider then: the cost borne to get to the nearest hospital providing the appropriate treatment; the accommodation costs borne by the person usually providing personal assistance in case of patient mobility. In a finer empirical analysis one might want to distinguish whether the person providing personal assistance is a specially trained person or not, for additional assistance costs might be involved.

Travel costs are computed using the Michelin Guide, once the distance separating any given province from the nearest hospital able to provide the appropriate treatment is determined. Accommodation costs - incurred by whoever provides assistance to the patient during the three weeks (on average) she is hospitalized - are calculated by using information on the accommodation prices required by the B&Bs advertised on the websites of the 19 Italian hospitals providing appropriate treatments, in the area dedicated to informing patients about accommodation opportunities.

To compute the cost associated to any given province, we consider the following:

$$\Gamma_{ijv} = f\left(PA_{jv}, TC_{jv}, AC_v, D_j, F_v\right)$$

where Γ_{ijv}, the total cost borne by any individual *i*, resident in province *j*, to get heart valve replacement in province *v*, is a function of

- PA_{jv}, personal assistance costs borne by *i*, related with the payment made by *i* to whoever possibly provides her personal assistance;
- TC_{jv}, travel costs from province *j* to province *v*, borne by *i* himself and/or by whoever provides personal assistance to her;

- AC_v, accommodation costs in province *v*, borne by i himself and/or by whoever provides personal assistance to her;
- D_j, other direct costs borne by i (e.g. drugs);
- F_v, patients' fees in province *v*.

Some of these costs are not relevant in the case at hand. There are no fees to be paid nor other costs directly related to heart valve replacement. In general, however, things may be different. Despite the universal coverage of specific health risks, co-payments can be asked to patients receiving particular health care services. Clearly, such co-payments, as well as other direct costs, have to be considered in estimating the cost of access, hence in assessing the ex-ante probability of access an individual with specific characteristics enjoy.

3.2. Computing ex-ante accessible resources

To compute disparities in access opportunities, besides cell-specific costs it is also necessary to consider the ex-ante distribution of accessible financial resources. The distribution of accessible resources may be remarkably different from the simple distribution of income. Whoever in need may indeed use its wealth (past savings) or receive additional resources from other members of the social networks she belongs to (her family, her friends, and so on).

To estimate accessible resources, we use data provided by the Bank of Italy: Survey on Household Income and Wealth (2015). The survey gathers data on the incomes and savings of Italian households. It includes wealth and other aspects of households' economic and financial behaviour, including, for instance, the payment methods employed. The sample comprises about 8,000 households (20,000 individuals), distributed over about 300 Italian municipalities.

For any of the household in the survey we have drawn information about net disposable income and consumption. Then, by using the equivalence scales provided by the Italian Statistical Office (ISTAT), we have computed equivalent consumption on an individual basis. Comparing this with the poverty threshold (ISTAT, 2018) – determining equivalent absolute poverty in consumption – we have estimated, for each individual, the amount of resources, beyond the subsistence level, that can be possibly used to tackle unforeseen risky events related to the health status.

Grounding in the hypothesis that in the case an adverse event occurs all the family savings can be used to help the member in need, we have added to the difference between one's equivalent consumption and the poverty threshold, the whole family savings and other financial assets. We have excluded nonfinancial illiquid assets, such as, for example, the house where one lives. Notice furthermore that as we are presently not considering rehabilitation but just treatments promptly planned in case of need, illiquid assets are not considered; in cases like this they would be of no help to the individuals, for the obvious difficulties to readily convert them into cash.

Although we have implicitly made the assumption of intra-household transfers – for the overall savings, by hypothesis, can be used by the needy individual – we have neglected – for the lack of reliable data – other transfers that individuals can enjoy as members of other social networks.

The accessible resources of individual i in province j, can be written as

$$Y_{ij} = \left(C_{ij}^{E} - P_{ij}^{E}\right) + S_{hj} + FA_{hj}$$

where Y_{ij} denotes the accessible resources available to individual i in province j. Such resources are given by the difference between equivalent consumption C_{ij}^{E} and the equivalent poverty line P_{ij}^{E}, where *equivalent* means that use is made of the equivalence scales provided by ISTAT to take into account the composition of the household. That is $C_{ij}^{E} = \frac{C_{hj}}{K_{hj}}$, $h = 1, \dots, H$,where C_{hj} is the overall consumption of household h, to which individual i belongs, in province j, and K_{hj} is the equivalence scale associated to household h. C_{ij}^{E} is therefore the per-capita consumption within the household taking into consideration economies of scale in consumption. P_{ij}^{E} is calculated in the same way, $P_{ij}^{E} = \frac{P_{hj}}{K_{hj}}$. The difference $C_{ij}^{E} - P_{ij}^{E}$ gives the resources that an individual can rely upon in case of need together with the overall savings of family h, S_{hj}, and other financial (immediately available) assets, FA_{hj}.

Notice that the survey on Household Income and Wealth provides information concerning only the region where a given household lives. As our purpose is to carry on the analysis at the provincial level, we have employed an incremental *nearest-neighbourhood* strategy to place individuals in the *right* province.

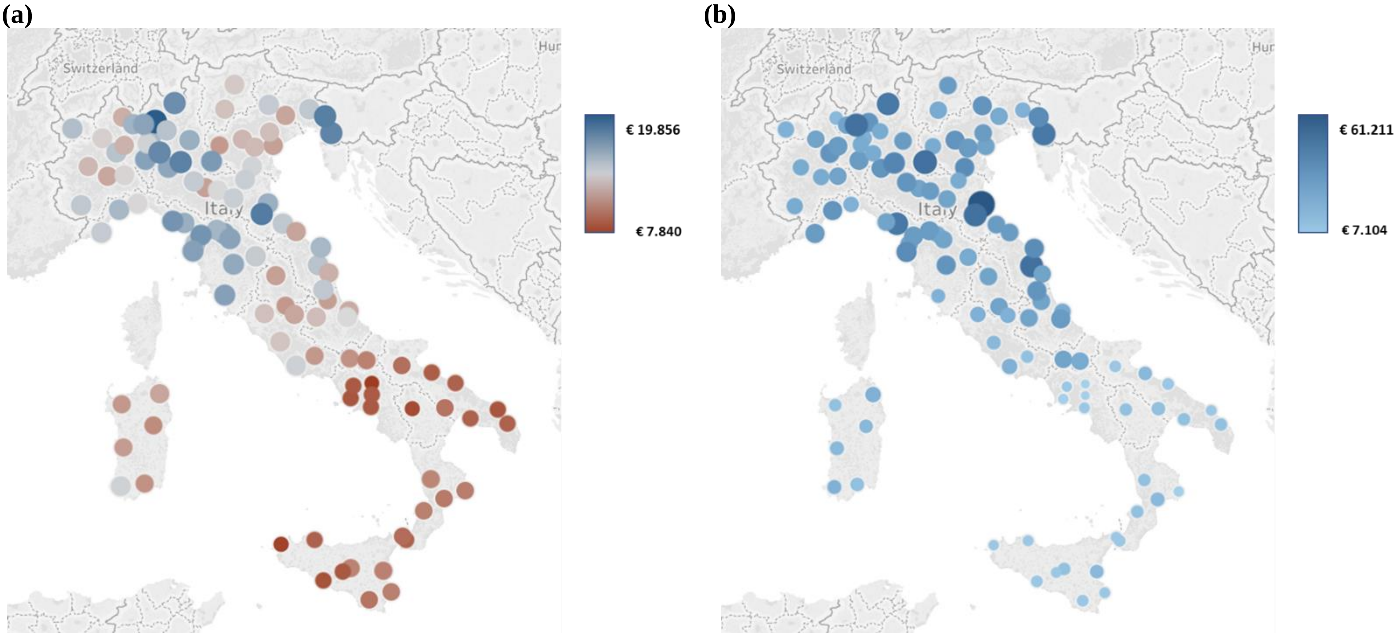
To this end we have first computed the average income in each of the Italian provinces, then we have considered each region in turn. For any given region, we have performed a fuzzy clustering analysis providing, as a probability vector, the likelihood that a given household belongs to a certain province. Individuals are so randomly associated to provinces. The analysis has been designed in such a way as to respect the two following conditions: 1. the proportion of sampled individuals assigned to a given province respects the real proportion of the province population over the regional one; 2. the expected income in the pool of individuals associated to a given province must be consistent with the real mean income of the province.

Figure 1 below shows the per-province distribution of the median equivalent consumption, C_{ij}^{E}, and of the equivalent accessible resources, Y_{ij}. The figure depicts some marked asymmetries among areas.

In particular, it confirms the well-known North-South gradient in the distribution of resources, hence in the distribution of equivalent consumption.

Figure 1. Geographical distribution of the median equivalent consumption per province (a); Geographical distribution of the median equivalent accessible resources per province (b).

(a) **(b)**



The picture does not change that much if one considers the geographical distribution of the 5th percentile per province relative to the equivalent accessible resources.

Figure 2. Geographical distribution of the 5th percentile equivalent accessible resources per province

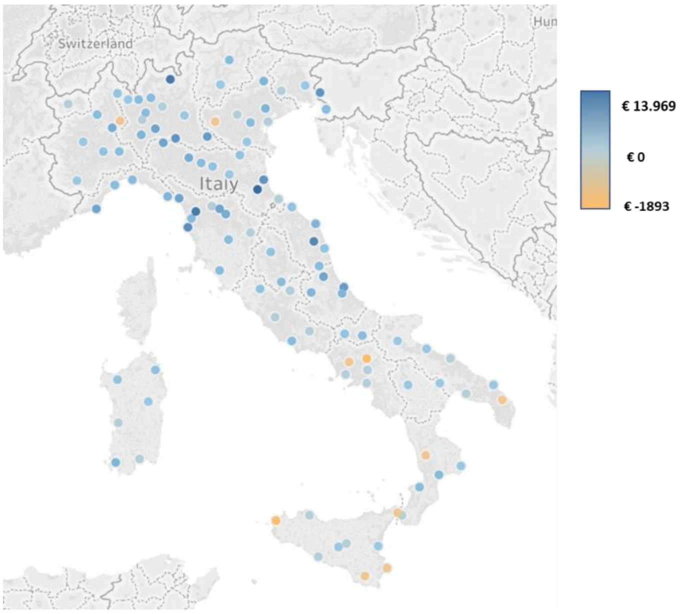
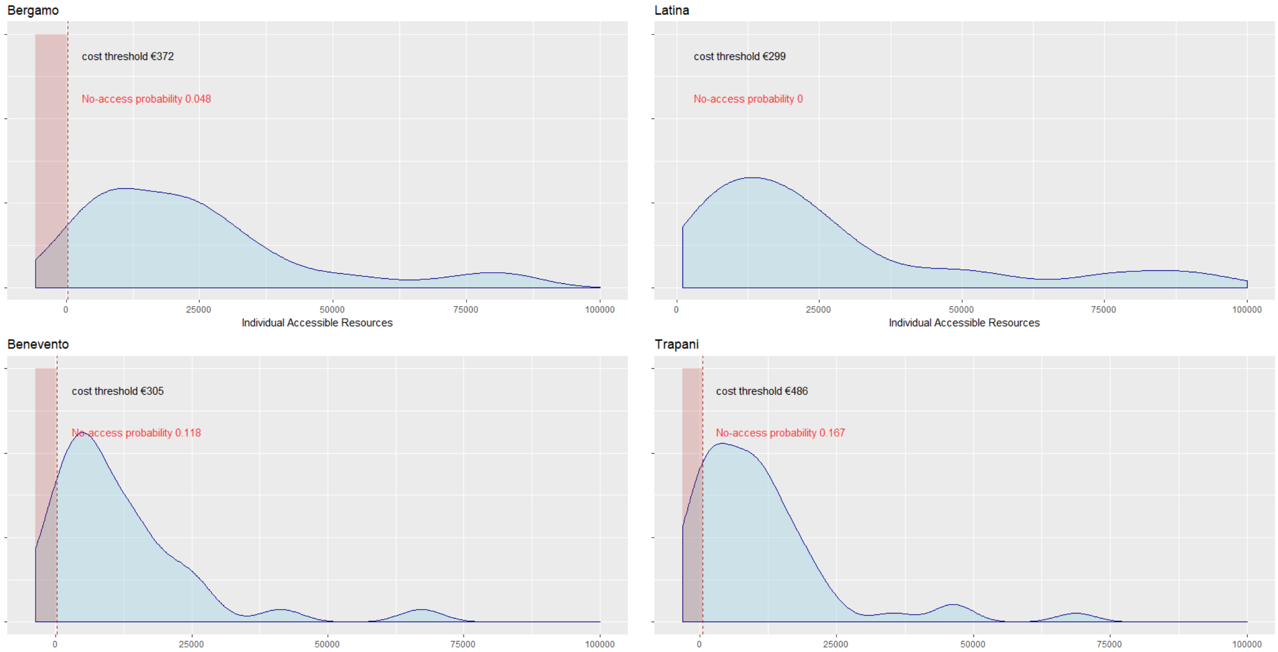


Figure 2 highlights that for a small, but non-negligible, fraction of the population, the endowment in terms of accessible resources goes negative, meaning that, for some of the individuals belonging to these cells access to any health treatment is granted if, and only if, this is supplied at zero cost.

3.3. Computing effective and virtual probabilities of access

Once computed the per-province distribution of accessible financial resources, it is possible to confront it with the per-province cost of access, in such a way as to compute the effective ex-ante probability of access to health care according to equation (1). Figure 3 below shows both the distribution of accessible resources and the cost of access for a selected group of provinces.

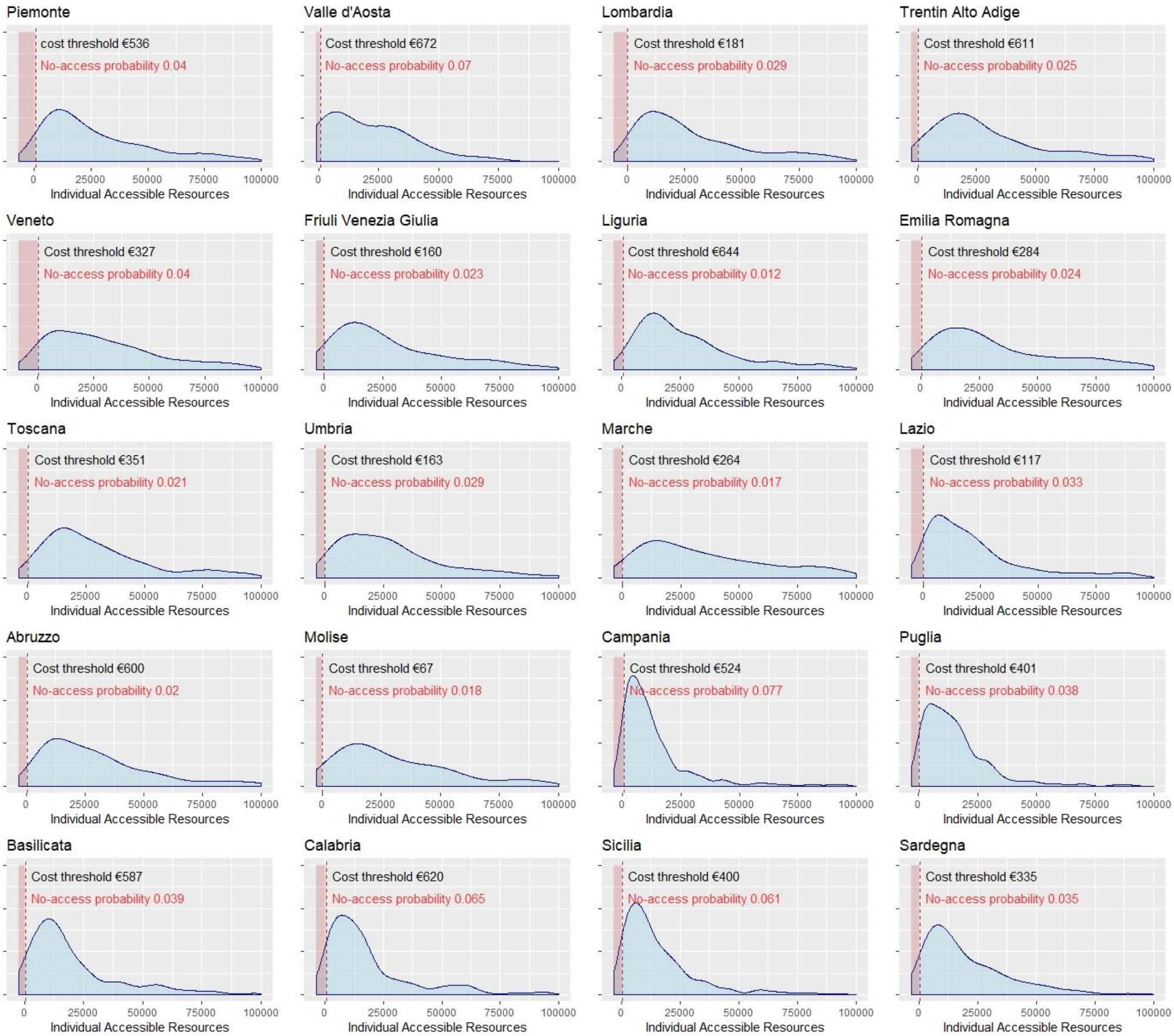
Figure 3. Distribution of accessible resources, cost of access and ex-ante probability of access to health care.



Among these, Trapani, in the extreme South of Italy, is the cell with the lowest ex-ante effective probability of access, whereas Latina is the cell with the highest one: given the distribution of accessible resources and the cost of access, the ex-ante probability of access for an individual occupying this cell, is equal to one.

Data at the provincial level can be easily aggregated at the regional level in such a way as to compute the ex-ante probability of access (see Fig. 4).

Figure 4. Distribution of accessible resources, cost of access and ex-ante probability of access to health care (Italian regions).



In this case, the cell would coincide with the region and the distribution of accessible resources as well as the cost of access would be computed at the regional level (the regional cost of access would be obtained by averaging per-province costs). Excluding Valle d’Aosta, a region in the extreme North-West of Italy, the regions with the highest no-access probabilities are all located in the South: Campania, Calabria, Sicilia (Fig. 4).

Figure 5. No access probability per region.

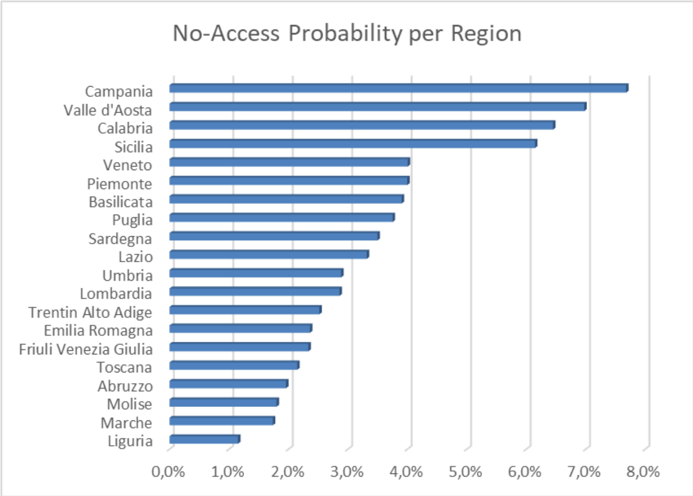


Figure 6(a) takes the effective probability of access and plots its difference to the virtual probability of access when accessible resources are homogeneous across cells, $\Delta^f = \left(\rho_i - \rho_i^f\right)$, against the same difference calculated with respect to the virtual probability of access when costs are the same, $\Delta^c = (\rho_i - \rho_i^c)$. To better highlight the gap of performances in different geographic areas, we also plot the two differences above when cells are defined at the regional level by averaging per-province performances (Fig. 6(b)). As one can see, cells in the North-East quadrant are those over-performing in terms of both costs and accessible financial resources. Basically this means that for these cells, costs are lower than average and the distribution of accessible resources is more favourable than the one resulting from pooling together all the cells, that is, by considering the whole distribution of accessible financial resources.

Cells under-performing in terms of accessible resources but over-performing in terms of access cost are in the North-West quadrant; cells under-performing in terms of access cost but over-performing in terms of accessible resources are in the South East quadrant; finally, cells in the South-West quadrant under-perform in terms of both access cost and accessible resources.

Three major findings emerge from Fig. 6(a) and Fig. 6(b).

First, inequalities in the distribution of accessible resources, on average, matter more than inequalities in the cost of access; indeed, when effective costs are replaced by the average cost of access, except that for a bunch of provinces, there are no relevant differences in access; instead, substantial differences emerge as far as the overall distribution of accessible resources is considered instead of cell-specific distributions (Fig. 6(a)). This is not surprising; as far as the design of public expenditure programs is sensibly driven by equity judgments, disparities in the cost of access to a health treatment supplied by the public sector are expected to be sensibly lower than inequalities in the distribution of accessible financial resources. On the other side of the coin, it is surprising that for some cells (e.g. Cosenza) the excessive cost of access sensibly reduces the probability of access, whereas for some other cells (e.g. Lecce) the relatively low cost of access allows to get much better access performances than in the rest of the population.

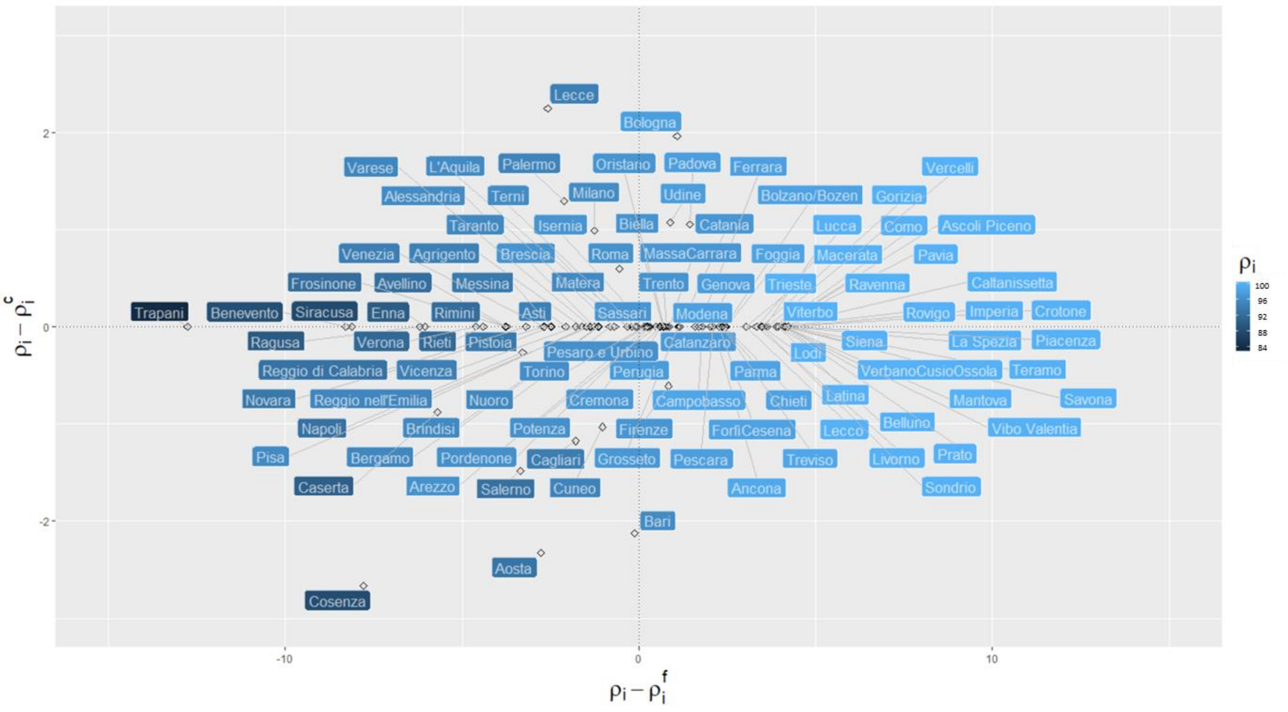
Second, both Fig. 6(a) and 6(b) clearly show a positive correlation, respectively, *0.18* and *0.35*. Hence, cells under-performing because of higher cost of access are also expected to under-perform as a result of less favourable distribution of accessible resources. Once again, this is not surprising, in that richest geographic areas are reasonably expected to collect more tax revenues, and, in turn, to supply better public services (Aria et al. 2018). However, on the other side of the coin, this result is definitely threatening because it highlights the existence of a double-disadvantage for individuals associated to poorest cells.

Finally, while confirming previous evidences (Fig. 5) on the existence of four regions with considerably negative performances (Calabria, Campania, Sicilia, Valle d'Aosta), figure 6(b) allows to distinguish the case of Sicilia with respect to the other three Italian regions, in that the low probability of access in Sicilia is exclusively originating from a less favourable distribution of accessible resources (the cost of access being lower on average than in other cells).

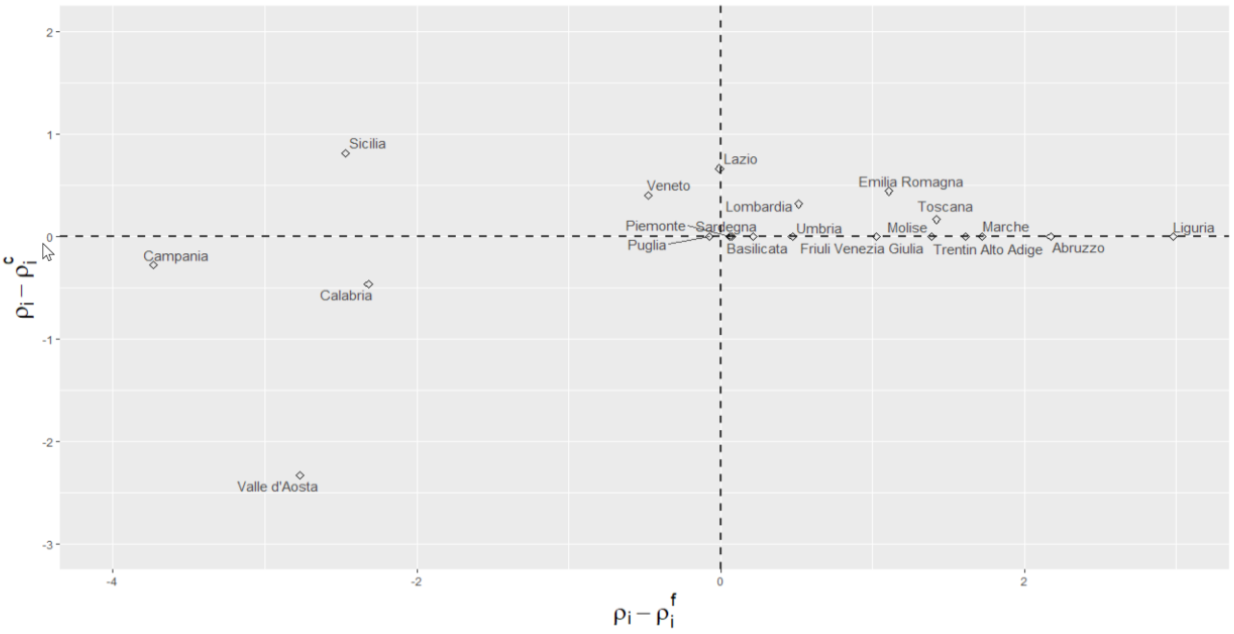
All of these findings have important implications for the design of health policies. If the problem of getting access is mainly related to the fact that its cost is unevenly distributed across cells, then improving the distribution of services and other policies in such a way as to reduce financial barriers to access may be more effective in increasing the ex-ante probability of access. If the problem is mainly related to a particularly unfavourable ex-ante distribution of accessible resources for some cells, then what a policy whose aim is increasing accessibility should aim at, is improving the distribution of resources for these cells, also by targeting transfers to them.

Fig. 6. Cost and resource related virtual probability of access and effective cell/province performance (a); cost and resource related virtual probability of access and effective cell/region performance (b).

(a)



(b)



4. Extension: comparative studies

The analysis conducted so far allows to determine the probability a given cell has to access a health treatment of appropriate quality. In particular, it allows to quantify the number of cells to which access is ex-ante precluded, the key determinants of denied access (either the cost of access or the distribution of accessible financial resources) and, most importantly, the possibility of a double disadvantage – given the value taken by relevant characteristics – related to both low accessible financial resources and high cost of access to health treatments.

The framework developed through the analysis does also allow, however, to make comparisons in terms of equality of opportunity in health care among different societies; that is, over time or across areas. In this Section, we indeed show how the methodology can be suitably extended for these purposes, although an application is beyond the scope of this paper and left to future research[2].

In our framework, what is salient for the comparison of different societies is the distribution of the probability of access across cells, that is $\mathrm{P} = (\rho_1, \dots \rho_n)$, with $\mathrm{P} \in \Re_+^n$.

Provided that *perfect equality in the opportunity of access* would be obtained whenever universal access were granted, i.e. $\mathrm{P}^* = (1, \dots, 1)$, any departure from P^* reduces equality of opportunity; indeed, as the entries of any P vector are probabilities (not income or other resources), any departure from P^* implies that someone has (ex-ante) access, someone else has not. This applies also to any equally distributed vector of probabilities different from P^* (we leave aside the degenerate case in which any entry equals zero).

All this naturally leads to the adoption of two partial-ordering criteria to make comparisons in terms of equality of opportunity in health care among different societies, over time or across areas.

First, if $\mathrm{P}^A = (\rho_1^A, \dots \rho_n^A)$ is obtained from $\mathrm{P}^B = (\rho_1^B, \dots \rho_n^B)$ in such a way that $\rho_i^A = \rho_i^B + \Delta$ with $\Delta > 0$ and $\rho_j^A = \rho_j^B, \forall j \in I, j \neq i$, then society A is better off than society in B.

Second, consider $\rho_i^B, \rho_j^B \in \mathrm{P}^B$ and suppose that $\rho_i^B < \rho_j^B$. A different distribution of the probabilities of access, P^A, such that $\rho_h^A = \rho_h^B$, $\forall h \neq (i, j)$, must be preferred under aversion to unequal probabilities of access, whenever $\rho_i^A = \rho_i^B + \Delta$ and $\rho_j^A = \rho_j^B - \Delta$, with $\Delta > 0$, provided that the ranking between i and j is not reversed, i.e. $\rho_i^A < \rho_j^A$.

The first criterion simply states that if the probability of access increases for at least one cell, the distance from perfect equality of opportunity P^*shrinks. The second criterion states instead that the variance of the distribution of the probability of access matters, depending on the society's aversion to unequal probability distributions of access to health care.

[2] Consider that *equal access to health care* is obtained if any cell gets access on equal terms. A possible specification of this principle would require that: (i) the cell-specific minimum amount of available resources is greater than the cost of access for any cell; (ii) the cost of access to health care is the same for any cell. Other specifications of the principle of *equal access to health care* are certainly possible and related to the normative principles one adopts (Sen 2002).

As one can see, the methodology we propose in this paper, can be easily extended in such a way as to meet standard normative requirements in the theory of inequality measurement (Lambert 1993). Accordingly, several indicators might be proposed for comparative analyses in such a way as to ensure ordering consistency with the two normative criteria stated above. In particular, it is possible to argue that the Hölder (or generalized) mean – with respect to the distribution of the probabilities of access – is a particularly convenient indicator for the measurement of equality of opportunity in health care.

Formally, let $\mathrm{P} = (\rho_1, \dots \rho_n)$ be the distribution of the probability of access across *n* cells, the Hölder mean is $\bar{\rho} = \left(\frac{1}{n}\sum_{i=1}^{n} \rho_i^{\varepsilon}\right)^{1/\varepsilon}$.

Notably, by definition of Hölder mean, whose major applications in economics trace back to Markowitz (1951) and Atkinson (1970), $\bar{\rho}$ is the upper support of the distribution for $\varepsilon \to +\infty$, the arithmetic mean for $\varepsilon = 1$, the geometric mean for $\varepsilon = 0$, and the harmonic mean for $\varepsilon = -1$; the lower support for $\varepsilon \to -\infty$. Most importantly, ε indicates the degree of aversion to inequality in the distribution of the probabilities of access: $\varepsilon < 1$ indicates aversion to inequality; $\varepsilon = 1$ indifference to inequality; $\varepsilon > 1$ preference for inequality.

As far as preferences for inequality is fairly excluded, the parameter ε is restricted to the interval $(-\infty, 1]$, so that, as compared to the notion of Hölder mean, $\bar{\rho}$ can be better identified as the 'certainty equivalent probability of access' associated to distribution $\mathrm{P} = (\rho_1, \dots \rho_n)$. Intuitively, given the distribution $\mathrm{P} = (\rho_1, \dots \rho_n)$, the certainty equivalent probability of access is a specific probability value, $\bar{\rho}$, that, if equally distributed across all cells in the population, i.e. $\bar{\mathrm{P}} = (\bar{\rho}, \dots \bar{\rho})$, would make the policy-maker indifferent between P and $\bar{\mathrm{P}}$ in terms of equality of opportunity in health care.

Two major advantages characterize the use of the certainty equivalent probability of access to compare different societies in terms of equality of opportunity in health care.

First, as far as distributive value judgments on the disparities of access probabilities (across cells) are immediately relevant for comparative purposes, this indicator is sufficiently general to accommodate different social preferences, i.e. different degrees of aversion to inequality in the distribution of the probability of access. Hence, comparative studies might be enriched trough sensitivity analyses aimed at evaluating the robustness of social orderings with respect to differing social preferences.

Second, the certainty equivalent probability of access satisfies desirable properties for the comparison of different societies in terms of equality of opportunity in health care. Specifically: *i*) $\bar{\rho} \in [0,1]$; *ii*) $\bar{\rho} = 0$ if either $\rho_i = 0\ \forall i$, or $\exists i \in I : \rho_i = 0$ and $\varepsilon \to -\infty$; *iii*) $\bar{\rho} = 1$ if, and only if, $\rho_i = 1\ \forall i$;

iv) by concavity of the aggregation function for $\varepsilon \leq 1$, $\bar{\rho}$ is non-decreasing with respect to non-reranking transfers of access probabilities across cells (Pigou-Dalton transfers); *v*) the certainty equivalent probability of access, $\bar{\rho}$, is both population and scale invariant: respectively, any k-fold replication of the population with $k > 0$ leaves $\bar{\rho}$ unchanged, moreover, multiplication of both the costs of access and the accessible financial resources by the same constant $\lambda > 0$ – e.g. changing the currency of analysis – does not alter the indicator $\bar{\rho}$.[3]

Following the analysis carried out in the previous Section, the comparison among different societies in terms of certainty equivalent probability of access might be enriched by considering the *virtual* values of the certainty equivalent probabilities of access a country would have achieved if either the cost of access or the distribution of accessible financial resources had been the same for all cells.

Let $\bar{\rho}^c = \left(\frac{1}{n}\sum_{i=1}^{n}(\rho_i^c)^\varepsilon\right)^{1/\varepsilon}$ and $\bar{\rho}^f = \left(\frac{1}{n}\sum_{i=1}^{n}\left(\rho_i^f\right)^\varepsilon\right)^{1/\varepsilon}$ be these two *virtual* certainty equivalent probabilities of access respectively. The difference $\bar{\Delta}^c = (\bar{\rho} - \bar{\rho}^c)$ is the gain/loss which would emerge were the cost of access the same for all the cells in the population; the difference $\bar{\Delta}^f = (\bar{\rho} - \bar{\rho}^f)$ is the gain/loss emerging if accessible financial resources were equally distributed across cells. From previous discussion, by comparing these two gaps in different countries, one may identify the main sources of the better/worse performance of one country as compared to another.

5. Concluding remarks

Equity in health care is usually defined in terms of horizontal equity according to the principle by which equal health care should be granted to individuals with equal health needs. Accordingly, the principle of equal use-per-need has been empirically implemented through the application of standard inequality metrics (e.g. concentration curves) to existing data on effective, not potential, use of health treatments. To the extent that individual preferences, health needs and endowments are observed, and data on effective health care utilization are considered, existing studies have been mostly investigating equality of opportunity in health care from an ex-post perspective. As a major drawback, needs without use is not something that is taken care of in evaluating opportunities, for lack of utilization is misinterpreted as lack of need: individuals who need health care without having access

[3] Note that the certainty equivalent probability of access, $\bar{\rho}$, does not satisfy the property of decomposability, unless a third component – measuring the interdependence among between-group and within-group inequality – is admitted (e.g. Abatemarco 2010).

to the appropriate treatments would be surprisingly excluded when assessing equality of opportunity in health care.

In this paper, a different approach from the one based on the use-per-need criterion has been proposed; the major emphasis is posed on the probability of access to a health treatment (of appropriate quality), independently from whether use comes about or not.

A given probability of access can be computed for any individual; it depends on both the monetization of access barriers the individual would face in case of health need - given all the relevant characteristics affecting the cost of access (place of living, age, assistance needs, etc.) - and the available financial resources.

As compared to the existing literature, we suggest to use the disparity among those who can get access to health treatments of appropriate quality, and those who cannot, as the crucial information to assess opportunities in health care. In our view, such a disparity is a priority with respect to the inequality in utilization/access to heath treatments, since society should be primarily concerned with granting as much access as possible; the aim of equalizing access conditions among those who already have access comes next. This is consistent with the view that the design of health system should "close gaps in access and incrementally to approach equality of access" (Daniels 2013).

Provided that the evaluation of equality of opportunity in health care is centred on the probability of access to a (bundle of) health treatment(s) of appropriate quality, it has been highlighted that restrictions to access might be originated by high access costs as well as low accessible financial resources, or even both of them. In order to account for the different origins of access restrictions, two virtual distributions of the probability of access – under the hypotheses of, respectively, equal cost of access and equal accessible financial resources – have been defined, whose gap with respect to the effective distribution of the probability of access is shown to reveal relevant policy insights for intervention.

The proposed methodology has been applied to the case of heart valve replacement in Italy. For our purposes, cells have been identified by provinces and the appropriateness of the health treatment has been obtained from the national report 'Programma Nazionale Esiti' of the Italian Ministry of Health. Our results suggest that the probability of access is unequally distributed across Italian provinces, and, not surprisingly, such a disparity is found to be mostly, if not entirely, driven by the unequal distribution of accessible financial resources. Most importantly, we have observed that for a bunch of provinces, mostly placed in the South of Italy, a double disadvantage materializes, due to the simultaneous presence of higher cost of access and lower amount of accessible financial resources.

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