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Measuring Access and Inequality of Access to Health Care: a Policy-Oriented Decomposition

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Measuring Access and Inequality of Access to Health Care: a Policy-Oriented Decomposition

Antonio Abatemarco[*], Massimo Aria[†], Sergio Beraldo[‡], and Michela Collaro[§]

Abstract
We propose an approach for the measurement of health care inequalities inspired by the ideal of *equal universal access*. The approach assesses the chances of access to health treatments of appropriate quality, for any given realization of socially relevant characteristics an individual may have. It allows to assess supply-side (cost-specific) and demand-side (resource-specific) determinants of health care inequality. An empirical exercise using Italian data shows that the methodology can be employed to improve the design of policies addressing health care inequalities.

Keywords: health care, equality of opportunity, factor-decomposition, health policy.

JEL classification: I14, I18, D63.

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1 Introduction

Universal health coverage presupposes access to a wide variety of quality health services (Evans et al. 2013). In developing as well as developed countries, striking access limitations to health care however persist (Karanikolos 2013, Cylus and Papanicolas 2015), raising concerns for the key disparity between individuals having access and individuals having not.

In this paper we propose a novel strategy to assess disparities in access to healthcare. Such strategy, based on the ideal of *equal potential access* (e.g. Aday et al. 1980, Mooney 1983, Khan 1992), is suitable to disentangle the contribution of supply-side factors from that of demand-side factors to overall inequality.

Despite some similarities with popular conceptions of equity in health/ health care — i.e., those based on the principle of 'equal health care for those in equal health need' (Wagstaff and van Doorslaer 2000) and those inspired by the ideal of 'equal health care for those equally responsible' (Fleurbaey and Schokkaert 2009) — our proposal is, overall, quite off-path. Following the Rawlsian tradition of *fair equality of opportunity* (Rawls 1971, Daniels 1981), it assesses equity in health care by looking at the distribution of 'potential access' in society.

In opting for a notion of potential access as the cornerstone of a theory of equality of opportunity in health care, our paper agrees with a venerable tradition (e.g. Le Grand 1982, 1987; Olsen and Rodgers, 1991; Khan, 1992), whose attractiveness has been diminishing over time. The lack of an adequate consensus on what should be meant by equality of potential access, coupled with the difficulties arisen in the attempt to carry on empirical investigations, seriously contributed to its progressive neglect in favour of an approach based on the equal use-per-need principle (Allin et al. 2007).

We propose to partially restore the potential access approach, in such a way as to make it sufficiently general to attract consensus and not excessively information-demanding so as to hinder empirical investigations.

In the ex-ante perspective we propose (e.g. Abatemarco et al. 2020a, 2020b), the use-per-need principle is disregarded in favour of a criterion that focuses on the cost of a bundle of quality health services for any set of relevant characteristics an individual may have. A specific list 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 place of residence, age, disability, need for personal assistance, and so on. These characteristics are relevant in that they determine the size of the barriers that must be overcome.

Note that, within the framework at hand, equity in health care is concerned with expected disparities in access health care from any given cell (no information is instead available about the identity of the individuals populating any given cell).

For each cell we consider (i) the cell-specific minimum cost of access to adequate health care, which is defined through the monetization of access barriers to a bundle of health treatments of adequate quality[1];(ii) the cell-specific distribution of accessible financial resources, which is defined by taking into account both income and wealth.

By exploiting some similarities with the wide literature on poverty measurement (Foster et al. 1984, Blackwood and Lynch 1994), we make extensive use of an Access Gap index, defined as the average amount of financial resources required to achieve universal access within a cell (universal local access). This index - that can be expressed as the product of the *frequency* (headcount ratio) and the *intensity* (money gap) of non-access - is factor-decomposable in terms of supply-side (cost-specific) and demand-side (resource-specific) determinants. As for the supply-side, our approach allows to disentangle the contribution to the Access Gap of productive inefficiencies from that deriving by local shortages of health care providers. As for demand-side, it allows to determine how both the level and the dispersion of accessible financial resources available in the cell, impact non-access.

Given the distribution of the Access Gap Index across cells, overall inequality of opportunity in health care can be measured by applying standard inequality metrics (Gini, Entropy, ...).[2] and the determinants of inequality of opportunity in health care can be identified by standard techniques for the factor-decomposition of inequality (Shorrocks 1982, Lerman and Yitzhaki 1985, Shorrocks 2013).

In a policy perspective, the factor-decomposition we propose is immediately relevant, since different sources of health care inequality require different policy responses [3]. For instance, inequality of opportunity in health care originating from supply-side (cost-specific) factors require a better administration of public funds allocated to the health sector. Differently, demand-side (resource-specific) determinants of inequality may require more general redistributive policies - based, for example, on means-tested tax expenditures or travel and accommodation reimbursements.

[1] For our purposes we restrict the attention to the sole direct costs of access (Levesque et al. 2013), neglecting other out-of-pocket costs, like, for example, foregone earnings opportunities.

[2] As for the application of inequality metrics to local poverty distributions see, among all, Andreoli et al. (2021).

[3] Not surprisingly, decomposition procedures have been proposed also for outcome-based approaches to equity in health status (Wagstaff et al. 2003, Carrieri and Jones 2018).

To sum up, three major traits characterize our methodological proposal. First, following the Rawlsian tradition of *fair equality of opportunity*, equity in health care is measured with respect to the distribution of opportunities (potential access), not outcomes (health care utilization). Second, since inequality of opportunity is assessed in monetary terms, it is possible to account for disparities in the chance of access as well as for disparities in access conditions. Third, it is possible to capture the contribution of several determinants to inequality of opportunity in health care by disentangling the impact of supply-side (cost-specific) and demand-side (resource-specific) factors.

The paper is organized as follows. In section 2, we outline our framework. The focus is on the measurement of potential access in terms of Access Gap and then on the measurement of overall inequality of potential access. In Section 3 we run a simple empirical exercise to illustrate how our methodology can be easily applied. We consider a single health treatment, i.e. breast cancer surgery, and focus on Italian data. Section 4 concludes.

2 Methodology

2.1 Notations

Let $\Theta = \times\Theta_{k=1}^{m}$ be the space of individual characteristics (e.g., place of living, age, assistance needs, ...) that, given the features of the health care delivery (e.g. geographical distribution of health care providers, structure of access fees, and other out-of-pocket payments,...), and other more general aspects of the economy (e.g. transportation system), affect the cost of access to health care, that is, the out-of-pocket cost borne by an individual to actually have a need for care fulfilled, independently from individual preferences and choices (Levesque et al. 2013).

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 defining a disjoint and exhaustive partition of the entire population. Individuals belonging to a given cell, θ_i, or populating a cell, are pooled together because their situation is identified by the same point in the space of characteristics (for example: they live in the same place, they have the same age, and so on). To each cell is associated a given cost of access to health care in case a health need emerges.

Let $\hat{H}$ be the set of all healthcare providers of the NHS supplying a given health treatment. We indicate by $H \subset \hat{H}$ the sub-set of healthcare providers granting appropriate quality of the health treatment according to official statistics[4]. For instance, the appropriateness of health treatments may be indirectly jeopardized by excessive diffusion of health needs at the local level (i.e. excess demand) causing long waiting lists, and disservices in general.

We write $C(\Theta|H) = \{c(\theta_1|H), c(\theta_2|H)\ldots, c(\theta_n|H)\}$ to denote the distribution of the minimum cost of access to a health treatment of appropriate quality, i.e. the minimum cost that individuals populating the i^{th} cell must bear to obtain the health treatment under consideration. Whereas $C(\Theta|\hat{H}) = (c(\theta_1|\hat{H}), c(\theta_2|\hat{H})...c(\theta_n|\hat{H}))$ is the corresponding distribution of the minimum cost of access to a healthcare provider independently from the quality of supplied care (usually the nearest provider).

To simplify notations, in what follows we will write $c_i = c(\theta_i|H)$ and $\hat{c}_i = c(\theta_i|\hat{H})$ to indicate the cost associated to cell i under $C(\Theta|H)$ or $C(\Theta|\hat{H})$ respectively, with $c_i \geq \hat{c}_i$ ($c_i = \hat{c}_i$ when the cheapest provider to cell i supplies health treatments of appropriate quality). Finally, we define the average cost of access to a health treatment as $\hat{\bar{c}} = (1/n)\sum_{i=1}^{n} \hat{c}_i$.

For each individual j populating cell i, we define the accessible financial resources, y_{ij}, as the overall value of the assets the individual can readily employ to gain access to healthcare in case of need. Hence, $y_i = (y_{i1}, y_{i2}, ...y_{in_i})$ indicates the accessible resource distribution (hereafter, resource distribution) in the population of individuals belonging to ith cell.

Cell-specific and overall average resources are defined as, respectively, $\mu_i = (1/n_i)\sum_{j=1}^{n_i} y_{ij}$ and $\mu = (1/N)\sum_{i=1}^{n}\sum_{j=1}^{n_i} y_{ij}$ with $N = \sum_{i=1}^{n} n_i$.

2.2 Measuring potential (non-)access

Before health needs emerge, an individual j in the ith cell is said to have potential access to a health treatment of appropriate quality if he can afford it, that is, if the private cost of access is not greater than his/her resource endowment, i.e. $c_i \leq y_{ij}$.

If one considers all of the individuals populating the ith cell, the ex-ante *frequency* (or probability) of non-access to a health treatment of appropriate quality is given by the headcount ratio (q_i/n_i), where q_i is the number of individuals in the ith cell for whom access is denied. The *intensity* of non-access — intended as the average amount of financial resources required to grant universal access to all the individuals populating the ith cell — is $\Big((1/q_i)\sum_{j=1}^{q_i}(c_i - y_{ij})\Big)$.

[4] Official statistics on the quality of health treatments are increasingly available for health systems, at least in advanced economies (e.g., PNE (Programma Nazionale Esiti) in Italy, NHQDR (National Healthcare Quality and Disparities Report) in the U.S., QSI (Quality and Safety Indicators) in France, ...).

Hence, drawing from the wide literature on poverty measurement (Blackwood and Lynch 1994), given the ith cell populated by individuals $j = 1, \dots n_i$, we define the Access Gap index, A_i, as follows

$$A_i = \frac{1}{n_i} \sum_{j=1}^{n_i} \max\left(c_i - y_{ij}, 0\right) = \left(\frac{q_i}{n_i}\right) \left(\frac{1}{q_i} \sum_{j=1}^{q_i} (c_i - y_{ij})\right) \tag{1}$$

This index accounts for both the frequency (non-access rate) and the intensity of potential (non-)access, which is our money measure of access (dis-)opportunities associated to the ith cell. Specifically, the Access Gap, A_i, measures the *absolute* amount of financial resources that should be allocated, on average, to individuals of the ith cell in order to grant universal access to them (what we term *local universal access*). By normalizing for c_i, *relative* versions of the same index may be considered as well (Foster et al. 1984); however, provided that the currency is the same across cells, here we opt for the absolute money metric since it facilitates the intelligibility for policy purposes.[5]

The Access Gap index in (1) satisfies the following standard properties.

- *Income Monotonicity* (IM): if $c_i = c_k$, let (y_i, y_k) be two equally-sized income vectors such that $y_{ij} = y_{kj}$ $\forall$ $j \neq z$ and $y_{iz} > y_{kz}$ with $y_{iz} \leq c_i$ and $y_{kz} \leq c_k$, then $A_i < A_k$.

- *Cost Monotonicity* (CM): given two income vectors such that $y_i = y_k$, if $c_i < c_k$, then $A_i < A_k$.

- *Focus* (F): let (y_i, y_k) be two equally-sized income vectors such that $y_{ij} = y_{kj}$ $\forall$ $j \neq z$ and $y_{iz} > y_{kz}$ with $y_{iz} > c_i$ and $y_{kz} > c_k$, then $A_i = A_k$.

From IM and F, it follows that within-cell (non-reranking) rich-to-poor income transfers, from an individual having access to care to another one for whom access is denied, must reduce the Access Gap.

- *Symmetry* (S): if $c_i = c_k$, let (y_i, y_k) be two income vectors such that $y_k = y_i \times M$ with M indicating any $n_i \times n_i$ permutation matrix, then $A_i = A_k$.

- *Translation Invariance* (TI): let (y_i, y_k) be two income distributions such that $y_k = y_i + \lambda\mathbf{1}$ and $c_k = c_i + \lambda$ with $\lambda \in \Re$, then $A_i = A_k$.[6]

[5] For a review on the debate between relative and absolute poverty indexes see Blackorby and Donaldson (1980), Foster and Shorrocks (1991), Zheng (1994).

[6] This property is replaced by *scale invariance* when the relative version of the Access Gap index is obtained by normalizing A_i for c_i.

- *Replication Invariance* (RI): let (y_i, y_k) be two income distributions such that y_k is a t-fold replication of Y_i with t indicating any positive integer and $c_k = c_i$, then $A_i = A_k$.

- *Additive Subgroup Decomposability* (ASD): let $(A_i^1, A_i^2, ...A_i^s)$ be the Access Gap indexes associated to a disjoint and exhaustive s-partition of the population in the ith cell, $A_i = A_i^1 + A_i^2 + ...A_i^s$.

Clearly, ASD allows to implement factor-decompositions aimed at identifying different possible sources of the Access Gap which we will discuss in the next section.

As compared to the absolute version of the well known FGT poverty index (Foster et al., 1984), we assume that the Access Gap index, A_i, is neutral with respect to rich-to-poor income transfers among individuals for whom access to the health treatment is denied. This is formalized in the following property.

- *Transfer Independence* (TIn): let (y_i, y_k) be two income distributions such that $y_{ij} = y_{kj}\ \forall\ j \neq v, z$, provided that $y_{iv} < y_{iz} \leq c_i$ and $y_{kv} < y_{kz} \leq c_k$, if $y_{iv} = y_{kv} + \delta$, $y_{iz} = y_{kz} - \delta$ with $\delta > 0$, then $A_i = A_k$.

As for TIn, while rich-to-poor income transfers among poor income recipients may reasonably alleviate overall poverty conditions, provided that access to care is still denied after the transfer, rich-to-poor transfers among individuals without access to appropriate healthcare services do not ameliorate access conditions at all (as far as access is still denied for both the donor and the recipient). In this sense, since rich-to-poor transfers among individuals having no access (i) do not alter the amount of overall resources required to achieve universal access; and (ii) do not induce better access conditions in the society, TIn seems to be a natural starting-gate for our purposes.

As compared to poverty measurement, it is also worth observing that the cost of access, c_i, in eq. (1) is not exogenously given in a policy perspective. Hence, access opportunities may be ameliorated by both/either reducing the cost of access and/or increasing accessible financial endowments. This implies that universal access may be alternatively or jointly pursued through health care and income or wealth distribution policies.

2.2.1 Decomposing the Access Gap

In what follows, we propose a factor-decomposition of the Access Gap in eq. (1) into four different determinants; two of them concern the supply of healthcare services and are related with the cost of access; the other two pertain to demand factors, and are related with the distribution of resources. Specifically, we consider the following decomposition.

$$
\begin{aligned}
A_i &= A_i^1 + A_i^2 + A_i^3 + A_i^4 = \\
&= \left(\frac{q_i}{n_i}(c_i - \hat{c}_i)\right) + \left(\frac{q_i}{n_i}(\hat{c}_i - \hat{\bar{c}})\right) + \left(\frac{q_i}{n_i}\sum_{j=1}^{q_i}\frac{\hat{\bar{c}} - \tilde{y}_{ij}}{q_i}\right) + \left(\frac{q_i}{n_i}\sum_{j=1}^{q_i}\frac{\tilde{y}_{ij} - y_{ij}}{q_i}\right)
\end{aligned}
\tag{2}
$$

where $\tilde{y}_i = (\tilde{y}_{i1}, \tilde{y}_{i2}, ...\tilde{y}_{in_i})$ with $\tilde{y}_{ij} = (\mu/\mu_i)y_{ij}$ is the *virtual* resource distribution in the ith cell obtained by rescaling the corresponding actual distribution, y_i, under the hypothesis of equally distributed average resources across cells.

A_i^1 is the contribution to the Access Gap, A_i, of the greater cost of access originating from local productive inefficiencies (lack of appropriate quality of the nearest healthcare provider), as weighted by the non-access rate, since the extra-cost is expected to be more deleterious when the non-access rate is higher; specifically, $A_i^1 = 0$ if, either universal local access is granted ($q_i = 0$), or the nearest healthcare provider supplies a health treatment of appropriate quality ($c_i = \hat{c}_i$).

A_i^2 is the cost gap for the ith cell with respect to the NHS (National Health Service) average cost of access to cheapest healthcare provider delivering the treatment — independently from quality standards — calculated for the entire population. This is weighted by the non-access rate since the extra-cost is more penalizing when the non-access rate is higher. The A_i^2 component is positively contributing to the Access Gap in the ith cell if the cost of access in this cell is greater than the NHS average cost of access, and vice versa; specifically, $A_i^2 = 0$ if, either universal local access is granted ($q_i = 0$), or the cost of access to the healthcare treatment supplied by the cheapest healthcare provider is the same as the NHS average cost ($\hat{c}_i = \hat{\bar{c}}$).

A_i^3 is the average gap — weighted by the non-access rate in the ith cell — between the NHS average cost of access to cheapest healthcare providers (i.e. independently from quality standards) and the virtual resource endowment of individuals for whom access is denied in the ith cell. Provided that the virtual endowment, $\tilde{y}_{ij}$, is obtained under the hypothesis of equal average resource endowments across different cells while preserving existing within-cell (local) inequalities, and that the NHS average cost of access, $\hat{\bar{c}}$, is not cell-specific, it must be the case that, given a fixed non-access rate, (q_i/n_i), the A_i^3 component is decreasing in the share of financial resources held by the individuals for whom access is denied in the ith cell. Moreover, the contribution of the A_i^3 component to the overall Access Gap, A_i, is zero if, either the virtual resource distribution in the ith cell, $\tilde{y}_i$ is sufficiently egalitarian to avoid excessive low resource conditions causing non-access to health treatments for some[7], or access is universally granted in the ith cell when the actual resource distribution, y_i, is considered ($q_i = 0$).[8]

A_i^4 is the gap between the virtual and the actual resource endowment of each individual in the ith cell. As such, given the amount of resources held by those having no access, the A_i^4 component measures the contribution of the average resource endowment gap across cells to the Access Gap, A_i, which is negative (positive) when $\mu_i > \mu$ ($\mu_i < \mu$) and it is zero if, either the local average resource endowment in the ith cell is the same as the national one ($\mu_i = \mu$), or access is universally granted in the ith cell ($q_i = 0$).[9]

Since the Access Gap, A_i, measures potential (non-)access in terms of a *monetary* distance between real and universal access conditions at the local level, the factor-decomposition in eq. (2) resembles the standard income (so monetary) decomposition by sources which is well known in the field of inequality measurement (Shorrocks 1982, Lerman and Yitzhaki 1985, Shorrocks 2013). For our purposes, the factor decomposition is used to capture how much local productive inefficiencies (A_i^1), local undersupply of healthcare providers (A_i^2), local income inequalities (A_i^3), and local average income (A_i^4), contribute to non-access in the ith cell.

Notably, from the factor-decomposition in eq. (2), the proportional contribution to the Access Gap of each factor can be measured both at the local and at the national level. At the local level, provided that $k = 1, ...4$, $a_i^k = (A_i^k / A_i)$ identifies the proportional contribution of the kth factor to the Access Gap in the ith cell ($\sum_{k=1}^4 a_i^k = 1$). As for the national level, instead, let $\mathbf{A} = \sum_{i=1}^n \sum_{k=1}^4 A_i^k$ be the Access gap index for the entire population, which is the amount of income that should be given, on average, to each member of the entire population to grant universal access at the national level. Hence, $\mathbf{a}^k = \frac{\sum_{i=1}^n A_i^k}{\mathbf{A}}$, with $\sum_{k=1}^4 \mathbf{a}^k = 1$, is the proportional contribution of the kth factor to the national Access Gap, $\mathbf{A}$.

The identification of the contribution of each determinant to the local and national Access Gap is not only relevant for a better design of healthcare policies but, as discussed in the next section, it is additionally important for a better understanding of the origins of unequal opportunities of access to

[7]This would not imply that access is universally granted according to the actual resource distribution in the ith cell, and vice versa.

[8]It can be shown that $A_i^3 = \frac{q_i}{n_i}\hat{\tilde{c}} - \mu L(\frac{q_i}{n_i})$ where $L(\cdot)$ is the Lorenz curve of the original (or, equivalently, virtual) income distribution. Hence, given a fixed non-access rate, (q_i/n_i), the A_i^3 component is lower the larger is the income share held by individuals without access to health treatments of appropriate quality.

[9]This is straightforward from $A_i^4 = (\frac{\mu - \mu_i}{n_i \mu_i}) \sum_{j=1}^{q_i} y_{ij}$.

health care.

2.3 The measurement of inequality of access

Let $A = (A_1, ..., A_n)$ be the vector of local Access Gaps associated to the disjoint and exhaustive partition of the entire population into n cells. Inequality of access to health care across cells can be measured by taking any inequality metric. As far as the factor decomposition of the inequality metric is crucial for our analysis, we opt for generalized entropy measures and the Gini index, which are known to be additively decomposable by sources.

Generalized entropy measures

Let $\mu(A)$ indicate the average local Access Gap. The generalized class of entropy measures is defined as follows

$$GE(\alpha) = \begin{cases} \dfrac{1}{n\alpha(\alpha-1)} \sum_{i=1}^{n} \left(\left(\dfrac{A_i}{\mu(A)} \right)^{\alpha} - 1 \right) & \alpha \neq 0, \\ \dfrac{1}{n} \sum_{i=1}^{n} \dfrac{A_i}{\mu(A)} \ln \dfrac{A_i}{\mu(A)} & \alpha = 1, \\ -\dfrac{1}{n} \sum_{i=1}^{n} \ln \dfrac{A_i}{\mu(A)} & \alpha = 0 \end{cases} \tag{3}$$

The parameter α regulates the weight given to distances between local Access Gaps at different parts of the Access Gap distribution; the greater is α the more the index is sensitive to high Access Gaps, that is, inequality is more increasing when a high Access Gap increases. Vice versa, the lower is α the more the index is sensitive to low Access Gaps, that is, inequality is more increasing when a low Access Gap decreases.

Several well known inequality metrics can be obtained from generalized entropy measures by using different values of α (e.g., the mean log deviation index for $\alpha = 0$, the Theil index for $\alpha = 1$, ...). In this paper, we restrict our attention to $GE(2)$, which is known to be half the square Coefficient of Variation (CV), i.e.

$$GE(2) = \frac{1}{2} \frac{\sigma^2(A)}{(\mu(A))^2} = \frac{1}{2} CV \tag{4}$$

This decision is driven by reasons of expediency since some of the factor-components, A_i^k, might go reasonably negative, so that both log transformations and odd exponents wouldn't be applicable for our purposes.

Define the vector $A^k = (A_1^k, ..., A_n^k)$ with A_i^k indicating the contribution of the kth component to the Access Gap in the ith cell. By definition of variance

$$\sigma^2(A) = \sum_{k=1}^{4} \sigma^2(A^k) + \sum_{j \neq k} \sum_{k=1}^{4} \rho_{jk} \sigma(A^j) \sigma(A^k) \tag{5}$$

where ρ_{jk} is the correlation coefficient between the vectors A^k and A^j. Notice that, as far as ρ_{jk} can be also negative, $\sum_{k=1}^{4} \sigma^2(A^k)$ might be greater than $\sigma^2(A)$, implying that some factor(s) is (are) reducing the overall variance.

Hence, if $\rho_{jk} = 0 \ \forall \ j, k$ then the decomposition of overall inequality would be simply obtained by considering the variances originating from each of the four components distributions $\sigma^2(A^k)$. Instead, if $\exists \ j, k : \rho_{jk} \neq 0$, as shown in Shorrocks (1982), the 'natural' decomposition of the variance assigns to factor k half the value of all the interaction terms involving this factor. The contribution of factor k then becomes

$$\sigma^2(A^k) + \sum_{j \neq k} \rho_{jk} \sigma(A^j) \sigma(A^k) = Cov(A, A^k) \tag{6}$$

Hence, it follows that the Coefficient of Variation is factor-decomposable as follows,

$$CV = \sum_{k=1}^{4} \frac{Cov(A, A^k)}{(\mu(A))^2} \tag{7}$$

so that, the proportional k-factor contribution to overall inequality of access (to be not confused with the k-factor contribution to the Access Gap, a_i^k, defined above) is

$$CV_k(\%) = \frac{Cov(A, A^k)}{\sigma^2(A)} \tag{8}$$

which sum up to unity for all factors.

Gini index

Let $A = (A_1, ..., A_n)$ be the distribution of the local Access Gaps associated to n cells. Following Stuart (1954) and Kakwani (1980), the Gini index can be defined with respect to the covariance between local Access Gaps and cell's ranks (in terms of Access Gap) so that

$$G = \frac{2Cov(F(A), A)}{\mu(A)} \tag{9}$$

where $\mu(A)$ and $F(A)$ indicate, respectively, the average and the cumulative distribution (rank). Remarkably, as shown by Lerman and Yitzhaki (1985), the Gini coefficient can be factor-decomposed as follows

$$G = \frac{\sum_{k=1}^{4} 2Cov(F(A), A^k)}{\mu(A)} \tag{10}$$

where $Cov(F(A), A^k)$ is the covariance between the cumulative distribution, $F(A)$, and the k-factor contributions, $A^k = (A_1^k, ..., A_n^k)$.

Through easy algebraic calculations, the k-factor contribution can be further decomposed in terms of the product of three components, that is,

$$\begin{aligned} G &= \sum_{k=1}^{4} \left(\frac{Cov(F(A), A^k)}{Cov(F(A^k), A^k)} \right) \left(\frac{2Cov(F(A^k), A^k)}{\mu(A^k)} \right) \left(\frac{\mu(A^k)}{\mu(A)} \right) = \\ &= \sum_{k=1}^{4} (R_k G_k S_k) \end{aligned} \tag{11}$$

where R_k is the correlation between the k-factor contribution, A^k, and the Access Gap, A; G_k is the Gini calculated with respect to the k-factor contribution, A^k;[10] S_k is k-factor share.

From the Gini's decomposition in eq. (10), the proportional k-factor contribution to overall inequality of access is then defined as

$$G_k(\%) = \frac{Cov(F(A), A^k)}{Cov(F(A), A)} \tag{12}$$

which sum up to unity for all factors.

Two major differences can be highlighted with respect to the Coefficient of Variation. First, the Gini index is rank-dependent (Atkinson 1970); hence, rich-to-poor redistribution is more inequality-reducing according to the Gini when occurring between top and low ranked cells, whereas the sole money values of the Access Gaps matter for the Coefficient of Variation. Second, the Coefficient of Variation is known to be much more sensitive than the Gini to variations of top values (Cowell and Falchaire 2007); hence, the contribution of a factor is over-estimated by the Coefficient of Variation (with respect to the Gini) when this is highly positive in cells with a higher Access Gap.

Shapley decomposition

Despite the vast use of inequality metrics decomposable by sources, a new methodology based on some concepts of the cooperative game theory has spread out in the economic literature related to decomposition analysis. This

[10]Notice that the vector of k-factor contributions, A^k, may include negative values as well. Hence, the Gini index, G_k, loses the normalization property, since it is known to be no longer bounded between 0 and 1 (Chen et al. 1982, Berrebi and Silber 1985).

technique has come to be called the *Shapley decomposition* as it aims at assessing the relative importance of different factors affecting the aggregate statistical indicator of interest, applying a procedure formally equivalent to the *Shapley value* (Shorrocks 2013).

Basically, this procedure consists of calculating the marginal impact of dropping each factor in sequence, and then averaging the marginal effects obtained considering all of the possible dropping sequences. For the desirable properties in terms of intuitive interpretation, as well as for the exact additivity of the contributory terms, the Shapley decomposition has attracted a large interest for its applicability to both factor- and subgroup-decomposition procedures.[11]

Recall the distribution of local Access Gaps associated to n cells, $A = (A_1, ..., A_n)$, and the k-factor contributions, $A^k = (A_1^k, ..., A_n^k)$ with $k = 1, ...4$. Given a generic inequality index $I : \Re_+^n \rightarrow \Re$, let $\sigma = (\sigma_1, ..., \sigma_m)$ be the order in which factors are removed and $S(\sigma_r, \sigma) = \{\sigma_i | i > r\}$ the set of factors that remain after factor σ_r has been excluded. Considering altogether the $m!$ possible elimination paths $[\Sigma]$, and then averaging the marginal effects of adding factor k to the set S, denoted by $\Delta_k I(A|S)$, the Shapley decomposition allows to disentangle the expected marginal contribution of the k factor to the overall level of inequality of access, i.e.

$$C_k = \frac{1}{m!} \sum_{\sigma \in \Sigma} C_k^{\sigma} = \frac{1}{m!} \sum_{\sigma \in \Sigma} \Delta_k I \left(A | S \left(k, \sigma\right)\right) \tag{13}$$

Hence, the proportional k-factor contribution to overall inequality of access is

$$C_k(\%) = \frac{C_k}{I(A)} \tag{14}$$

which sum up to unity for all factors.

3 An application to Breast cancer surgery in Italy

In the remainder of the paper we illustrate with an example how our methodology can be easily applied. To this end, we consider a single health treat-

[11] As for the decomposition in terms of within-group and between-group inequality, it has been show that Shapley decomposition satisfies path independence, in that the within-group inequality component does not depend on between-group inequality, a property satisfied by the sole mean log deviation index among all other generalized entropy measures (Foster and Shneyerov, 2000; Shorrocks, 2013).

ment, i.e. breast cancer surgery, and focus on Italian data. The case of breast cancer surgery is of particular interest, for breast cancer is the most common cancer among women; it represents about 30% of all female cancer diagnoses in Italy (AIOM 2020). Moreover, as reported by AGENAS – the Italian National Agency which supervises the performance of the Regional Health Services – about 13.50% of total hospital admissions in 2017 occurred in regions different from the one in which the patient resided, what clearly affects the cost of access to treatments [12]. As we rely only on one characteristic affecting access opportunities - i.e. region of residence - the exercise performed has to be intended as merely illustrative of the proposed methodology. In a companion paper we will develop a more comprehensive application.

3.1 Data

The Italian NHS allows patients to get breast cancer surgery anywhere in Italy. However, according to the data provided by the Ministry of Health (Programma Nazionale Esiti, 2018), only 8 over 490 hospitals, respected quality standards in 2017. Figure 1a illustrates the number of healthcare providers by province, whereas Figure 1b shows where the hospitals providing appropriate treatments are localized. As it is evident from the maps, despite healthcare providers are evenly distributed across Italian provinces, those delivering treatments of appropriate quality are not.

As for access costs, despite the Italian NHS grants breast cancer treatment and surgery to anyone in need, a considerable amount of out-of-pocket expenses is generally sustained by oncological patients. These significantly affect patients' consumption patterns (FAVO 2019). Out-of-pocket expenses are mainly related to: a) transportation and accommodation costs; b) physicians' consultations; c) diagnostic tests; d) non-oncology drugs.

We assume that the only relevant characteristic – distinguishing each cell from any other – is geographic location (region of residence).

The map in Figure 1c displays the distribution of the cost of access to breast cancer surgery of appropriate quality associated to each cell [13]. Such cost is significantly different across Italian regions. In particular, it is higher for people living either in Southern regions or in the extreme North.

To compute disparities in access opportunities, besides the cell-specific cost of access, it is also necessary to consider the distribution of financial re-

[12]More in general, a large flow of patients going from southern to northern regions in search for better quality health treatments has been observed (Levaggi and Zanola 2004, Fabbri and Robone 2010, Beraldo et al. 2020).

[13]See section A1.2 in the Appendix for a detailed description of costs' computation.

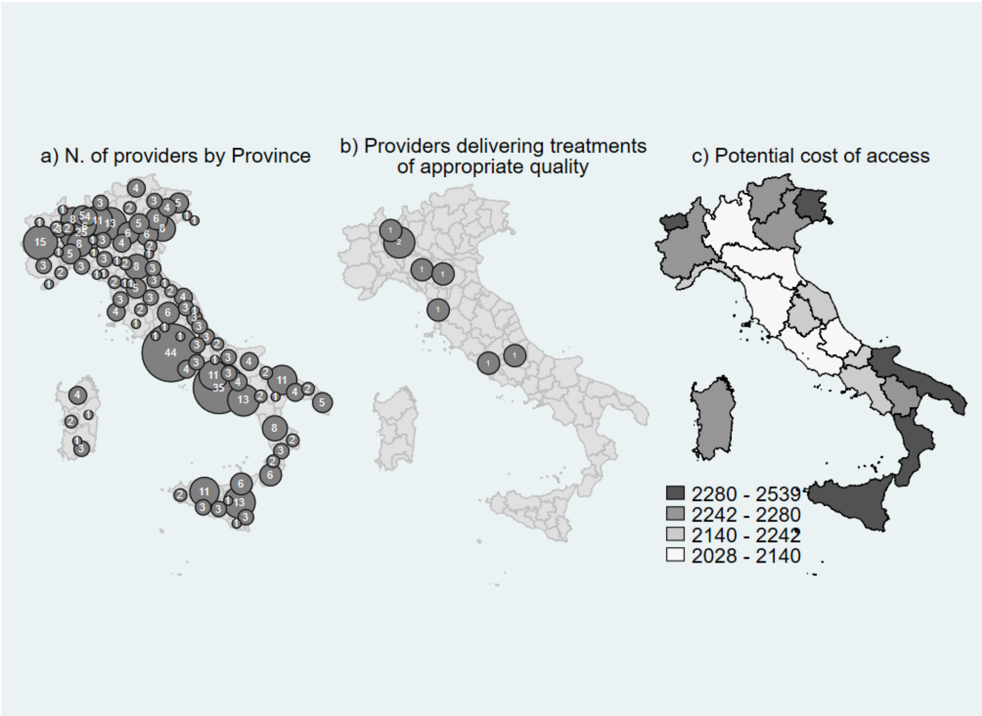

Figure 1: Geographical distribution of healthcare providers and related access costs (€)

Notes: List of providers delivering appropriate treatments (b): i. Mater Domini (VA); ii. IEO (MI); iii. Humanitas (MI); iv. AOU-MO; v. AOU-PR; vi. AOU-PI; vii. S. Eugenio (RM); viii. S. Salvatore (AQ).

sources available to potential patients. Figure 2 shows the results of our computation procedure in assessing available resources (details are described in section A1.3 in the Appendix). Figure 2, shows marked asymmetries among areas. In particular, it confirms the well-known North-South disparities in income and wealth levels.

3.2 Results

Given the distribution of accessible resources and the cost of access associated to each cell, computations of the Access Gap index in eq. (1) are reported in Table A1 in the Appendix. A graphical illustration of the Access Gaps – disentangling the frequency of non-access (headcount ratio) from the intensity of non-access (money gap) according to eq. (1) – is in Figure 3.

Our computations highlight that the Access Gap is sensibly higher in Southern regions (Fig. 3a), especially in Campania. This result is driven

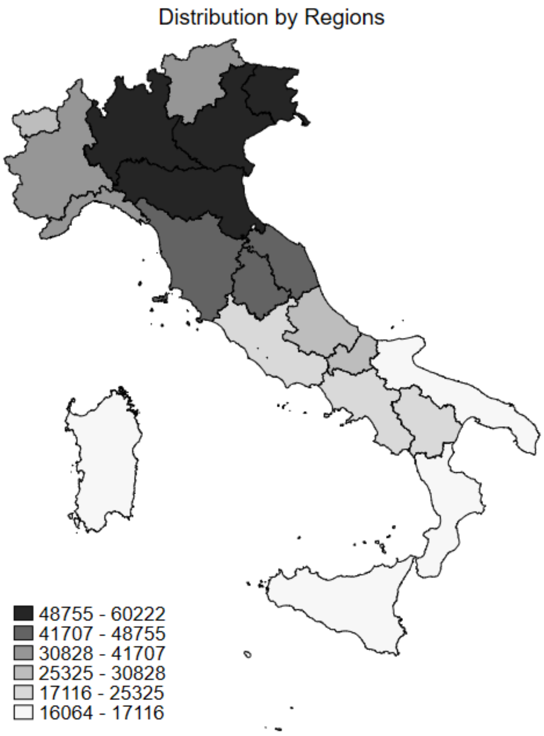

Figure 2: Equivalent accessible resources (€)

by the probability that a randomly chosen person does not have access to a breast cancer surgery of adequate quality (Fig. 3b). This probability is equal to about 25% in Southern regions and to about 15% in Northern ones (see column 2, Table A1 in Appendix). Moreover, the intensity of non-access (Fig. 3b) – given by the amount of financial resources required, on average, by people not having access in order to fill the gap – is, in Southern regions, slightly higher than in Northern ones (respectively 1750 versus 1726 euro according to column 3, Table A1 in Appendix). As emphasized in Section 2, a finer decomposition of the local Access Gap allows to catch the contribution to the Access Gap of four factors; two of whom are related with supply-side conditions, whereas other two with the demand-side.

Table A2 in the Appendix reports the results of the decomposition exercise. Figure 4 is based on these results.

As for the supply-side, it is evident that productive inefficiencies of local healthcare providers – whose proportional contribution is measured by $a_i^1 = A_i^1/A_i$ (see Section 2.2.1) – cause extra-costs for patients in several regions. According to the results of the present exercise, under-supply of healthcare providers has instead a negligible impact on the Access Gap in almost all

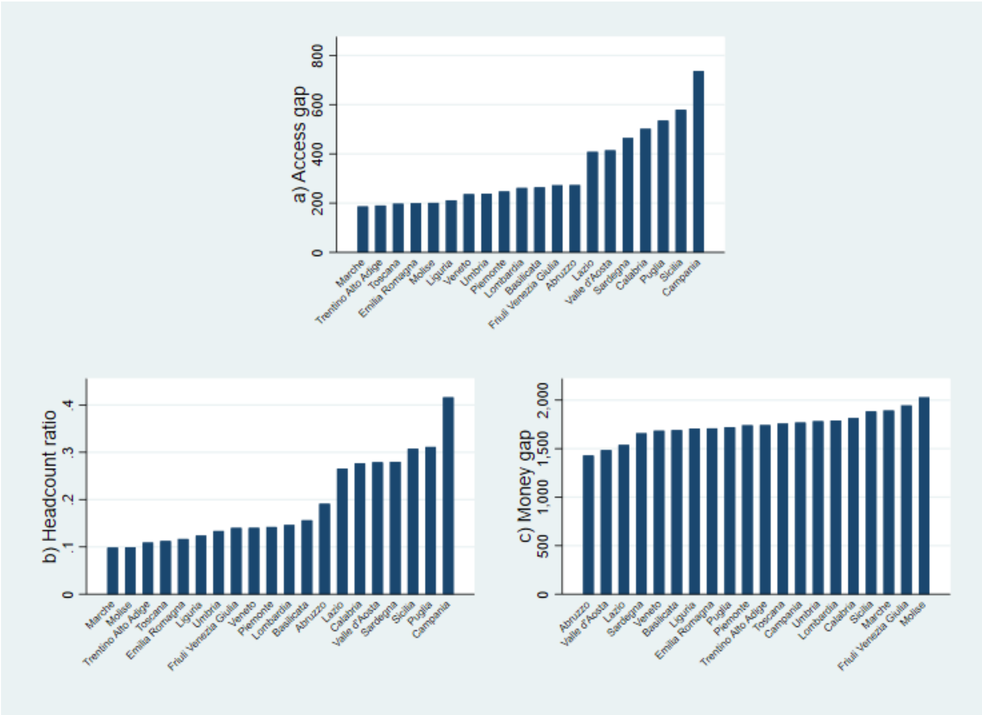

Figure 3: Non-access for breast cancer surgery in Italy

regions.

As for the demand-side, a huge effect on access conditions is caused by income and wealth inequality at the local level (within-cell), $a_i^3 = A_i^3/A_i$; this effect is extremely relevant in Northern regions (e.g. 106% in Emilia Romagna and Lombardia). Conversely, local average income and wealth conditions, $a_i^4 = A_i^4/A_i$, raise the amount required to reach universal access in most Southern regions.

Overall, the local Access Gap decomposition shows that the causes of non-access considerably differ across regions. The problem is not related with the lack of health care providers, rather with the fact than most providers do not deliver treatments of adequate quality.

The analysis also suggests that – in comparative terms – in Northern regions non-access problems are mainly related to inequalities in the local distribution of available resources (within-cell inequality), whereas in Southern regions denied access mainly originates from the low level of accessible resources (between-cell inequality).

To evaluate inequality of Access Gaps among different cells, we compute standard inequality measures, i.e. the Coefficient of Variation and the Gini index.

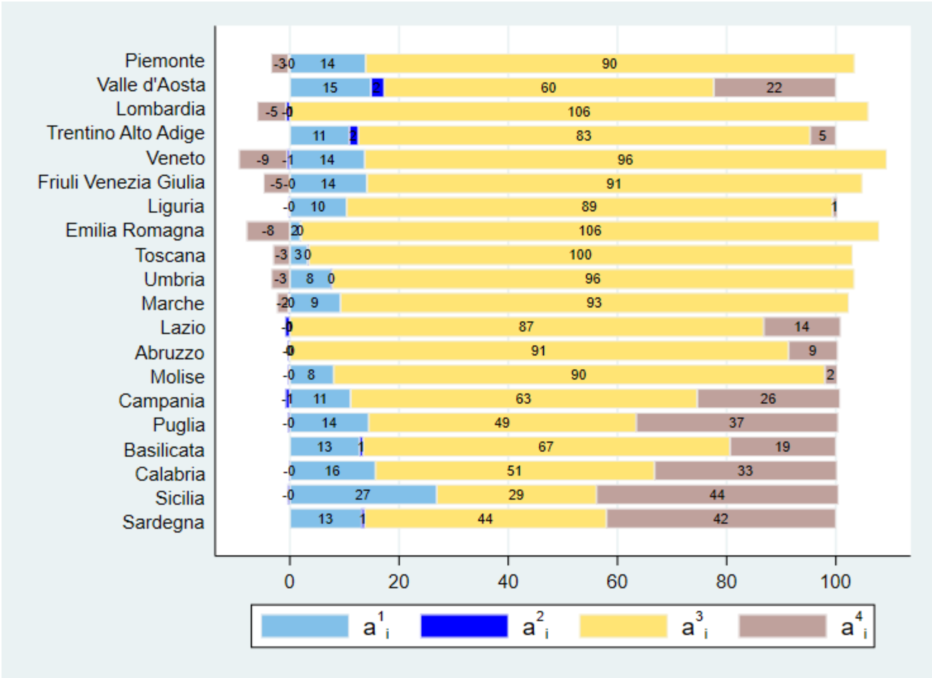

Figure 4: Access gap decomposition

In columns 1 and 3 of Table 1, we report the relative contribution of each factor, according to the decomposition of the Coefficient of Variation, $CV_k(\%)$, and the Gini index, $G_k(\%)$, respectively. Columns 2 and 4, rely on the Shapley rule (Section 2.3). Results are found to be very similar in each of the four columns, so that we only comment Column 1.

The evidence shows that the main contribution to disparities in access conditions come from demand-side factors. More specifically, given overall inequality $CV = 0.108$, 28.7% comes from local inequalities in the distribution of resources and 52.8% derives from delays in the overall level of economic activity.

Looking at the supply side, local productive inefficiencies are responsible for 19.1% of the overall inequality of access opportunities, whereas local under-supply of healthcare providers displays a negligible negative contribution (-0.6%).

4 Concluding Remarks

In this paper we have proposed a novel strategy to assess disparities in access to healthcare. Such strategy is based on the ideal of *equal potential access*

	CV (=0.108)		Gini (=0.243)	
	(1)	(2)	(3)	(4)
	$CV_k(\%)$	$C_k^{CV}(\%)$	$G_k(\%)$	$C_k^{G}(\%)$
Source	Shorrocks (1982)	Shapley rule	Lerman & Yitzhaki (1985)	Shapley rule
A_1	0.191	0.191	0.190	0.186
A_2	-0.006	-0.006	-0.004	0.002
A_3	0.287	0.287	0.284	0.304
A_4	0.528	0.528	0.529	0.507
Total	1.00	1.00	1.00	1.00

Table 1: Application of different Inequality decomposition by sources

and is suitable to disentangle the contribution of supply-side factors from that of demand-side factors to overall inequality.

Our approach allows to account for different inequities characterizing access to care, that is, (i) the disparity among individuals having access and those having not, and (ii) the disparity of access conditions across the population.

In a way that resembles previous contributions (Wagstaff et al. 2003, Carrieri and Jones 2018), our measurement strategy allows to gather direct policy suggestions through the application of standard factor-decomposition techniques. By virtue of such decomposition, it is indeed possible to isolate the impact on access opportunities of various supply and demand factors, what is particularly relevant for policy-makers, especially in decentralized health systems.

For illustrative purposes, we have performed a simple exercise on data from breast cancer surgery in Italy. Results suggest that isolating the impact on access opportunities of various supply and demand factors might be relevant. For example, we find that in Northern regions non-access problems are mainly related to inequalities in the local distribution of available resources (within-cell inequality), whereas in Southern regions denied access mainly originates from the low level of accessible resources (between-cell inequality) or inadequacy of health care providers.

Overall our approach is very general, and can be applied to very different health care settings, such as those in developing countries or those characterized by a massive presence of private providers.

Although the example described in the previous Section focuses on spatial inequality of access, it is worth noticing that the geographical dimension is just one of the dimensions that our methodology can cope with. Another interesting application would be, for instance, the study of health treatments whose access conditions are influenced by characteristics other than geographic location.

Just to make an example, consider the case of edentulism and oral health. Edentulism is a debilitating and irreversible condition; a major disease worldwide, especially among older adults. It affects life quality not only by jeopardizing oral functions; it severely constrains social life and daily activities, for tooth loss influences self-image, leading to isolation, psychosocial well-being decline and decreased self-esteem. Since dentures and dental prostheses are excluded by the essential levels of health assistance (LEA – Livelli essenziali di assistenza) set by the Italian Ministry of Health, the chance of access to appropriate treatments might be extremely sensitive to characteristics other than the place of living.

Also in this case, our methodology would allow assessing both the intensity and the frequency of non-access to appropriate dental treatments, besides identifying the role of inadequate economic resources and inadequate supply in hampering care opportunities.

Appendix

A1 Empirical exercise: variables' definition

A1.1 Identifying quality standards

As for the appropriateness of breast cancer surgery, the Italian Ministry of Health lists the following criteria:

1. number of per-year surgical treatments, greater than 150;
2. share of breast cancer surgical treatments, implemented in hospital divisions performing more than 135 breast cancer surgeries per year, no smaller than 80%;
3. share of patients readmitted within 120 days of discharge, no greater than 8%;
4. share of patients receiving breast reconstruction with prosthesis during total mastectomy, no smaller than 70%.

To be considered as a health facility providing appropriate treatments, in what follows we posit that all of the above criteria must be at once satisfied. We concede that this is a particularly severe perspective that might be softened in different applications, where appropriateness might be assessed with less stringent criteria. This choice is justified in our empirical exercise, for our aim is just one of providing insights in how the methodology can be applied. As we consider just a restricted number of cells (specifically, the twenty Italian regions), more stringent criteria allow us to catch differences at the macro level that we would otherwise overlook.

A1.2 Computing costs

Since we assume that the only relevant characteristic – distinguishing any cell from any other – is geographic location (region of residence), we treat all of the usual out-of-pocket expenses for breast cancer as fixed, focusing on the cost of mobility (transportation and accommodation costs). Hence, let $v = 1, ...8$ indicate the location of the healthcare providers satisfying the quality standards discussed above, the minimum cost of access to adequate care for an individual living in cell i is obtained by summing up, respectively,

$$c_{iv} = \overline{CI} + TC_{iv} + AC_v \qquad \forall\ i = 1, ..., 20; \forall\ v = 1, ..., 8 \tag{15}$$

where

- $\overline{CI}$ is the cell-invariant cost the patient has to bear independently from where s/he resides. Cell-invariant costs are defined up to the sum of main out-of-pocket expenses related to care needs and informal payments. Data come from a survey aimed at assessing breast cancer costs borne by Italian households (LILT 2008). Such expenses basically consist of: 1) cancer specialist's consultations, 2) medical examinations, 3) rehabilitation services, 4) drugs never covered by the NHS, 5) reconstructive supports (prostheses, hairpieces)[14];

- TC_{iv} is the travel cost from region i to province v, borne by the patient and by whoever provides personal assistance to him/her. Transportation costs are computed using the Michelin Guide, considering the cheapest route between any province including the regional capital and each healthcare provider supplying the appropriate treatment [15];

- AC_v is the accommodation cost, borne by the caregiver during the period of hospitalization. Accommodation costs — incurred by the caregiver during the four days (on average) the patient is hospitalized — are calculated by using information on the accommodation prices required by the B&Bs and/or the Hotels advertised on the websites of the eight Italian hospitals providing appropriate treatments, in the area dedicated to informing patients about facilities.

As for the cost of access to the cheapest provider in the ith cell, $\hat{c}_i$, since there is at least one health facility delivering breast cancer surgery in any region we consider the sum of the cell-invariant costs related to care needs, $\overline{CI}$, and the public transportation cost to commute to the health facility, PTC_i, as follows,

$$\hat{c}_i = \overline{CI} + PTC_i \qquad \forall\ i = 1, ...20 \tag{16}$$

where PTC_i is computed by considering the regional hourly cost of public transportation adjusted for a ratio proxying for the regional kilometer coverage of health facilities with respect to the national one[16].

[14] Some additional costs might be considered in more comprehensive applications, such as those related with the necessary professional assistance to people with disabilities.

[15] We assume that all of the out-of-pocket expenses associated to any regional capital are representative of those borne by people residing in any other area of the region to which the regional capital belongs.

[16] Notice that PTC_i is sustained twice by the patient, whereas the caregiver commutes during the four days (on average) the patient is hospitalized.

A1.3 Computing accessible financial resources

The distribution of accessible financial resources may be remarkably different from the simple distribution of income. Whoever in need may indeed either use its wealth (past savings) or receive additional resources from other members of the social networks she belongs to (family, friends, and so on).

To estimate accessible resources, we use data provided by the Survey of the Bank of Italy on Household Income and Wealth (Bank of Italy, 2015). This survey gathers data on income and wealth of the Italian households. The sample comprises about 8,000 households (20,000 individuals), distributed across the twenty provinces including the regional capitals of Italy.

For any household in the survey, we have drawn information about the net disposable income and consumption. Then, by using the equivalence scales provided by the Italian Statistical Office (ISTAT), we have computed the 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 j[17], the amount of resources, beyond the subsistence level, that can be possibly used to tackle unforeseen risky events related to the health status.

Accepting the hypothesis that in the case one's health is adversely affected, 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[18].

The amount of equivalent accessible resources (y_{ij}) for individual j in cell i is therefore equal to

$$y_{ij} = (C_{ij}^E - P_{ij}^E) + S_j + FA_j \tag{17}$$

where the difference between the equivalent per-capita consumption within the household, C_{ij}^E, and the equivalent poverty line, P_{ij}^E, gives the amount of resources that an individual can rely upon in case of need; S_j and FA_j indicate, respectively, the overall savings of the family and other financial (immediately available) assets.

[17] We assume that a generic individual j is representative of the household's potential health need. Despite the probability of having the need might vary according to family composition, we maintain this simplifying assumption due to the illustrative nature of the exercise.

[18] Since we are not considering rehabilitation costs, we have excluded non-financial illiquid assets, such as, for example, the house where one lives, for the obvious reason that they cannot be converted into promptly usable resources. Moreover, although we have implicitly made the assumption of intra-household transfers, we have neglected – for the lack of reliable data – other transfers that individuals can enjoy because of their membership to other social networks.

A1.4 Detailed results

Region	(1) A_i	(2) Headcount ratio	(3) Money gap
Piemonte	247.34	0.142	1740.98
Valle d'Aosta	414.52	0.279	1485.35
Lombardia	261.64	0.146	1789.78
Trentino Alto Adige	190.35	0.109	1742.41
Veneto	236.35	0.140	1684.84
Friuli Venezia Giulia	272.69	0.140	1945.20
Liguria	211.65	0.124	1707.94
Emilia Romagna	199.47	0.117	1709.37
Toscana	197.63	0.112	1758.33
Umbria	238.16	0.134	1783.00
Marche	186.55	0.099	1892.97
Lazio	408.39	0.265	1538.28
Abruzzo	273.32	0.191	1429.69
Molise	201.10	0.099	2029.25
Campania	736.48	0.416	1769.52
Puglia	535.58	0.311	1720.70
Basilicata	264.19	0.156	1690.82
Calabria	501.87	0.276	1815.09
Sicilia	579.16	0.307	1883.79
Sardegna	464.34	0.280	1659.06

Table A1: Local Access Gaps with frequency and intensity components

Region	A_i	(1) A_1	(2) A_2	(3) A_3	(4) A_4
Piemonte	247.34	34.28	-0.58	221.52	-7.88
Valle d'Aosta	414.52	61.41	10.14	250.32	92.64
Lombardia	261.64	0.00	-1.82	277.20	-13.74
Trentino Alto Adige	190.35	20.68	3.20	157.52	8.95
Veneto	236.35	32.42	-1.25	226.01	-20.84
Friuli Venezia Giulia	272.69	38.47	-0.18	247.38	-12.97
Liguria	211.65	21.96	-0.53	188.41	1.80
Emilia Romagna	199.47	3.81	0.26	211.25	-15.85
Toscana	197.63	6.42	0.38	196.90	-6.07
Umbria	238.16	18.05	0.42	227.74	-8.04
Marche	186.55	17.30	-0.52	173.67	-3.90
Lazio	408.39	0.00	-3.48	354.37	57.50
Abruzzo	273.32	0.00	-0.97	249.65	24.64
Molise	201.10	16.12	-0.60	180.87	4.71
Campania	736.48	81.87	-5.82	467.44	192.99
Puglia	535.58	77.35	-2.25	262.22	198.26
Basilicata	264.19	33.84	1.59	177.49	51.27
Calabria	501.87	78.61	-0.95	256.56	167.65
Sicilia	579.16	155.87	-2.73	169.35	256.67
Sardegna	464.34	61.03	2.68	205.54	195.09

Table A2: Factor-decomposition of local Access Gaps

References

[1] Abatemarco, Aria, M., A., Beraldo, S., Stroffolini, F.: *Measuring Disparities in Access to Health Care: A Proposal Based on an Ex-ante Perspective*. Social Indicators Research, **150**, 549–568, 2020a.

[2] Abatemarco, A., Beraldo, S., Stroffolini, F.: *Equality of opportunity in health care: access and equal access revisited*. International Review of Economics, **67**, 13-29, 2020b.

[3] Aday, L.A., Andersen, R., Fleming, G.V.: *Health Care in the U.S.: Equitable for Whom?*. Beverly Hills, Calif.: Sage Publications, 1980.

[4] Andreoli, F., Mussini, M., Prete, V., Zoli C: *Urban poverty: Measurement theory and evidence from American cities.* J Econ Inequal 19, 599–642, 2021.

[5] Atkinson, A.B.: *On the Measurement of Inequality*. Journal of Economic Theory, **2**, 244-263, 1970.

[6] Allin, S., Masseria, C., Sorenson, C., Papanicolas, I., Mossialos, E.: *Measuring inequalities in access to health care: a review of the indices.* European Commission, Brussels, 2007.

[7] Beraldo, S., Collaro, M., Marino, I.: *Do Harder Local Budget Constraints Affect Patient Mobility?*. CSEF, Centre for Studies in Economics and Finance, Department of Economics, University of Naples., 2020.

[8] Berrebi, Z.M., Silber, J.: *The Gini coefficient and negative income: a comment*. Oxford Economic Papers, **37**(3), 1985.

[9] Blackorby, C., Donaldson, D.: *Ethical Indices for the Measurement of Poverty*. Econometrica, **48**(4), 1053-1060, 1980.

[10] Blackwood, C., Lynch, D.: *The Measurement of Inequality and Poverty: A Policy Maker's Guide to the Literature*. World development, **22**(4), 567-578, 1994.

[11] Carrieri, V., Jones, A.M.: *Inequality of opportunity in health: A decomposition-based approach*. Health Economics, **27**, 1981-1995, 2018.

[12] Chen, C., Tsaur, T., Rhai, T.: *The Gini coefficient and negative income*. Oxford Economic Papers, **34**(3), 1982.

[13] Cylus, J., Papanicolas, I.: *An analysis of perceived access to health care in Europe: how universal is universal coverage?*. Health Policy, **119**(9), 1133–1144, 2015.

[14] Cowell, F.A., Flachaire, E.: *Income distribution and inequality measurement: The problem of extreme values.* Journal of Econometrics, **141**(2), 1044-1072, 2007.

[15] Donaldson, C., Gerard, K.: *The economics of health care financing, the visible hand.* MacMillan, Basingstoke, 1993.

[16] Daniels, N.: *Just health care.* Philosophical Public Affairs, **10**, 146–179, 1981.

[17] Evans, D.B., Hsua; J., Boerma, T.; *Universal health coverage and universal access.* Bulletin of the World Health Organization, **91**, 546–546, 2013.

[18] Fabbri, D., Robone, S.: *The geography of hospital admission in a national health service with patient choice.* Health Economics, **19**(9), 1029-1047, 2010.

[19] Federazione Italiana delle Associazioni di Volontariato in Oncologia: *11° Rapporto sulla condizione assistenziale dei malati oncologici*, 2019. `https://osservatorio.favo.it/undicesimo-rapporto/`

[20] Fleurbaey, M., Schokkaert, E.: *Unfair inequalities in health and health care.* Journal of Health Economics, **28**(1), 73 – 90, 2009.

[21] Fleurbaey, M., Schokkaert, E.: *Equity in health and health care.* In: Pauly Mark V, Mcguire Thomas G, Barros Pedro P (eds) Handbook of health economics, vol 2. Elsevier, Amsterdam, pp 1003–1092, 2011.

[22] Fleurbaey, M., Peragine, V.: *Ex ante versus ex post equality of opportunity.* Economica, **80**, 118 – 130, 2013.

[23] Foster, J.E., Greer, J., Thorbecke, E.: *A class of decomposable poverty measures.* Econometrica, **52**(3), 761–776, 1984.

[24] Foster, J. E., Shneyerov, A. A.: *Path independent inequality measures.* Journal of Economic Theory, **91**(2), 199-222, 2000.

[25] Foster, J.E., Shorrocks, A.: Subgroup Consistent Poverty Indices. Econometrica, **59**(3), 687–709, 1991.

[26] Kakwani, N.C.: Income Inequality and Poverty: Methods of Estimation and Policy Applications. Oxford University Press, 1980.

[27] Kakwani, N., Wagstaff, A., van Doorslaer, E.: *Socioeconomic inequality in health: measurement, computation and statistical inference.* Journal of Econometrics, **77**(1), 87–104, 1997.

[28] Karananikolos, M.: *Financial crisis, austerity, and health in Europe.* Lancet, **381**(9874), 1323–1331, 2013.

[29] Khan, A. A.: *An integrated approach to measuring potential spatial access to health care services.* Socio-Economic Planning Sciences, **26**(4), 275-287, 1992.

[30] Kranich, L.: *Equitable Opportunities: An Axiomatic Approach.* Journal of Economic Theory, **71**(1), 131-147, 1996.

[31] Lega Italiana per la Lotta contro i Tumori: *Indagine Retrospettiva Sul Costo Del Tumore Al Seno Per Le Famiglie*, 2008. `https://www.lilt.it/notizie/primo-piano/2008/indagine-retrospettiva-sul-costo-del-tumore-al-seno-per-le-famiglie`

[32] Lerman R.I., Yitzhaki S.: *Income Inequality Effects by Income Source: A New Approach and Applications to the United States.* The Review of Economics and Statistics, **67**(1), 151–156, 1985.

[33] Levaggi, R., Zanola, R.: *Patients' migration across regions: the case of Italy.* Applied economics, **36**(16), 1751-1757, 2004.

[34] Levesque J.F., Harris M.F., Russell G.: *Patient-centred access to health care: conceptualising access at the interface of health systems and populations.* Int J Equity Health 11:12–18, 2013.

[35] Le Grand, J.: *The strategy of equality: Redistribution and the social services.* London: Allen ad Unwin, 1982.

[36] Le Grand, J.: *Equity, health and health care.* . Social Justice Research, **1**, 257–274, 1987.

[37] Li Donni, P., Peragine, V., Pignataro, G.: *Ex-ante and ex-post measurement of equality of opportunity in health: a normative decomposition*, Health Economics, **23**(2), 182 – 198, 2014.

[38] Mooney, G.H.: *Equity in health care: confronting the confusion.* Effective Health Care, **1**(4), 179 – 185, 1983.

[39] O'Donnell, O., van Doorslaer, E., Wagstaff, A., Lidelow, M.: *Analyzing Health Equity Using Household Survey Data*. World Bank, Washington DC, 2008.

[40] Olsen, E.O., Roers, D.L.: *The welfare economics of equal access*. Journal of Public Economics, **45**(1), 91–105, 1991.

[41] Rawls, J. *A theory of justice*. Massachusetts: Harvard University Press, 1971.

[42] Shorrocks A.F.: *Inequality Decomposition by Factor Components*. Econometrica, **50**(1), 193–211, 1982.

[43] Shorrocks A.F.: *Decomposition procedures for distributional analysis: a unified framework based on the Shapley value*. Journal of Economic Inequality, **11**(1), 99 -126, 2013.

[44] Stuart, A.: *The Correlation between Variate-Values and Ranks in Samples from a Continuous Distribution*. British Journal of Statistical Psychology, **7**, 37-44, 1954.

[45] Wagstaff, A., van Doorslaer, E.: *Equity in health care finance and delivery*, in: Culyer A. and Newhouse J. (eds.), *Handbook of Health Economics* Vol. 1, 1803 – 1862, 2000.

[46] Wagstaff, A., van Doorslaer, E., Watanabe, N.: *On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam*, Journal of Econometrics, **112**, 207-223, 2003.

[47] Zheng, B.: Can a Poverty Index be Both Relative and Absolute? Econometrica, **62**(6), 1453–1458, 1994.