

Evaluating the quality and effectiveness of regional healthcare systems: A non-parametric analysis of ISTAT health for all data

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Abstract

Purpose. The aim of this paper is to evaluate the effectiveness and efficiency of the Health Services (RHSs) in Italy. Based on the Istat's Health for All (IHFA) data, this study assesses Italian Hospital Services (HSs) and Health Assistance Services (HASs) between 2010 and 2013, considering both quantitative and qualitative aspects.

Methodology. The Multiplicative Non-Parametric Corporate Performance (MNCP) model by Emrouznejad and Cabanda (2010), namely the Data Envelopment Analysis (DEA). The assessment of effectiveness and efficiency of RHSs goes through three different steps. At first, we evaluate efficacy of regional HSs, integrating quantitative and qualitative analysis. Next, quality and efficacy of HASs have been evaluated. Finally, starting from the results obtained in the first two steps, the efficiency of RHSs in producing their quali-quantitative level of services has been assessed.

Practical implications. This research provides evidences of the potential of DEA to evaluate the quality and effectiveness of healthcare service.

Originality/value. In most of the existing literature, the evaluation of RHSs focuses on efficiency of health services supply, assessed by quantitative variables. This means not only that qualitative aspects are ignored, but also that efficacy is overlooked. The main aim of this kind of studies is to minimize RHSs cost, even if this choice implies low level of services provided, in terms of number and quality of benefits. This paper aims to fill in this gap, the aforementioned methodology.

Keywords

Healthcare management; service quality; public management; non-parametric analysis; data envelopment analysis

1. Theoretical Background

Nowadays it is widely acknowledged how the introduction of New Public Management principles promotes efficiency, effectiveness and accountability in public sector. As far as the reforms of the 1980s and 1990s are concerned, Lapsley (1999) claims that “the trappings of the market place – the need for contracts, employee incentives to perform – are deployed in the name of a greater efficiency in the public services”. Against this backdrop, the adoption of sophisticated and comprehensive multidimensional performance measurement systems for the public sector are suggested by many authors, such as Linard et al. (2000), Kloot and Martin (2000), Fottler et al. (2006), Yang and Tung (2006).

As far as the healthcare sector is concerned, several studies have developed conceptual frameworks and models in order to help governments in building effective managerial tools. These analyses present single or comparative studies on the design of performance evaluation systems adopted at an organizational, regional or national level. As an example, Arah et al. (2003, 2006) explored indicators for monitoring and assessing health systems in United Kingdom, Canada, Australia and United States. Aidemark (2001) proposed balanced scorecards as “control mechanism”, by virtue of their capability to replace “the one-sided financial measurement with control mechanisms that not only focused on the balancing judgements of the organization, but also on the optimizing judgements.” These scorecards reduced goal uncertainty, communicated the complex work of professionals to management and politicians and stimulated a new dialogue about vision and strategy. Zelman et al. (2003) reviewed the use of balanced scorecards in the healthcare sector and concluded that this mechanism is relevant to healthcare. The authors, indeed, highlighted how it has been modified to include patients’ perspectives, such as the quality of care’s assessment, and stated that it increases the need for valid, comprehensive and timely information. They added, in any event, that additional modifications are required, in order to reflect industry and organizational realities.

While there is a broad range of literature on performance evaluation systems at hospital level, few papers have been written about the regional scale, and the majority of these works focus on the design and implementation process (Hilarion et al. 2009). However, the analysis of performance evaluation systems at the regional level and the effects of its use on system’s performance are of particular interest, given the devolution process which has recently involved most of the European countries, such as Italy. Here, in the last decade, each of the twenty Italian regions have developed their own management tools (Mapelli et al. 2007; Vainieri and Nuti 2011). Nuti et al. (2013) reported the experience of the Tuscan PES, a tool designed and implemented in order to pursue the regional strategic objectives on the basis of a specific willingness of the Regional Health Councilor. The system is intended to measure the quality of services provided and the capacity to meet citizens’ needs in order to achieve better health and quality of life standards on one side and, on the other, to preserve financial equilibrium. Lovaglio (2010) presented a multilevel model, based on Lombardy Hospital Discharge Cards data, for a benchmarking analysis.

In spite of these researches, however, the existing literature on healthcare management efficiency and effectiveness is still limited because scant attention has been paid to assessing the efficiency and effectiveness of hospital and ambulatory structures in a simultaneous way. Hence, the research question guiding the present study can be formulated as the following: Is Data Envelopment Analysis (DEA) appropriate to evaluate the efficiency and effectiveness of regional healthcare management systems?

To such a purpose, we focus on ISTAT Health for All data on Italian regional healthcare services.

2. Methodology

2.1 *The Potential of DEA to Evaluate Italian Regional Healthcare Systems*

Many authors have used model based on DEA technique to assess Italian healthcare systems. Schiavone (2008) evaluated the technical efficiency of Italian public hospitals in light of the main features of the hospital system at a regional level. The evaluation was carried out using data on endowments and admissions of all Italian public hospitals over the period 2000-2004. Individual efficiency is partly explained by the composition of input endowment and the case-mix of hospital services provided. However, a significant portion of variance is related to differences in regional averages. A second stage of analysis was performed to detect determinants of technical efficiency, including supply side structural features at the regional level. It demonstrates that some features of local markets, such as the existence of hospital networks and competitiveness between providers, lead to higher levels of efficiency. Another source of variance between regions consists in pressures on the demand for in-patient care.

Cellini et al. (2009) focused on the Italian National Health System in order to investigate whether competition exerts positive effects on the hospitals' efficiency. Using different models based on the DEA technique (input and output oriented versions with constant and variable returns-to-scale), they measured the efficiency of Italian hospitals' production. Secondly, they took a regression analysis approach to analyze efficiency determinants. A general conclusion stemming out of the analysis was that competition is not a value per se and that its effects on hospitals' performance are affected by the rules governing the health system.

For Veneto region hospitals, Guerrini et al. (2016) investigated the determinants of efficiency in this Italian regional health system and estimated the effect exerted by public vs. private ownership on hospitals' performance. To achieve this aim, a full dataset (2011–2012) containing non-publicly available technical data, cost and income items was analyzed. Efficiencies were measured by applying a three-stage DEA. Results suggested that private hospitals perform better than public hospitals in productivity and cost saving, not considering the effect of other environmental and operational variables such as length of stay and beds per capita.

Similarly, Magherini et al. (2016) developed a model for evaluating the technical efficiency by considering different organizational and management aspects and for understanding whether the presence of differences on management, information technology, financial and innovation on healthcare delivery can affect the efficiency level. The results of a survey show the implementation status of the guidelines of the Italian “Patto per la Salute 2014 – 2016” to verify if some of the levers proposed by the survey can positively influence the efficiency. The analysis was carried out in two stages. In the first stage, healthcare efficiency was measured via bootstrapped DEA. In the second stage, the impacts of organizational and environmental variables on efficiency were investigated. Results show an increase of the efficiency gap between the best practice and small hospitals due to economies of scale and low reachability.

2.2 *Data Envelopment Analysis and Multiplicative Non-Parametric Corporate Performance Model*

Data Envelopment Analysis (DEA) is a widely used mathematical programming technique for comparing inputs and outputs of a set of homogenous Decision Making Units (DMUs) by evaluating their relative efficiency. Due to its solid underlying mathematical basis and wide applications to real-world problems, much effort has been devoted to elaborate DEA models since the pioneering work of Charnes et al. (1978, 1979). Differing from statistical methods, DEA models' approach does not require specification of a functional form for the frontier of

performance possibilities. It provides a single measure of efficiency and obviates the need to assign pre-specified weights to either even when dealing with multiple inputs and outputs.

The most frequently used DEA models are the CCR model, named after Charnes et al. (1978) under the assumption of Constant Returns-to-Scale (CRS) and the BCC model, named after Banker et al. (1984), under the assumption of Variable Returns-to-Scale (VRS).

The conventional DEA methods require accurate measurement of both input and output data. However, the observed values of inputs and outputs in real-world problems are sometimes defined as interval ratios instead of crisp numbers. In this paper, the relative efficiency and effectiveness of DMUs with ratio data is assessed by using a Multiplicative Non-parametric Corporate Performance (MNCP) model, by Emrouznejad and Cabanda (2010).

Fernandez Castro and Smith (1994) applied DEA to ratios data for the first time. They presented the General Non-Parametric Corporate Performance model (GNCP):

(1)

$$\begin{aligned} & \max z_p \\ \text{s. t. } & \sum_{j=1}^n \lambda_j r_{ij} \geq z_p r_{ip}, \quad \forall i, \\ & \sum_{j=1}^n \lambda_j = 1, \\ & \lambda_j \geq 0, \quad \forall j \end{aligned}$$

Emrouznejad and Cabanda (2010) proposed the MNCP model to deal with two shortcomings that characterize GNCP: the convexity and the proportionality properties (Emrouznejad and Cabanda, 2010; Emrouznejad et al., 2010; Emrouznejad et al., 2009). The MNCP model formalization is:

(2)

$$\begin{aligned} & \max h_p \\ \text{s. t. } & \prod_{j=1}^n \lambda_j r_{ij} \geq h_p r_{ip}, \quad \forall i, \\ & \sum_{j=1}^n \lambda_j = 1, \end{aligned}$$

The following alteration is applied to model (2) to obtain a linear programming model:

(3)

$$h_p r_{ip} = e^{-s_i} \prod_{j=1}^n h_p r_{ip}, \quad \forall i$$

Furthermore, we obtain the following model by substituting h_p with $\exp(\varepsilon \sum_{i=1}^m s_i)$ for the objective function in model (2) where $s_i \geq 0$ and ε are the slacks and the non-Archimedean infinitesimal, respectively:

$$\begin{aligned}
 & (4) \\
 & \max g_p + \varepsilon \sum_{i=1}^m s_i \\
 \text{s. t. } & \sum_{j=1}^n \lambda_j \rho_{ij} - s_i = g_p + \rho_{ip}, \quad \forall i, \\
 & \sum_{j=1}^n \lambda_j = 1, \\
 & s_i \geq 0, \quad \lambda_j \geq 0, \quad \forall i, j
 \end{aligned}$$

In detail, in the last formula it is possible to observe how $g_p = \log(h_p)$ and $\rho_{ij} = \log(r_{ij}) - 1$. Model (4) is used to maximize the output and the efficiency of the DMU_p which is equal to e^{g_p} in model (2) where g_p is obtained from model (4). Note that DMU_p is efficient if $e^{g_p} = 1$ otherwise, $e^{g_p} \geq 1$, and the $e^{g_p}=1$ is inefficient.

3. Results

Expenditure on hospital services accounts for approximately 45% of total health spending (due to distinctions between regions). Starting from the information available in the Istat Health for All (HFA) database, an evaluation of regional hospital services is proposed in the period 2010-2013. The analysis consists of, on the one hand, the assessment of coverage of hospital services with respect to the population of Reference, on the other hand, the evaluation of the quality of the same, on the basis of the judgments of the inmates².

With reference to the construction of Hospital Coverage Index (ICSO), the variables taken into account are:

- hospital bed rates (for ten thousand inhabitants);
- ordinary hospital beds rate (for ten thousand inhabitants);
- rate of doctors, dentists in public care institutes, private accredited (for ten thousand inhabitants);
- personal nursing rate in public care institutions, private accredited (for ten thousand inhabitants);
- personal rate rehabilitation functions in public care institutions, private accredited (for ten thousand inhabitants);
- personal medical and health care in institutions public care institutions, private accredited (for ten thousand inhabitants).

¹ Note that the log transformation we used here is natural logarithm.

² The evaluation here has a different purpose than that of, for example, the monitoring of Essential Care Levels (or LEAs). In the case of the LEA, the intention is to assess whether the regions are able to guarantee a minimum level of service deemed essential. In the evaluation here, however, the aim is to identify the best regional performance in hospital services, in order to identify what is generally referred to as a best practice, which becomes a benchmark for measuring the "distance" of Regions with poor performance.

Starting from these rates, the synthesis, with the construction of a single index, is realized using the MNCP model of Emrouznejad and Cabanda (2010).

As far as the construction of the Hospital Quality Index (IQSO) is concerned, the variables taken into account are:

- 'very satisfied' people for hospital medical care (as a percentage of the inmates);
- 'very satisfied' nursing staff (as a percentage of the inmates);
- 'very satisfied' people with hospital hygiene (as a percentage of the inmates).

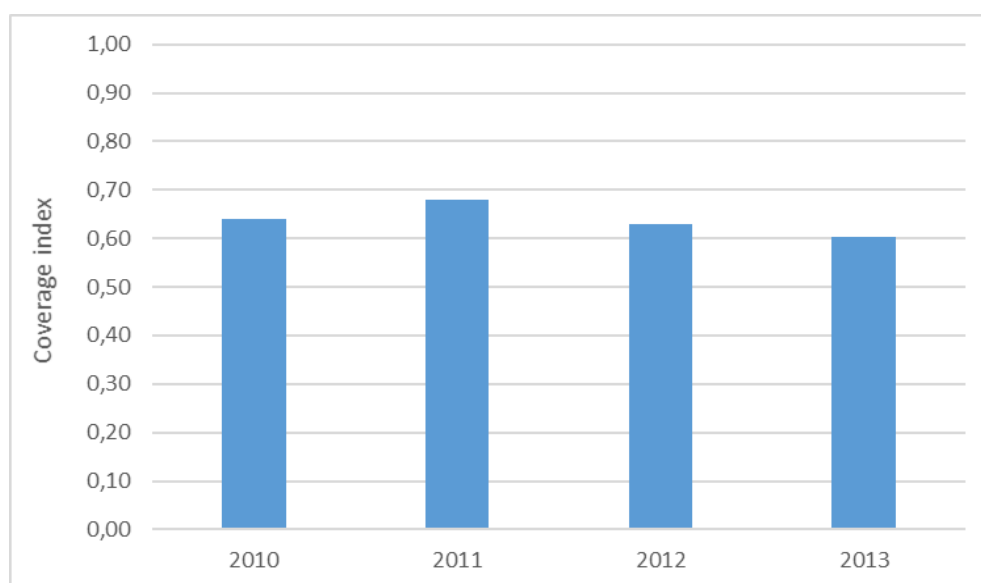
In this case, even for homogeneity with respect to measured quantities, the synthesis in one indicator is achieved through simple medium.

3.1 The Hospital Coverage Index (“L’Indice di Copertura del Servizio Ospedaliero, ICSO”)

The ICSO is a synthesis index referring to the regional capacity to deliver certain hospital services (see previous paragraph) in relation to the local population. The value of the index is between 0 (minimum value) and 1 (maximum coverage).

Looking at the annual average value of regional ICs, it is evident that between 2010 and 2011 this increases from 0.64 to 0.68, which is no longer true between 2011 and the following years. Indeed, in 2013, the average ICs of Italian regions is 0.6, lower than four years earlier (Fig. 1.1).

Fig. 1.1: ICSO between 2010 – 2013: regional mean values per year



Source: Authors' elaboration

Looking at the detailed situation for a single region, interesting differences emerge. The regions which, being quite stable, maintain a high or maximum IC50 over the whole period are: South Tyrol, Emilia Romagna, Friuli Venezia Giulia, and Liguria (Table 1.1).

Among the regions which, on the contrary, remain the last places throughout are Sicily and Campania (Table 1.1).

The regions that improve their performance over time are Valle d'Aosta, Trentino and, more limited, Basilicata and Veneto (Table 1.1).

Lombardy is the region which, however, worsens more clearly, especially between 2011 and subsequent years (Table 1.1).

In general, there are those of Northern Italy, especially the least widespread and of special status. Among the regions with the lowest ICSO, these are mostly southern ones (Table 1.1).

Table 1.1: ICSO regional values between 2010 - 2013

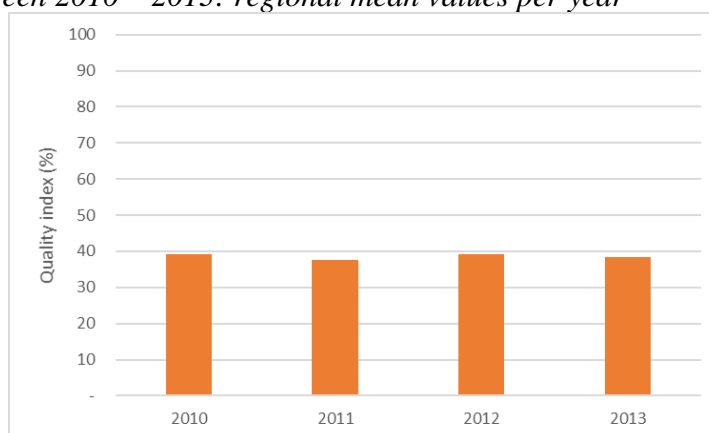
Regions	2010	2011	2012	2013
Abruzzo	0,533	0,506	0,548	0,495
Alto Adige	1,000	0,888	1,000	1,000
Basilicata	0,585	0,577	0,587	0,769
Calabria	0,391	1,000	0,656	0,554
Campania	0,317	0,282	0,285	0,247
Emilia-Romagna	1,000	1,000	0,925	0,828
Friuli-Venezia Giulia	1,000	1,000	1,000	0,986
Lazio	1,000	1,000	0,784	0,698
Liguria	0,795	1,000	1,000	1,000
Lombardia	0,798	0,799	0,275	0,290
Marche	0,487	0,697	0,414	0,371
Molise	1,000	0,505	0,615	0,473
Piemonte	0,769	0,815	0,838	0,790
Puglia	0,533	0,485	0,325	0,281
Sardegna	0,353	0,412	0,284	0,263
Sicilia	0,251	0,219	0,262	0,260
Toscana	0,492	0,530	0,534	0,523
Trentino	0,673	0,805	0,867	0,790
Umbria	0,380	0,500	0,478	0,462
Valle d'Aosta	0,619	0,721	1,000	1,000
Veneto	0,487	0,558	0,545	0,597

Legend: The color scale used ranges from intense red (low IC50) to intense green (high IC50).
Source: Authors' elaboration

3.2 IQSO (The Hospital Quality Index)

Having seen the chronological and territorial differences regarding the amount of hospital services offered to the population, it is useful to look at what is happening from a purely qualitative point of view. The IQSO summarizes in a single index the proportion of patients who are very satisfied with hospital services (see first paragraph). Its value ranges between 0 (poor quality) to 100 (maximum quality). The average regional level of quality of hospital services is substantially constant over the period considered. This value varies between 38 and 40% (Fig. 1.2). Limited standard deviation, and in this case, constant over the years, to indicate how the variability of scores obtained from individual regions remained average, constant over time (values ranging from 12 to 15%).

Fig. 1.2: IQSO between 2010 – 2013: regional mean values per year



Source: Authors' elaboration

As far as regional detail is concerned, it is noted that the regions, that over the period, are considered to have the highest proportion of patients who are very satisfied with hospital

services are: Veneto, Umbria, Piedmont, Emilia Romagna, Friuli Venezia Giulia and the two autonomous provinces (Table 1.2). Among the regions that have the lowest IQSO are: Sicily, Apulia, Campania and Calabria (Table 1.2). Molise performance worsens over time, while Lazio improves it (Table 1.2).

Tab. 1.2: IQSO values between 2010 – 2013

Regions	2010	2011	2012	2013
Abruzzo	27,670	26,410	24,033	28,750
Alto Adige	56,330	54,253	66,550	59,460
Basilicata	28,323	33,070	28,413	24,863
Calabria	23,050	16,883	27,233	29,453
Campania	15,590	23,030	17,167	24,237
Emilia-Romagna	43,430	62,730	62,793	50,437
Friuli-Venezia Giulia	50,690	44,653	63,797	41,040
Lazio	25,953	30,417	36,193	38,217
Liguria	42,480	30,443	43,367	42,723
Lombardia	45,363	43,223	51,277	47,907
Marche	28,760	34,993	29,500	40,673
Molise	31,437	32,847	32,313	17,683
Piemonte	51,930	42,560	46,893	50,430
Puglia	20,310	28,557	20,497	23,997
Sardegna	34,527	33,363	41,360	26,170
Sicilia	21,487	18,507	16,943	15,113
Toscana	40,180	36,243	35,797	34,980
Trentino	75,267	61,457	59,257	66,763
Umbria	45,670	42,743	37,650	50,977
Valle d'Aosta	61,980	51,780	26,967	37,973
Veneto	54,647	42,043	56,947	52,783

Legend: The color scale used ranges from intense red (poor quality) to intense green (maximum quality).
Source: Authors' elaboration

3.3 Coverage and quality

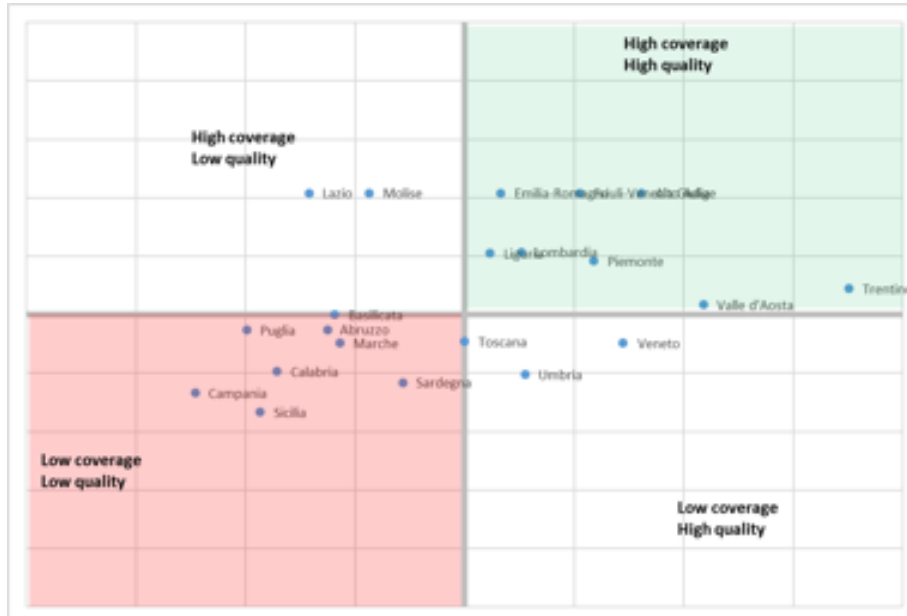
After looking at the two indicators separately, the information is crossed so that one can assess whether and to what regions a high ICSO goes with a satisfactory IQSO and vice versa. To do this, we use graphic analysis. Because of this, it is possible to divide the Cartesian plane into four quadrants and regions into as many groups:

- Top right quadrant - "High Coverage, High Quality": it is the area where the best performing regions are located both from the point of view of hospital service coverage and quality of service offered;
- Low-right quadrant - "Low Coverage, High Quality": is the area where the regions are located, while providing good performance from the point of view of the quality of the service they offer, are unable to guarantee coverage levels comparable to those of the regions in the upper quadrant;
- Lower left quadrant - "Low Coverage, Low Quality": it is the area where the worst regions are located in terms of hospital services, having a low ICSO and an equally low IQSO;
- Top left quadrant - "High Coverage, Low Quality": is the area where the regions are located that, while offering good coverage of hospital services compared to the population, do not excel in terms of quality of the service offered.

Among the regions of excellence in 2010 are the autonomous provinces, the regions with special statutes of the North, Liguria, Piedmont, Lombardy, Emilia Romagna (Fig. 1.3).

Among the worst performing regions, there are all those of the South, with the exception of the Molise, which, although having a high ICSO, is characterized by a low level of middle IQSO and the Marche (Fig. 1.3).

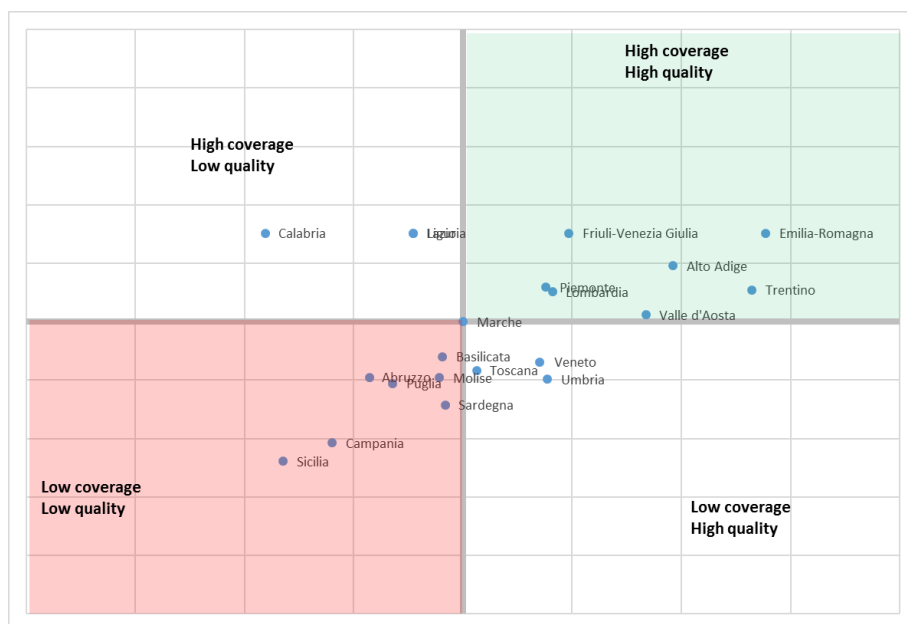
Fig. 1.3: ICSO vs. IQSO, 2010



Source: Authors' elaboration

The situation in 2011 is about the same as previous year. Among the main differences, the fact that Liguria and Calabria move to the "High Coverage, Low Quality" dial, coming from diametrically opposed situations. In addition, Molise reaches the other southern regions of the "Low Coverage, Low Quality" dial and the Marche assume the median value both for IQSO and ICSO (Fig. 1.4).

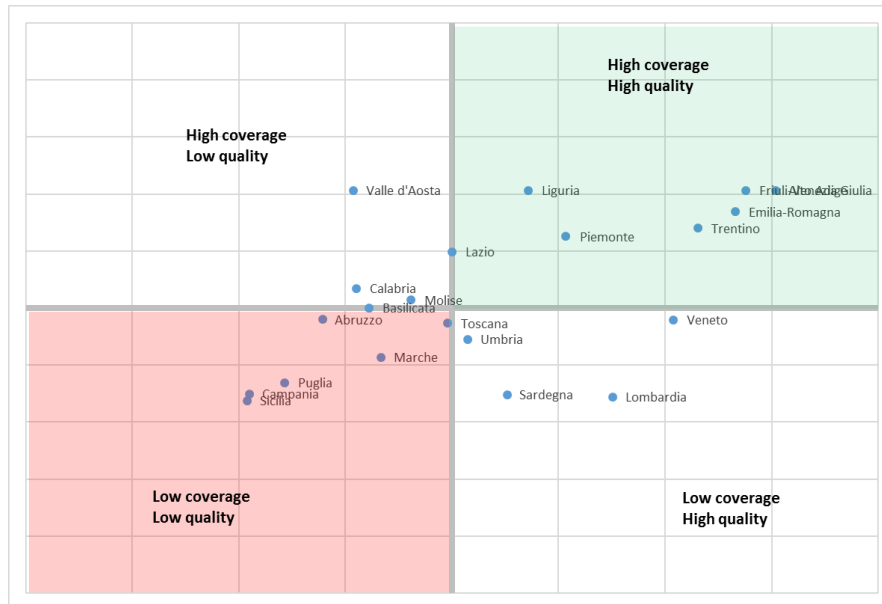
Fig. 1.4: ICSO vs. IQSO, 2011



Source: Authors' elaboration

In 2012, the group of regions with high ICSO and high IQSO lost Lombardy, which, however, maintains a level of high quality hospital services, and the Aosta Valley, migrating to the quadrant with high coverage and low Quality level (Fig. 1.5). It is reported that Lazio, steadily in the top left hand quadrant in 2010 and 2011, makes a steep move towards the quadrant of the excellent regions, positioning at the vertical axis in 2012 (Fig. 1.5).

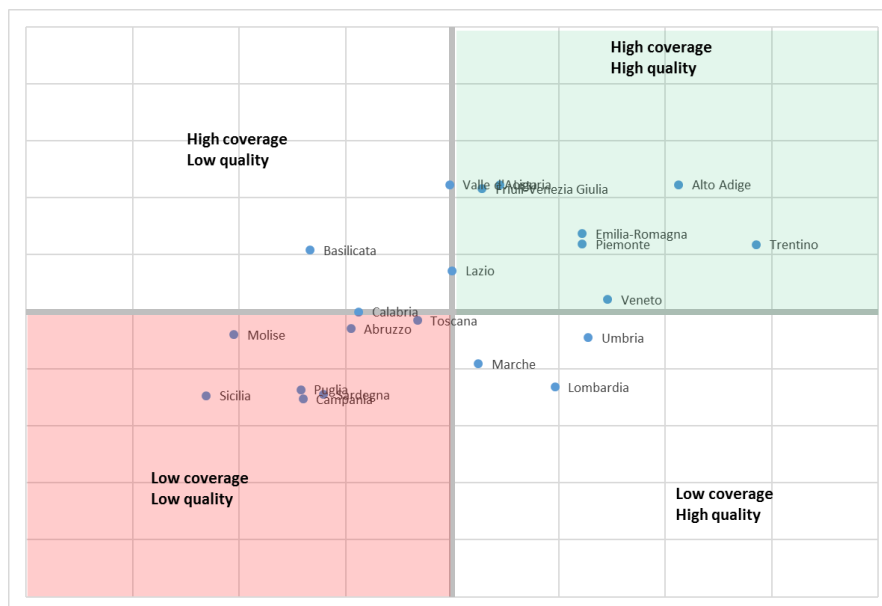
Fig. 1.5: ICSO vs. IQSO, 2012



Source: Authors' elaboration

Lastly, the situation in 2013. Interestingly, as Veneto joins the quadrant of the regions of excellence, Basilicata exits from the regions with the lowest indices and Tuscany, having seen the region's lowest ICSO and IQSO levels already in 2012, this year is consolidated within this group, the only non-southern region in that year having low coverage and low quality (Fig. 1.6).

Fig. 1.6: ICSO vs. IQSO, 2013



Source: Authors' elaboration

3.4 Results

The main observations that can be obtained by crossing data on coverage and quality of hospital services are:

- The difference between North and South Italy is strong in both respects. The regions of the Center, on the other hand, tend to sit close to the two groups;
- Small regions (with a population of less than 2 million inhabitants) tend to be more numerous in the group of the best, although their geographic location is important;
- Regions with special statutes are those that most focus on, alternatively, the best and the worst.

It is interesting to note that, except for some exceptions, the regions with the worst performance in terms of both service coverage and quality are the same as those who, when looking at the balance of mobility figures, have a debt situation. This, in part, would depend on those patients who, in order to receive hospital care, migrate to other regions (Table 1.3).

Tab. 1.3: Balance mobility between 2008 – 2014

REGIONS	Allocation 2008	Allocation 2009	Allocation 2010	Allocation 2011	Allocation 2012	Allocation 2013	Allocation 2014
PIEMONTE	-6.622	2.344	7.166	7.412	6.509	-7.508	-26.186
VALLE D'AOSTA	-18.415	-16.189	-11.205	-15.727	-12.816	-10.752	-9.647
LOMBARDIA	420.547	461.011	464.268	433.028	457.499	555.183	533.960
ALTO ADIGE	4.987	9.087	6.668	1.665	3.597	10.629	18.217
TRENTINO	-19.178	-17.400	-13.619	-15.438	-15.992	-15.488	-16.830
VENETO	104.612	79.705	84.635	93.741	95.180	75.790	75.357
FRIULI VENEZIA GIULIA	7.834	15.100	28.470	31.914	30.467	30.076	33.444
LIGURIA	1.618	-28.797	-37.866	-40.029	-43.967	-56.743	-51.770
EMILIA ROMAGNA	344.159	367.316	366.754	376.985	358.525	336.690	327.978
TOSCANA	107.011	100.731	99.435	121.082	131.927	132.294	151.214
UMBRIA	777	-2.946	9.722	9.886	2.649	9.411	3.295
MARCHE	-44.491	-46.099	-32.507	-19.644	-22.472	-33.677	-46.146
LAZIO	-62.869	-108.361	-99.562	-55.149	-118.979	-199.100	-201.575
ABRUZZO	-6.334	-34.647	-71.692	-124.377	-101.407	-69.559	-70.715
MOLISE	36.328	36.353	28.196	37.548	35.839	30.109	25.722
CAMPANIA	-313.066	-318.434	-308.213	-331.542	-299.132	-310.810	-270.403
PUGLIA	-222.316	-103.002	-139.981	-177.009	-171.737	-180.058	-187.265
BASILICATA	-30.188	-37.429	-40.348	-33.211	-19.140	-19.111	-38.796
CALABRIA	-224.172	-239.292	-257.493	-233.992	-250.009	-251.654	-251.687
SICILIA	-209.720	-224.162	-203.788	-208.590	-203.844	-188.774	-161.682
SARDEGNA	-70.476	-74.401	-67.050	-50.956	-64.796	-68.787	-70.564

Source: Agenas 2008-2014.

4. Discussion and conclusion

From our results, it emerges how DEA may represent an appropriate methodology to simultaneously assess the quality and effectiveness of regional healthcare systems. Actually, DEA provides a single measure of efficiency and effectiveness. Thus, it avoids the need to allocate pre-specified weights of multiple inputs and outputs. Regulators and policy makers may use such a methodology to compare with a benchmark the worst and the best regional socio-healthcare services. Concerning the hospital service coverage ratio, we found that Italian northern regions perform better than southern regions. Similarly, the quality service was better performed in northern regions. As shown by Figure 1.4, by assembling quality and coverage ratios, interesting results are related to Calabria and Liguria, which share a good coverage ratio but a low-quality services; moreover, Veneto, Umbria and Toscana, albeit being characterized by high levels of quality show low coverage ratio in the period ranging

between 2010-2013. These results provide useful insights to policy makers and regulators, especially in time of high public expenditure (Ciappei et al., 2016). Specifically, governmental institutions may exploit the aforementioned benchmarking instrument to reduce inefficiency and better locate regional resources. Furthermore, private sector players - such as both for-profit organizations and voluntary associations (see Zollo et al., 2016a; b; 2017) – may benefit from DEA by identifying strategic “niche” positioning.

Notwithstanding these interesting results, our paper suffers from some limitations. First, our quali-quantitative analysis does not fully reflect patients’ expectations. Next, only secondary data has been used in the proposed methodology. Finally, our results are limited to one single country, namely Italy; hence, it would be useful for future researches to expand these insights by applying DEA methodology to other European countries.

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