Italian Economic Journal
https://doi.org/10.1007/s40797-023-00229-3

RESEARCH PAPER

Is Transparency a 'Free Lunch'? Evidence from the Italian Local Health Authorities

Paolo Lorenzo Ferrara[1,2] · **Calogero Guccio**[1,2] · **Carla Scaglioni**[3,4]

Received: 22 June 2022 / Accepted: 17 April 2023

Abstract
The healthcare is often considered one of the sectors most prone to corruption, and transparency policies have been proposed in several countries to fight bribery and corruption. Indeed, the transparency of public bodies potentially plays a relevant role in preventing misbehaviour and favouring accountability. This study contributes to a broader understanding of the role of transparency in the healthcare sector using Italy as a case study. For this purpose, we first built a composite indicator to assess the differences in transparency, performance, and integrity between Italian local health authorities (LHAs) retrieving the administrative data available on their websites. Then, we used both non-parametric method and multivariate regression to explore the relationship between the performance of different expenditure functions (total production costs, administrative costs, and medical and non-medical-related service costs) at the LHA level and the transparency index. Our results show a wide difference in transparency, performance, and integrity among LHAs that does not always follow the classic north–south divide in Italy. In addition, we find results consistent with the idea that transparency is generally associated with a better capability of LHAs in the containment of healthcare expenditure while imposing larger administrative burdens. Overall, reforms promoting transparency impose administrative costs, which policymakers should bear in mind to develop less burdensome transparency measures, as they might not be a 'free lunch'.

Keywords Healthcare · Transparency · Corruption · Accountability · Italian NHS · Local Health Authorities · Administrative burdens

✉ Calogero Guccio
guccio@unict.it

1 Department of Economic and Business, University of Catania, Corso Italia 55, 95123 Catania, Italy

2 Health Econometrics and Data Group, University of York, York, UK

3 Department of Political Sciences, University of Pisa, via F. Serafini 3, 56126 Pisa, Italy

4 Department of Social Sciences and Economics, Sapienza University of Rome, Piazzale Aldo Moro, 00100 Rome, Italy

Published online: 22 May 2023

JEL Classification H30 · H41 · K20

1 Introduction

Worldwide, health is a sector that is extremely susceptible to corruption (European Commission 2013, 2017; Transparency International 2017) and various dimensions of corruption can have a relevant impact on the health domain (e.g. Dincer and Teoman 2019; Dincer and Gillanders 2021; Alfano et al. 2022).

Several factors contribute to making health a particularly sensitive ground, where opportunistic behaviours often degenerate into corruption (Vian 2008; Vian et al. 2010). Some of these factors are the magnitude of expenditure, ubiquity of information asymmetries, extent of the relationship with the private sector, unpredictability and inelasticity of demand, high specialisation of the products purchased, and need for complex regulation systems. Indeed, corruption challenges good governance and undermines health systems, thereby violating human rights (Vian 2020).

The means and intensity of corruption differ according to the overall level of integrity in various countries and the state of healthcare system development.[1] This theme deserves attention because corruption in the health sector not only has economic effects but also affects the health of populations, reducing access to services and undermining people's trust in the healthcare system (Davis 2004; Sahoo et al. 2016). According to these aspects, the affirmation of legality and integrity must be a priority for policymakers, especially when institutions are perceived as being detached from citizens' everyday concerns. Undoubtedly, what has been said so far raises the issue of accountability in the health sector (Vian 2012; Reich 2018).

Although transparency and accountability (e.g. Brinkerhoff 2004; Reich 2018) are often defined as separate concepts, they are closely related (Heald 2006). Understanding how transparency enhances accountability is key to identifying the types of information that should be disclosed (Paschke et al. 2018; Reich 2018). Moreover, accountability and transparency can act together to reduce exposure to corruption and unethical behaviour, while also improving citizens' trust in public authorities (Barbazza and Tello 2014; Vian et al. 2017; Reich 2018).

Transparency, which is understood as the public availability of information, is one of the main tools used to fight corruption (Kaufmann and Bellver 2005) as well as a fundamental prerequisite for the improvement of services and performance targets (Reich 2018). Empirical analysis supports the idea that more information leads to a reduction in corruption (Rose-Ackerman 2004). Nonetheless, these outcomes are insufficient to conclude that transparency always reduces corruption (Peisakhin and Pinto 2010; Cordis and Warren 2014).

Despite the efforts of ongoing research, to the best of our knowledge, the relationship between transparency and public health spending has been poorly understood. From this perspective, the Italian National Health System is a noteworthy case study. Indeed, Italy has one of the most interesting initiatives in detailing the transparency obligation

[1] The European Network against Fraud and Corruption in the Health Sector (EHFCN) estimates that in Europe, around 6% of the health budget is absorbed by corruption (Sauter et al. 2017).

for the public administrations among the OECD countries (Galli et al. 2017, 2020; Albanese et al. 2021); moreover, because of its high degree of decentralisation, Italian regions greatly vary in both regulation and services provision (Finocchiaro Castro et al. 2014; Francese et al. 2014; Cavalieri et al. 2018b; Cavalieri and Ferrante 2020). This variety in governance enables us to investigate how transparency regulations are applied across the country.

To this end, we first aimed to assess the level of transparency of Italian local health authorities (LHAs) by building a composite transparency indicator (CTI) and its two sub-indicators, referring to *Integrity* (CTI*In*) and *Performance* (CTI*MaEf*), following the methodology proposed by Galli et al. (2017). To this end, we used administrative data available on the LHAs' websites.[2] These indicators have the advantage of quantitatively describing the level of transparency of public authorities and the two main characteristics of public action (Galli et al. 2020; Albanese et al. 2021). We then investigated how transparency is related to different types of costs at the LHA level. Cost data were retrieved from the Ministry of Health for every LHA.[3] As valuable as the impact of transparency could be, it is worth noting that transparency has costs (Heald 2006; Vian 2012); thus, it might not be a 'free lunch'. For example, transparency has organisational costs in terms of implementation of monitoring procedures, creating databases or reports, providing public access, and answering information requests from the public. For this purpose, we built on the results obtained by Di Novi et al. (2018) to estimate the determinants of the cost incurred by LHAs in four cost functions: total cost, administrative cost, cost of purchasing goods, and cost of buying non-healthcare-related services. Starting from their data, we consider the determinants of cost to verify whether and to what extent transparency affects the healthcare costs incurred by LHAs.

Our empirical exercise has several results that we find interesting in terms of their policy implications. First, the composite index presents wide differences in transparency among LHAs, not strictly following the classic north–south gap in the country. Second, empirical analysis confirms that transparency matters and is associated with the better capability of LHAs in curbing total healthcare costs for both Ordinary Statute Regions (ORD) and Special Statute Regions (SSR). Finally, fulfilling the transparency obligation appears to be significantly associated with higher costs in terms of the administrative burden. Consequently, it is worthwhile assessing the expected impact of the intervention options considered. Undoubtedly, transparency constitutes crucial support for the decisions of the political body at the top of the administration, as it increases the degree of accountability and enhances the bond of trust between citizens and institutions. However, it is also fundamental to consider how regulatory intervention affects the organisation and functioning of public administration.

The remainder of the paper is organised as follows. Section 2 features a literature review. Section 3 presents the institutional background, data sample, and empirical strategy. The results are provided in Sect. 4. Finally, Sect. 5 features some concluding remarks.

[2] The index follows a 'top down' approach, which employs public data from the evaluation grid required by Italian law 33/2013 (see Sect. 3.4.1).

[3] For further details, see Sect. 3.4.2.

2 Literature Review

A large body of literature has analysed efficiency and productivity in the healthcare sector, but international empirical evidence on the role of corruption in the healthcare sector is scarce (Transparency International 2017; Cavalieri et al. 2017, 2018a). Recent evidence has come from studies on the characteristics, causes, remedies, and effects of illicit activities in various healthcare dimensions, which show how the opacity of budgets and control systems and administrative misperceptions help the emergence of illicit interests and collusion in the healthcare system. Independent research institutes, such as Afrobarometer and Eurobarometer, track regional data on informal payments through public surveys conducted over time (Vian 2020). Khodamoradi et al. (2018) conducted a systematic review on the Informal Patients' Payments, based on 38 studies on the methodology and costs of this phenomenon, and found that a large share of respondents made informal payments.[4]

Within the debate on transparency and health, Nikoloski and Mossialos (2013) demonstrate a positive relationship between transparency and the quality of healthcare services, stating that in nations with higher transparency in the public sector and lower levels of corruption, people report being more satisfied with the quality of health services.[5]

Likewise, a key issue in this debate is represented by governance (Reich 2018). Based on this perspective, Baldi and Vannoni (2017) focused on the relationship between the level of centralisation and decentralisation in the public procurement of Italian LHAs and the auction prices for pharmaceutical products selected for hospitals from 2009 to 2012. They demonstrate that centralised and mixed procurement systems are statistically related to lower prices than decentralised ones and that higher corruption and lower institutional quality reinforce the effects of centralisation in terms of lower prices.[6] In this regard, an interesting analysis was conducted by ANAC (2016) on the Italian case, highlighting how the application of reference prices in the health sector led to a reduction of over 114,000,000 euros in overall costs, mainly due to the renegotiation of contracts. Cavalieri et al. (2017) found that public work contracts in infrastructure are highly influenced by 'environmental' corruption.

Finally, Lambert-Mogiliansky (2015) has highlighted the relations between transparency, accountability and corruption showing that in the absence of any signal of

[4] Another example of misconduct likely associated with corruption in health sector is related to the quality of drugs (for the so-called substandard and falsified medical products). This is partly due to regulatory failures associated to corruption causing needless morbidity, increasing mortality, and boosting antimicrobial resistance (Ozawa et al. 2018).

[5] A research study in Honduras (World Bank 2001) provides evidence that 8.3% of general practitioners were 'ghost workers', that is, persons paid without actually working. Another survey conducted in 2004 found the absenteeism rate in Bangladesh to be slightly over 40% for physicians and 35% for the entire sample of practitioners (Chaudhury and Hammer 2004), while in 2015 in Rwanda, one-third of healthcare staff employed in primary care services were absent (Serneels and Lievens 2018). Moreover, the World Bank Service Delivery Indicator Survey provides evidence that in Africa, between 2012 and 2016, the absenteeism rates in healthcare varied from 14.3% in Tanzania to 33.1% in Niger.

[6] For other studies on the waste effects of corruption in the health sector procurement, see also Cavalieri et al. (2018a).

the public official's behaviour (*e.g.* a performance outcome, a verification result, statements, citizens' complaints), the officials cannot be 'controlled' on how they use public funds. Therefore, more transparency implies more possibilities for public officials to respond to their actions (Piotrowski and Borry 2010).

To assess the role played by the degree of transparency in the performance achieved by LHAs, we considered the case of the Italian National Health System. The reasons are twofold: first, among the OECD countries, Italy has one of the most remarkable legislations regarding administrative transparency obligations (Galli et al. 2017, 2020; Albanese et al. 2021) and, second, Italy is one of the main European countries where concern for the impact of corruption on economic activities has been raised (Del Monte and Papagni 2001, 2007).

3 Institutional Background, Data, and Methods

To explore whether transparency is relevant to the performance of the Italian LHAs, we first built an indicator to measure the degree of transparency for the Italian LHAs, and then we conducted an empirical assessment, using the data on cost provided by the Italian Ministry of Health (New Health Information System; NSIS). To this end and for the sake of completeness, we first present the Italian regulations on transparency and provide a brief overview of the Italian National Health System.

3.1 Transparency of Public Bodies in Italy

In 2015, the Italian National Agency for Regional Health Services (AGE.NA.S) presented its first report on actions adopted by the National Health System (NHS) in order to promote transparency and integrity (Buckland-Merret et al. 2017; AGE.NA.S., 2015). More recently, AGE.NA.S has launched a new website called 'Portal of the Transparency of Health Services' (*Portale della trasparenza dei servizi per la salute*) aimed at providing easily accessible health information to citizens in order to facilitate users' knowledge of the healthcare offer, increase the level of transparency of communication, and promote the efficiency and quality of the Regional Health Systems (https://www.portaletrasparenzaservizisanitari.it/).[7]

More in general, the topic of transparency of public administrations became an issue in Italy starting from 2009 when the concept of 'total accessibility' as a major tool to improve efficiency and transparency of public administrations was introduced, with emphasis on the central government.

A crucial step in this effort to enhance public sector accountability has been the Anti-Corruption Bill, which has introduced a new approach to transparency regulation, the so-called 'Code of Transparency—Leg. decree n. 33/2013', issued in 2013. The latter considerably improved the scope and substance of transparency regulations and broadened the number of obligations (approximately 270). All public offices

[7] At a global scale, transparency has been promoted by the World Health Organization through international projects aimed at fighting corruption (see, e.g., the Medicines Transparency Alliance and the Good Governance in Medicines programme).

were required to introduce a standardised format for their publication on the website (*Amministrazione trasparente*). The application of transparency rules involves interfaces between various actors. First, in each public body, the person 'Responsible for Transparency' is responsible for executing transparency obligations. Instead, an independent assessment unit (independent evaluation unit; OIV) is designated by the political body to evaluate compliance with transparency obligations and subsequently certify it on the bodies' websites. Centrally, the National Anti-Corruption Authority (*Autorità Nazionale Anticorruzione; ANAC*) performs regulatory and monitoring activities and imposes sanctions in case of non-compliance. In reality, monitoring is usually conducted on very small samples, especially when compared with the number of public organisations liable to transparency regulations (Galli et al. 2017, 2020; Albanese et al. 2021).

3.2 The Italian NHS

The Italian NHS (*Servizio Sanitario Nazionale*, SSN) has unique institutional features. Since 1978, Italy has developed a system that ensures a uniform and universal level of care for all its citizens. Italy has experimented with several progressive reforms led by the principles of decentralisation, competition, and managerialism. As a result, the responsibilities for financing and supplying healthcare services have shifted to regional governments, which now administer, finance, and run healthcare in line with the people's needs according to the national regulatory outline. This organisation involves multiple structures. First, there are the LHAs (*Aziende Sanitarie Locali*), a network of geographic and population-defined bodies, which are autonomous public bodies with independent funds and administrations. In this sense, their scope is to provide services to patients and to run small public hospitals. Second, there are the main public hospitals that have full management autonomy (*Aziende Ospedaliere*). Third, there are qualified private providers (Bordignon and Turati 2009; Finocchiaro Castro et al. 2014; Francese et al. 2014; Cavalieri et al. 2018b; Cavalieri and Ferrante 2020).

Moreover, the Italian NHS represents an interesting case study for the literature analysing the effect of healthcare decentralisation on several health outcomes (e.g. Tang and Bloom 2000; Del Monte and Papagni 2001; Arreondo et al. 2005; Saltman et al. 2007; Bordignon and Turati 2009; Piacenza et al. 2014; Cavalieri and Ferrante 2020) and focusing on the relationship between decentralisation and health policies' efficiency and effectiveness (Bordignon and Turati 2009; Finocchiaro Castro et al. 2014; Francese et al. 2014; Cavalieri and Ferrante 2020).

3.3 Data

The data used in this study were obtained from various sources. The data used to build the transparency indices were retrieved from the LHA websites. The data used to evaluate the relationship between transparency and costs of LHAs came from three

Table 1 Sample distribution of LHAs by geographical area and population size

Macro area	LHAs in the sample by geographical area and population					
	By geographical area		By population size			
	Obs	%	1.000.000 and above	999.999–500.000	499.999–200.000	Below 200.000
North	74	*52%*	6%	16%	19%	7%
Centre	27	*19%*	5%	5%	5%	1%
South	42	*29%*	7%	7%	18%	3%
All sample	143	*100%*	18,2%	28,3%	42,4%	11,1%

Source*:* own elaborations on data provided by the Italian Ministry of Health and Italian Statistical Office—I-STAT (2013)

main sources: the NSIS[8] (*Archivio banca dati economico-finanziari regionali*) of the Italian Ministry of Health, the Open data portal[9] of the Italian Ministry of Health, and Di Novi et al. (2018).

Our final dataset is a cross-section of 143 LHAs for the year 2013, covering the entire Italian territory, which is quite diverse, ranging from LHA in Milan (3,442,042 inhabitants) to Aosta (126,899). The LHAs were mostly concentrated in the north (representing 52% of the total sample). Medium-sized LHAs—with less than 500,000 and more than 200,000 inhabitants—account for more than 40% of the population and are located in both the north (19%) and the south (18%). Specifically, 74 of the 143 LHAs are in the northern regions (*Piemonte, Valle d'Aosta, Liguria, Lombardia, Veneto, Friuli-Venezia Giulia, Trentino-Alto Adige, and Emilia-Romagna*), 27 in the central regions (*Lazio, Marche, Toscana, and Umbria*), and 42 in the southern regions (*Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia, Sardegna*, and *Sicilia*). Table 1 summarises the descriptive statistics of the sample distribution according to geographical area and population size.

3.4 Empirical Strategy

Our empirical strategy consisted of the two steps described in this section. Specifically, we first describe the methodology used to build our transparency indices, and then describe the empirical approach employed to assess the relationship between transparency indices and costs.

[8] For further details see https://www.salute.gov.it/portale/temi/p2_6.jsp?id=1314&area=programmazioneSanitariaLea&menu=vuoto.

[9] For further details see https://www.dati.salute.gov.it/dati/homeDataset.jsp.

3.4.1 Measuring Transparency

Transparency refers to several attributes that render specific administrations more transparent. Practitioners and academics agree on considering *Integrity* and *Performance/Efficiency* as key features in assessing the degree of transparency reached by a public organisation. Based on this perspective, Galli et al. (2017) propose to measure them through two distinct indicators – respectively the CTI *Integrity* (CTI*In*) and the CTI *Performance* (CTI*MaEf*). To this end, they operationalise the two dimensions by selecting some of the obligations contained within the Italian 'Code of Transparency—Leg. decree n. 33/2013'. The second step consists of constructing a single synthetic measure, CTI, by aggregating the syntheses obtained for the two dimensions.

This 'top-down approach' provides a limited set of meaningful and robust indicators that, in our opinion, are suitable for appraising and measuring the degree of transparency of the authorities running the governance of local healthcare systems and driving policy choices. This belief is supported by the fact that the Italian legislations has extended the same obligation to LHAs.

Therefore, we followed the same methodology as Galli et al. (2017), Galli et al. (2020), and Albanese et al. (2021), by first building a dataset containing information about several aspects of LHAs' activity and then deriving the three indicators—the CTI, CTI*In*, and CTI*MaEf*. Data for each item are retrieved from LHAs' websites from the special section ('*Transparent Administration*')[10] and represent a completely new dataset. The value of each item corresponds to the assessment conducted by the OIV[11] along the criteria determined by the ANAC (i.e. 'publication of information', 'completeness', 'updating', and 'openness'). The scale goes from 0 to 3 except for the obligation 'publication of data', ranging from 0 to 2 and rescaled to from 0 to 3 for our computation purposes. This information was selected based on the methodology proposed by Galli et al. (2017). As a result, CTI*In* contains obligations concerning political-administrative information (*e.g.* income and asset disclosure and financial changes) and data on consultants and collaborators (curricula, remuneration, potential conflict of interest), whereas CTI*MaEf* comprises obligations on real estate management (*i.e.* properties and rentals) and quality of services provided (i.e. quality standards and waiting times). Table 2 presents the obligations and descriptions of each item, indicating those selected for our purposes.

Finally, we normalised the values and set the average for all indices to unity (following the methodology employed by Afonso et al. 2005; Afonso and Scaglioni 2006). The values for each item were recalculated relative to the average and assigned equal weights, in coherence with the ANAC methodology.[12] The outcome was the CTI index, constructed as a simple average of the two sub-indicators. These indicators were computed for all the LHAs in the sample.

[10] See Sect. 3.1.

[11] *Ibidem.*

[12] As far as the selection of the items is concerned, we also ran a robustness check calculating the correlation between a CTI that includes all the items in the grid and a CTI with selected items (Galli et al. 2017). The two indexes appear highly correlated both at regional level (0.97) and at LHA level (0.98). For illustrative purposes, in the Online Appendix A, we report the matrix for the Sicilian region. The full sample of raw and normalised data are available from the authors upon request.

Table 2 Transparency obligations (ANAC resolution n.77/2013)

Macrofamilies	Name of the individual obligation	Content of the obligation	CTI*In*	CTI*MaEf*
General provisions	Disciplinary code and code of conduct	Disciplinary code and code of conduct	–	–
Organization*	Political-administrative bodies	Competences; appointment; curricula; compensation of any nature*; travel reimbursement; other offices or assignments; asset disclosure*; income disclosure*; expenses for the electoral campaign; changes in income and in financial and real estate assets*; changes in income and in financial and real estate assets occurred after the publication on the websites*	✔	
Consultants and collaborators*	Consultants and collaborators	Details on collaboration or consultancy assignments with the indication of the beneficiary, the reason for the assignment and the amount paid*. For each assignee: curriculum vitae*; remuneration and performance indices*; paid positions in other public entities*; absence of situations, even potential, of conflict of interest*	✔	

Table 2 (continued)

Macrofamilies	Name of the individual obligation	Content of the obligation	CTI*In*	CTI*MaEf*
Activities and procedures	Procedural time monitoring	Results of the monitoring activity	–	–
Grants, contributions, subsidies, economic benefits	Criteria and methods	Acts which determine the criteria and procedures that administrations must follow	–	–
	Concession documents	Detailed information about grants, contributions, subsidies and financial aids (above one thousand euros) to public and private entities: beneficiary; amount; regulation; procedure supervisor; criteria of selection; project and beneficiary's curriculum	–	–
Real estate and asset management*	Real estate	Census of all the properties*		✔
	Rentals	Rentals paid and received*		✔
Services provided*	Service Charters and quality standards	Service Charters and quality standards*		✔
	Waiting lists	Expected and actual waiting times for each type of service*		✔
Territory planning and governance	Territory planning and governance	All types of territorial plans and their variants. For each Act: drafts before the approval; resolutions for adoption or approval and technical attachments	–	–

Table 2 (continued)

Macrofamilies	Name of the individual obligation	Content of the obligation	CTI*In*	CTI*MaEf*
		Full documentation related to each procedure for the presentation and approval of urban or private initiatives or urban transformation proposals	–	–
Other content—Corruption	Prevention of Corruption Supervisor	Prevention of Corruption Supervisor	–	–
	Transparency Supervisor	Transparency Supervisor	–	–

Source: own elaborations on ANAC resolution

Notes: Adapted from Galli et al. (2020) and translated from ANAC resolution. 77/2013—Annex 1. The original Annex 1 is available in Italian at https://www.anticorruzione.it/portal/public/classic/AttivitaAutorita/AttiDellAutorita/_Atto?id=0a64b73a0a778042039baa3213e920a8. Selected items used for CTI (Galli et al. 2017) are indicated by an asterisk (*). ✔ indicates for which pillar the obligations were selected for

3.4.2 Investigating the Relationship Between Cost Performance and Transparency

To evaluate the relationship between the cost performance of the Italian LHAs and transparency we employ the data on annual costs provided by the NSIS.[13] Our study is also related to the literature on the performance of local health departments and their determinants (e.g. Santerre 1985; Gordon et al. 1997; Bates and Santerre 2008; Mukherjee et al. 2010; Bates et al. 2012; Di Novi et al. 2018).

From this perspective, Gordon et al. (1997) identified the determinants of local health department expenditures, emphasising how they vary significantly across jurisdictions, even in cases of similar size. The authors emphasise the need for effective strategies to analyse the efficiency of public health spending. Potential cost savings may be owing to the consolidation of LHAs. Bates and Santerre (2008) further investigated this hypothesis in local health departments in the USA. They show how better-off municipalities are less likely to consolidate their health departments. The consolidation process is impeded by population and income differences among municipalities. Di Novi et al. (2018) proposed a related approach with a different outcome for the determinants of Italian LHAs costs and consolidation.[14] In particular, the authors estimated the potential advantages of consolidation with specific reference to the Italian NHS using a cross-section of LHAs for 2012. Their main result was the presence of economies of scale for a particular subset of LHAs' production costs: administrative costs, purchasing costs of goods (e.g. drugs and medical devices), and non-healthcare-related services. The latest approach seems particularly useful for our purposes, considering that our sample is a cross-section of 143 LHAs for 2013 and raises similar estimation issues.[15] Therefore, following the empirical strategy suggested by Di Novi et al. (2018), we explore whether transparency, as measured by our index, matters for different cost functions at the LHA level. The general specifications of the determinants of the cost functions are as follows:

$$\ln C_i = \alpha + \beta_1 \ln POP_i + \beta_2 \ln POP_i^2 + \beta_3 D_{SSR} + \beta_4 CTI_i^h + \sum_{j=1,k} \delta_{ji} X_{ji} + \varepsilon_i \tag{1}$$

where C_i is the dependent variable and represents the per-capita costs of the different functions incurred by the *i-th* LHA. More specifically, C_i refer to different expenditure functions (total costs, administrative costs, the cost of purchasing goods, and the cost of buying non-healthcare-related services). Total cost contains total production costs excluding revenues for services directed to non-residents and depreciations; administrative costs' function contains costs for all administrative personnel and operational costs such as grants and other contributions; costs for goods' function contains both costs for purchasing health goods such as drugs, medical devices, and chemical products and non-health goods such as food and sanitising products; the non-health

[13] For further details see https://www.salute.gov.it/portale/temi/p2_6.jsp?id=1314&area=programmazioneSanitariaLea&menu=vuoto.

[14] For an illustration of a different approach to assessing the potential efficiency gains of consolidation policies in the public sector, see Finocchiaro Castro and Guccio (2018).

[15] In Sect. 4.4. as a robustness check we also use the lagged cost variables for the year 2014.

services costs' function contains all costs related to other services such as washing, food preparation, waste disposal, and heating.

The variable POP refers to the population in the *i-th* LHA to verify whether the LHA size (in terms of inhabitants) would have an impact on healthcare expenditure per capita for each cost function. To control for potential scale effects on costs, we include the POP square in Eq. (1). To control for the difference between regions with ordinary statutes (ORD) and those with special statutes (RSS), we use a dummy variable (D_SSR).[16]

The variables CTI_i^h capture the degree of transparency achieved by the *i-th* LHA for the *h-th* transparency index (i.e.*CTI,* CTI*In* and CTI*MaEf*). X is a set of *k* explanatory variables, including dummy explanatory variables that capture LHAs' fixed characteristics, as reported in Table 3.

More precisely, the *k* covariates in the X set can be roughly classified into three categories: demand, supply, and institutional and financial characteristics of the LHAs. The variables of population, population density, income, elderly and foreign population rates, and number of municipalities in the LHAs were used as proxies for the demand for healthcare services. Instead, the variables on the number of doctors and paediatricians for 1000 residents, hospital beds and hours of medical emergency services per 100 residents, integrated home care assistance, and other healthcare facilities (e.g. purchasing systems, reservation, transportation, emergencies, mother–child departments) are used as proxies for the supply of healthcare services in the LHAs. The last category of variables relates to the institutional and financial characteristics of LHAs. The first group of dummy variables is related to regional health organisational models.[17] Another dummy variable concentrates on the circumstances of an LHA belonging to a Region under Recovery Plan. Another group of variables relates to the presence of a centralised purchasing system and the incidence of costs for goods and services on total costs. Lastly, we account for per-capita lump-sum funding received from the regions, the latter needing particular attention because it constitutes the main source of funding for LHSs.

Finally, ε_i is the error term.

An initial assessment of the relationships between the cost functions and the composite indices of transparency can be captured by the pairwise correlation matrix shown in Table 4. Table 4 shows a negative correlation between total costs and transparency composite indicators and a positive correlation between administrative costs and transparency. For other cost functions (*i.e.* the cost of purchasing goods and the cost for buying non-healthcare-related services), no clear relationship emerges.

In the following sections, we first show the results of our estimates of transparency indices at the LHA level and then investigate the relationship between transparency indicators and the cost performance of the LHAs. For the latter purpose, as preliminary

[16] As observed by Meleddu et al. (2020) regions with Special Statute receive supplementary funds from the Central State in order to cover overwhelming geographical and socio-economic disadvantages. We have also tried to assess the impact of regional autonomy through sub-sample estimates, with results overlapping with those reported here. These additional estimates are available from the authors upon request.

[17] Italian regional health systems can be classified in four different models according to the share of beds in hospitals controlled directly by the LHAs: integrated model (> 66%), semi-integrated model (40%–66%), semi-separated model (20%–40%) and separated model (< 20%) (Brenna 2011; Di Novi et al. 2018).

Table 3 Descriptive statistics of the employed variables

Variable	Meaning	Source	Obs	Mean	Std. Dev	Min	Max
TOTAL_COSTS	Total production costs (euro per capita)—year 2013	A	143	1709.275	230.390	1124.831	2266.623
ADM_COST	Costs for administrative services and personnel (euro per capita)—year 2013	A	143	46.086	17.799	13.773	137.921
COST_GOODS	Cost of buying health and non-health goods (euro per capita)—year 2013	A	143	193.245	100.542	26.081	719.953
COST_NOT_HEALTH	Cost of buying non-health services (euro per capita)—year 2013	A	143	100.500	50.753	6.312	222.056
LAG_TOTAL_COSTS	Total production costs (euro per capita)—year 2014	A	143	1774.580	284.987	1124.831	2510.981
LAG_ADM_COST	Costs for administrative services and personnel (euro per capita)—year 2014	A	143	48.038	19.003	13.773	141.959
LAG_COST_GOODS	Cost of buying health and non-health goods (euro per capita)—year 2014	A	143	203.369	109.580	26.081	812.431
LAG_COST_NOT_HEALTH	Cost of buying non-health services (euro per capita)—year 2014	A	143	103.105	52.788	6.312	238.217
CTI	Composite Indicator built upon selected transparency obligations validated by the OIV of each administration. according to ANAC resolution n.77/2013	B	143	0.755	0.476	0.000	1.482
CTI*In*	Composite Indicator built upon selected transparency obligations validated by the OIV of each administration. according to ANAC resolution n.77/2013	B	143	0.684	0.504	0.000	1.745

Table 3 (continued)

Variable	Meaning	Source	Obs	Mean	Std. Dev	Min	Max
CTI*MaEf*	Composite Indicator built upon selected transparency obligations validated by the OIV of each administration. according to ANAC resolution n.77/2013	B	143	0.827	0.504	0.000	1.277
POP	Resident population in the LHA on 1 January 2013	C	143	425,054.000	304,058.000	57,699.000	1,592615.000
DENSITY	Demographic density (pop/surface area)	C	143	534.277	1220.885	30.340	7477.567
DEPENDENCY	Dependency ratio of the population (pop over 65 and pop-under 14 upon pop between 15–64)—per cent	C	143	0.531	0.042	0.425	0.642
INCOME	Tax base of personal income tax (IRPEF), 2011 (euro per capita)	D	143	12,105.490	3007.114	6166.729	21,393.290
FOREIGNERS	Percentage share of foreign residents—per cent	C	143	0.067	0.033	0.009	0.137
MUNICIPALITIES	Number of municipalities in the LHA (2013)	C	143	0.172	0.139	0.001	0.594
DOCTORS	Number of General Practitioners (for 10,000 residents)	C	143	0.748	0.076	0.543	0.988
PAEDIATRICIANS	Number of paediatricians (for 100,000 residents)	C	143	0.122	0.020	0.079	0.165
HOSPITAL_BEDS	Number of beds programmed in hospitals/pop—per cent	C	143	0.084	0.273	0.000	1.006
EMERGENCY_SERVICE	Emergency medical service (hours/pop)—per cent	C	143	0.366	0.271	0.000	1.435
HOME_CARE	Integrated home care assistance 1000/pop	C	143	11.549	8.307	1.419	47.955

Table 3 (continued)

Variable	Meaning	Source	Obs	Mean	Std. Dev	Min	Max
FACILITIES	Doctor's offices and laboratories (accredited private providers) 100,000/pop	C	143	22.184	14.350	3.322	99.707
ADDICTION_SERVICE	Number of Addiction Treatment Services (for 10,000 residents)	C	143	1.177	0.661	0.285	4.101
D_RESERVATION	Unified reservation centres—Type 2 (dummy)	D	143	0.280	0.450	0.000	1.000
D_MATERNAL	Maternal and child department (dummy)	D	143	0.811	0.393	0.000	1.000
D_TRANSPORT	Transport service to dialysis centres (dummy)	D	143	0.629	0.485	0.000	1.000
D_REANIMATION	Mobile Resuscitation Units (dummy)	D	143	0.273	0.447	0.000	1.000
D_AMBULANCES	Ambulances for emergency transport of new-born babies (dummy)	D	143	0.077	0.267	0.000	1.000
D_SEP	Dummy for LHA in regions with a separate organizational model	D	142	0.106	0.308	0.000	1.000
D_SEMI_SEP	Dummy for LHA in regions with a semi-separated organizational model	D	143	0.238	0.427	0.000	1.000
D_INT	Dummy for LHA in regions with an integrated organizational model	D	143	0.259	0.439	0.000	1.000
D_SEMI_INT	Dummy for LHA in regions with a semi-integrated organizational model	D	143	0.399	0.491	0.000	1.000
D_CENTRAL_H	Dummy for LHA in regions with a Centralized Purchasing System only for Health services	D	143	0.280	0.450	0.000	1.000

Table 3 (continued)

Variable	Meaning	Source	Obs	Mean	Std. Dev	Min	Max
D_CENTRAL	Dummy for LHA in regions with a Centralized Purchasing System	D	143	0.490	0.502	0.000	1.000
D_RECOVERY	Dummy for LHA in regions under the Recovery Plan	D	143	0.399	0.491	0.000	1.000
PURCH_ADM_SERVICE	Cost of buying administrative services (as a percentage of Total production costs)—per cent	C	143	0.002	0.003	0.000	0.024
PURCH_HEALTH_SER	Reimbursements for health services (as a percentage of Total production costs)—per cent	A	143	0.166	0.072	0.045	0.375
LUMP_SUM_FUND	Per-capita lump-sum funding received from Regional Governments	A	143	1637.196	194.815	1121.482	2168.775
D_SSR	Dummy for LHA in Special Statue Regions	D	143	0.182	0.387	0.000	1.000

Source: (A) own elaborations on data provided by NSIS (Archivio banca dati economico-finanziari regionali) of Italian Ministry of Health—https://www.salute.gov.it/portale/temi/p2_6.jsp?id=1314&area=programmazione-SanitariaLea&menu=vuoto, (B) own elaborations on ANAC resolution, Section 'Transparent Administration' of the LHAs' websites in the year 2013, (C) own elaborations on data retrieved from Open data portal of Italian Ministry of Health—https://www.dati.salute.gov.it/dati/homeDataset.jsp, and (D) own elaborations on data retrieved from Di Novi et al. (2018)

Table 4 Pairwise correlation matrix

Variable	1	2	3	4	5	6	7	8	9	10	11	12
(1) TOTAL_COSTS	1.0000											
(2) ADM_COST	0.5783*	1.0000										
(3) COST_GOODS	0.6172*	0.5450*	1.0000									
(4) COST_NOT_HEALTH	0.6274*	0.5245*	0.6059*	1.0000								
(5) CTI	− 0.1913*	0.1753*	− 0.0015	0.0023	1.0000							
(6) CTI*In*	− 0.0318	0.0707	− 0.0067	− 0.0380	0.9453*	1.0000						
(7) CTI*MaEf*	0.1408*	0.1017*	0.0038	0.0423	0.9454*	0.7874*	1.0000					
(8) POP	− 0.3885*	− 0.5081*	− 0.3731*	− 0.4956*	− 0.1827*	− 0.1077	− 0.2377*	1.0000				
(9) DENSITY	− 0.0150	− 0.1842*	− 0.0895	− 0.1608*	− 0.0428	− 0.0192	− 0.0618	0.3700*	1.0000			
(10) DEPENDENCY	0.4993*	0.1891*	0.2227*	0.2226*	0.3413*	0.2536*	0.3916*	− 0.2126*	0.0389	1.0000		
(11) INCOME	0.3536*	− 0.0824	− 0.0022	0.0481	0.2895*	0.2411*	0.3063*	0.0387	0.2896*	0.6044*	1.0000	
(12) FOREIGNERS	0.2243*	− 0.1097	0.0432	0.0272	0.2680*	0.2113*	0.2955*	− 0.0136	0.1862*	0.4638*	0.7448*	1.0000
(13) MUNICIPALITIES	0.2157*	0.3681*	0.1455*	0.1325	0.0426	0.0349	0.0455	− 0.3680*	− 0.3514*	0.1126	− 0.0774	− 0.1397*
(14) DOCTORS	0.0912	0.0635	0.1787*	0.1301	− 0.2626*	− 0.2647*	− 0.2317*	− 0.0741	− 0.0070	− 0.0935	− 0.4586*	− 0.5672*
(15) PAEDIATRICIANS	− 0.2785*	− 0.1419*	− 0.0964	− 0.1054	− 0.1883*	− 0.1455*	− 0.2106*	0.3511*	− 0.0411	− 0.4739*	− 0.2742*	− 0.2049*
(16) HOSPITAL_BEDS	− 0.2408*	− 0.4171*	− 0.4576*	− 0.4815*	0.1066	0.0955	0.1061	0.1324	0.0286	0.0282	0.2422*	0.1719*
(17) EMERGENCY_SERVICE	− 0.0334	0.2495*	0.0779	0.1279	− 0.1454*	− 0.1346	− 0.1403*	− 0.2249*	− 0.2746*	− 0.3155*	− 0.6118*	− 0.5854*
(18) HOME_CARE	0.2029*	− 0.0694	− 0.0232	0.1584*	0.0842	0.0681	0.0911	− 0.1932*	− 0.1546*	0.2483*	0.1752*	0.2136*
(19) FACILITIES	− 0.2033*	0.0135	− 0.0256	− 0.1206	− 0.2183*	− 0.1822*	− 0.2305*	0.1840*	0.0820	− 0.2358*	− 0.5053*	− 0.5267*
(20) ADDICTION_SERVICE	0.2045*	0.1985*	0.0664	0.0161	0.0608	0.0209	0.0941	− 0.2009*	0.0093	0.1908*	− 0.0179	− 0.1208
(21) D_RESERVATION	0.2719*	0.1675*	0.1658*	0.2354*	0.2184*	0.1653*	0.2477*	− 0.1568*	0.0469	0.3529*	0.2589*	0.2047*
(22) D_MATERNAL	0.1385*	0.1020	0.0480	0.0611	0.0782	0.0164	0.1315	− 0.0331	0.0145	0.1567*	0.0641	0.2109*
(23) D_TRANSPORT	0.3288*	0.1355	0.2553*	0.2099*	0.0888	0.0697	0.0982	− 0.1123	− 0.0272	0.3130*	0.2616*	0.2317*
(24) D_REANIMATION	0.2077*	0.2128*	0.3090*	0.2369*	− 0.1540*	− 0.1540*	− 0.1371	− 0.0281	− 0.0380	− 0.0507	− 0.1096	− 0.0982
(25) D_AMBULANCES	0.0771	0.0310	0.0870	− 0.0106	− 0.0900	− 0.0591	− 0.1110	0.1318	− 0.0742	0.0135	− 0.0655	− 0.0871
(26) D_SEP	− 0.2843*	− 0.4164*	− 0.5141*	− 0.5490*	0.0674	0.0403	0.0871	0.2710*	0.1311	− 0.0267	0.2921*	0.2283*

Table 4 (continued)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
(27) D_SEMI_SEP	− 0.2091*	− 0.1726*	− 0.1781*	− 0.0807	− 0.2789*	− 0.2443*	− 0.2830*	0.1959*	0.1357	− 0.2937*	− 0.2437*	− 0.2873*
(28) D_INT	0.2191*	0.2944*	0.2062*	0.4268*	0.0311	0.0312	0.0277	− 0.3324*	− 0.1550*	− 0.2168*	− 0.0400	− 0.0275
(29) D_SEMI_INT	0.1638*	0.1473*	0.2922*	0.0319	0.1725*	0.1594*	0.1668*	− 0.0426	− 0.0613	0.4660*	0.0649	0.1315
(30) D_CENTRAL_H	− 0.0916	− 0.1087	0.0398	0.1888*	− 0.1308	− 0.1178	− 0.1295	0.0059	0.0000	− 0.2585*	− 0.2330*	− 0.0805
(31) D_CENTRAL	− 0.0184	− 0.1760*	− 0.1432*	− 0.1657*	0.0234	0.0050	0.0392	− 0.0071	0.1255	0.0361	0.3068*	0.1716*
(32) D_RECOVERY	− 0.2035*	− 0.0276	0.0450	− 0.2116*	− 0.3561*	− 0.3022*	− 0.3711*	0.2245*	0.1703*	− 0.3527*	− 0.4270*	− 0.4204*
(33) PURCH_ADM_SERVICE	0.1805*	0.4003*	0.1733*	0.4227*	0.0238	0.0149	0.0301	− 0.2891*	− 0.0506	− 0.0330	− 0.0298	− 0.1592*
(34) PURCH_HEALTH_SER	− 0.3027*	− 0.6019*	− 0.6065*	− 0.6261*	0.0685	0.0523	0.0773	0.4033*	0.3676*	− 0.0236	0.4802*	0.4116*
(35) LUMP_SUM_FUND	0.9548*	0.6109*	0.4969*	0.6284*	0.1022	0.039	0.1543*	− 0.3929*	− 0.0390	0.4531*	0.2939*	0.1665*

Variable	13	14	15	16	17	18	19	20	21	22	23	24

(1) TOTAL_COSTS
(2) ADM_COST
(3) COST_GOODS
(4) COST_NOT_HEALTH
(5) CTI
(6) CTI*In*
(7) CTI*MaEf*
(8) POP
(9) DENSITY
(10) DEPENDENCY

Table 4 (continued)

Variable	13	14	15	16	17	18	19	20	21	22	23	24
(11) INCOME												
(12) FOREIGNERS												
(13) MUNICIPALITIES	1.0000											
(14) DOCTORS	− 0.0314	1.0000										
(15) PAEDIATRICIANS	− 0.4421*	0.0777	1.0000									
(16) HOSPITAL_BEDS	0.0551	− 0.2561*	− 0.0915	1.0000								
(17) EMERGENCY_SERVICE	0.3645*	0.4833*	0.0873	− 0.1960*	1.0000							
(18) HOME_CARE	− 0.1052	− 0.0760	− 0.0371	0.1366	− 0.0539	1.0000						
(19) FACILITIES	− 0.2304*	0.5242*	0.2804*	− 0.2077*	0.2831*	− 0.1814*	1.0000					
(20) ADDICTION_SERVICE	0.4048*	0.0116	− 0.3662*	− 0.0501	0.1466*	− 0.0653	− 0.1137	1.0000				
(21) D_RESERVATION	− 0.0907	− 0.0544	− 0.0940	− 0.0180	− 0.1540*	0.1578*	− 0.1862*	− 0.0426	1.0000			
(22) D_MATERNAL	0.1491*	− 0.1325	− 0.1310	0.0169	− 0.1187	− 0.1180	− 0.2450*	0.1764*	− 0.0178	1.0000		
(23) D_TRANSPORT	0.0079	0.0122	− 0.0783	− 0.0280	− 0.1449*	0.0927	− 0.2832*	0.0868	0.1556*	0.2587*	1.0000	
(24) D_REANIMATION	0.1588*	0.0350	0.0397	− 0.1848*	0.2271*	− 0.0090	0.0309	0.1594*	− 0.0668	0.0146	0.1773*	1.0000
(25) D_AMBULANCES	0.0364	0.0961	0.0701	− 0.0873	0.0774	− 0.0026	0.0964	0.0545	− 0.1799*	0.0052	0.0585	0.4125*
(26) D_SEP	0.1142	− 0.3936*	− 0.0809	0.7181*	− 0.2114*	− 0.0099	− 0.2608*	− 0.0249	− 0.0608	0.1068	− 0.1626*	− 0.1584*
(27) D_SEMI_SEP	− 0.1889*	0.3943*	0.2248*	− 0.0510	− 0.0993	− 0.0835	0.4073*	− 0.1675*	− 0.1651*	− 0.2342*	− 0.1836*	− 0.1576*
(28) D_INT	0.1587*	− 0.1744*	− 0.0966	− 0.1774*	0.1628*	0.0509	− 0.1720*	− 0.0972	− 0.0480	0.0402	0.0236	0.1760*
(29) D_SEMI_INT	− 0.0492	0.0595	− 0.0585	− 0.2464*	0.0730	0.0333	− 0.0370	0.2482*	0.2245*	0.1008	0.2403*	0.0787
(30) D_CENTRAL_H	− 0.1707*	− 0.0706	0.0362	− 0.1879*	− 0.1058	− 0.0314	− 0.0513	− 0.1765*	− 0.0760	0.1016	0.0911	0.1431*
(31) D_CENTRAL	0.2286*	− 0.1017	− 0.1001	0.3084*	0.0301	0.2154*	− 0.3079*	0.2436*	− 0.0181	− 0.0995	− 0.1175	− 0.0657
(32) D_RECOVERY	0.0031	0.4388*	0.2601*	− 0.2476*	0.0860	− 0.3430*	0.3273*	0.1956*	− 0.2846*	− 0.0452	− 0.0850	0.0787
(33) PURCH_ADM_SERVICE	0.2756*	0.0584	− 0.1123	− 0.1495*	0.2867*	− 0.0143	− 0.0366	0.1045	0.1881*	− 0.1166	− 0.0995	0.1610*
(34) PURCH_HEALTH_SER	− 0.2175*	− 0.4457*	− 0.0369	0.6006*	− 0.4794*	0.0374	− 0.2410*	− 0.0923	− 0.0525	0.0509	− 0.1358	− 0.3048*

Table 4 (continued)

Variable	13	14	15	16	17	18	19	20	21	22	23	24
(35) LUMP_SUM_FUND	0.2298*	0.0589	− 0.2477*	− 0.2436*	0.0193	0.1876*	− 0.1912*	0.2403*	0.2322*	0.1630*	0.2925*	0.2000*
Variable	25	26	27	28	29	30	31	32	33	34	35	

(1) TOTAL_COSTS
(2) ADM_COST
(3) COST_GOODS
(4) COST_NOT_HEALTH
(5) CTI
(6) CTI*In*
(7) CTI*MaEf*
(8) POP
(9) DENSITY
(10) DEPENDENCY
(11) INCOME
(12) FOREIGNERS
(13) MUNICIPALITIES
(14) DOCTORS
(15) PAEDIATRICIANS
(16) HOSPITAL_BEDS
(17) EMERGENCY_SERVICE
(18) HOME_CARE
(19) FACILITIES
(20) ADDICTION_SERVICE
(21) D_RESERVATION
(22) D_MATERNAL

Table 4 (continued)

Variable	25	26	27	28	29	30	31	32	33	34	35
(23) D_TRANSPORT											
(24) D_REANIMATION											
(25) D_AMBULANCES	1.0000										
(26) D_SEP	− 0.0988	1.0000									
(27) D_SEMI_SEP	− 0.0996	− 0.1912*	1.0000								
(28) D_INT	0.0691	− 0.2023*	− 0.3300*	1.0000							
(29) D_SEMI_INT	0.0866	− 0.2787*	− 0.4547*	− 0.4810*	1.0000						
(30) D_CENTRAL_H	0.1124	− 0.2133*	− 0.0919	0.5212*	− 0.2528*	1.0000					
(31) D_CENTRAL	− 0.1777*	0.3496*	0.0446	− 0.3230*	0.0314	− 0.6102*	1.0000				
(32) D_RECOVERY	0.1402*	− 0.2787*	0.4847*	− 0.3179*	0.0373	0.0336	0.0599	1.0000			
(33) PURCH_ADM_SERVICE	− 0.0249	− 0.1874*	− 0.0647	0.3922*	− 0.1773*	− 0.0581	0.0449	− 0.1696*	1.0000		
(34) PURCH_HEALTH_SER	− 0.1306	0.7539*	− 0.0633	− 0.1602*	− 0.2735*	− 0.0692	0.3040*	− 0.1832*	− 0.3239*	1.0000	
(35) LUMP_SUM_FUND	0.0773	− 0.2761*	− 0.2591*	0.2968	0.1326	− 0.0578	− 0.0771	− 0.2174*	0.2233*	− 0.3063*	1.0000

Note: The table reports the correlation matrix between the variables. * indicates significance at 10% level
Source: our elaboration on the data provided by the sources reported in Table 3

evidence, the equality of cost distributions for the different groups of LHAs according to different levels of transparency was assessed using univariate kernel estimates. We then estimated Equation [1] using stepwise regression.

4 Empirical Findings

This section presents the empirical results. The focus is on the two main aspects previously mentioned: the degree of transparency across Italian LHAs (Sect. 4.1) and their costs of transparency (Sects. 4.2, 4.3 and 4.4).

4.1 The Degree of Transparency Across the Italian LHAs

The degree of transparency of Italian LHAs using composite indicators is shown in Fig. 1.

It partially depicts the usual geographical dichotomy between the north and south, with Tuscany and Emilia-Romagna aligned with the former macro-area, while Lazio,

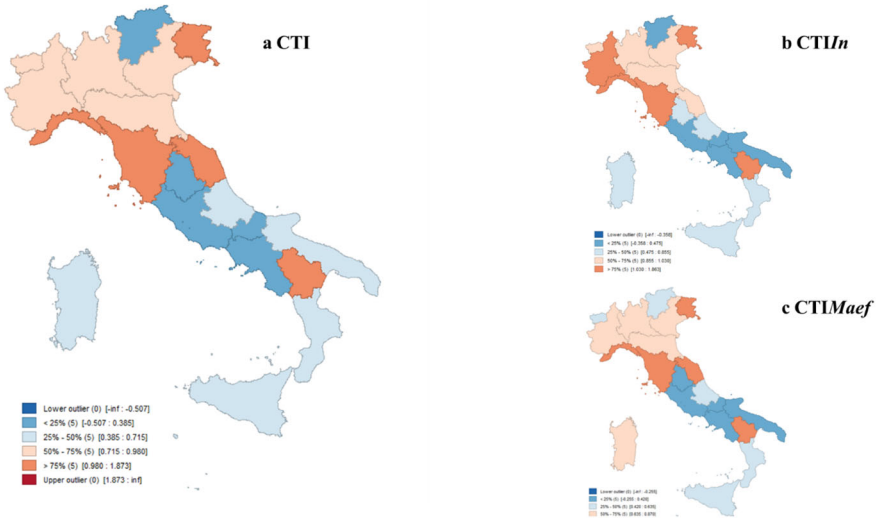

Fig. 1 Geographical distribution of *CTI* index and its dimensions: *CTI_Integrity* and *CTI_Performance*. Figure shows the geographical distribution of the average values of the composite transparency indicators (CTI, CTI_{In} and CTI_{MaEf}) at the regional level. Specifically, on the left is shown the geographical distribution of the CTI composite indicator while on the right is shown the geographic distribution of the CTI_{In} and CTI_{MaEf} indicators. Source: own elaborations on ANAC resolution and Section 'Transparent Administration' of the LHAs' websites in the year 2013

Table 5 Values of the CTI, CTI*In* and CTI*MaEf* at the regional level

Regions	CTI	CTI_{In}	CTI_{MaEf}
ABRUZZO	0.60	0.49	0.70
BASILICATA	1.16	1.08	1.24
CALABRIA	0.52	0.51	0.53
CAMPANIA	0.21	0.26	0.17
EMILIA ROMAGNA	0.90	0.83	0.97
FRIULI-VENEZIA GIULIA	1.02	0.88	1.16
LAZIO	0.35	0.29	0.41
LIGURIA	1.07	1.07	1.07
LOMBARDY	0.85	0.74	0.95
MARCHE	1.03	1.12	0.94
MOLISE	0.00	0.00	0.00
PIEDMONT	0.95	0.86	1.05
APULIA	0.40	0.37	0.42
SARDINIA	0.71	0.66	0.77
SICILY	0.64	0.58	0.71
TRENTINO-ALTO ADIGE/SÜDTIROL	0.37	0.61	0.12
TUSCANY	1.01	0.89	1.14
UMBRIA	0.33	0.12	0.54
AOSTA VALLEY	0.72	0.47	0.97
VENETO	0.92	0.83	1.01

Source: own elaborations on ANAC resolution, Section 'Transparent Administration' of the LHAs' websites in the year 2013

Umbria, and Marche with the latter.[18] *CTI* and $CTI_{\mathbf{MaEf}}$ were almost aligned. Basilicata and Friuli Venezia Giulia reached the highest levels, while Liguria was the best performer in terms of integrity besides Basilicata. Marche and Molise ranked the lowest in the ranking. Nonetheless, our results are in line with those presented by AGE.NA.S (2015), despite the different approaches used to measure LHAs' transparency. The same picture emerged from the composite indicators at the regional level, as shown in Table 5.

4.2 Preliminary Findings Using Non-Parametric Approach

As a preliminary investigation of the relationship between per-capita costs and transparency indicators, we employed a univariate kernel estimator. Specifically, we split the distribution of each composite indicator into two categories (low and high) based on the median value. In Fig. 2, we report the univariate kernel smoothing distribution

[18] The region Basilicata represents an exception, but Potenza is not, as among the 10 most transparent LHAs, there are Oristano, Brindisi, and Caltanissetta. The data at LHA level are available from the authors upon request.

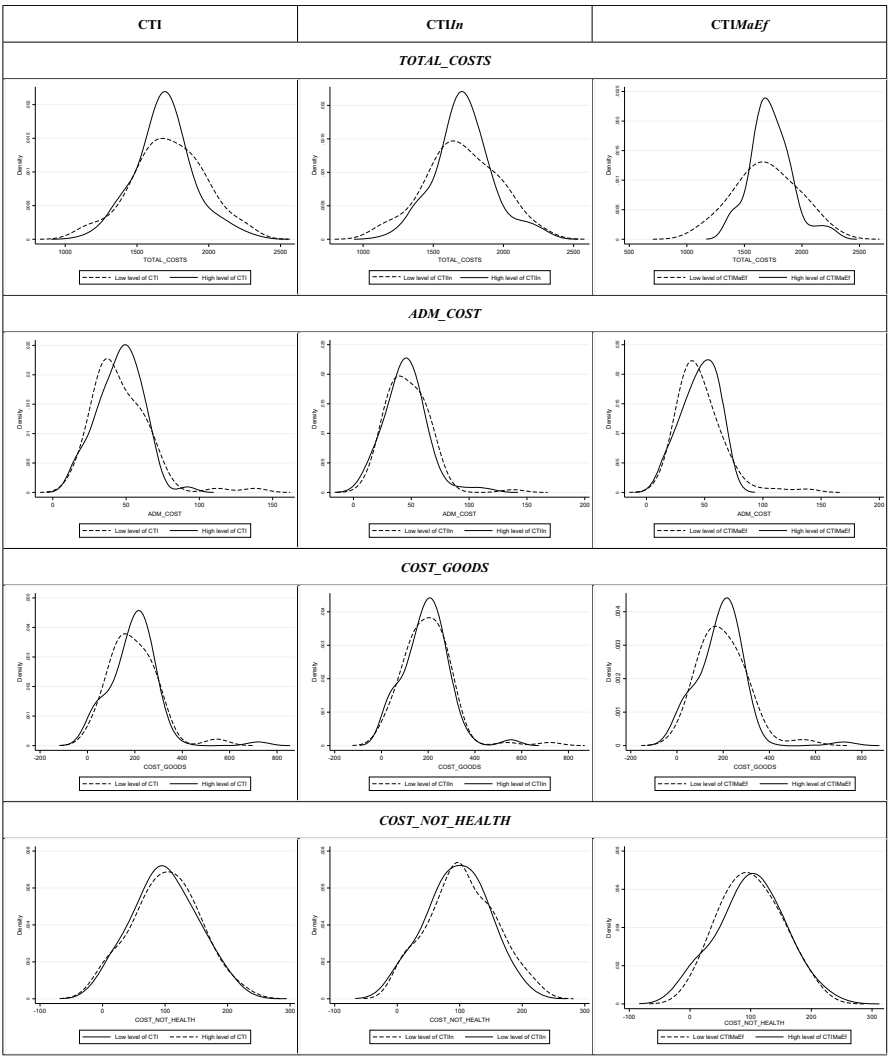

Fig. 2 Kernel density estimates. Note: Figure reports the univariate kernel for levels of the composite transparency indicators below (low) or above (high) the median value of the distribution. The kernel smoothing distribution estimated through the reflection method (Wand and Jones 1995). The criterion for bandwidth selection followed the plug-in method proposed by Sheather and Jones (1991). Source: our elaboration on the data provided by the sources reported in Table 3

(Wand and Jones 1995) and the reflection method used to determine the densities for the different categories of costs (*i.e.* TOTAL_COSTS, ADM_COST, COST_GOODS and COST_NOT_HEALTH). The bandwidth selection criterion follows the plug-in method proposed by Sheather and Jones (1991).

Specifically, Fig. 2 shows the kernel density estimates for two different levels (i.e. high and low, based on the related sampling distributions) of each composite indicator

of transparency. The kernel distributions in Fig. 2 allow us to provide a preliminary result in terms of the role of LHA transparency of the LHAs on cost performance. In general, the differences between the two groups (i.e. low and high levels) appeared quite slight, and the kernel distribution seemed quite consistent with respect to the three composite indicators, CTI, CTI_{In}, and CTI_{MaEf}. Looking at the individual cost components, the kernel density estimates seem to confirm the results of Table 4 on the pairwise correlation. The total per-capita costs (TOTAL_COSTS) were generally slightly lower for LHAs with composite transparency indices above the median value. The opposite occurred for administrative costs (ADM_COST), which were generally higher for the group of LHAs with composite indicators above the median value. In contrast, no substantial differences were detected between the two groups of LHAs with respect to the other two cost items (i.e. COST_GOODS and COST_NOT_HEALTH). This preliminary result seems to indicate that greater transparency is associated with lower total costs per capita, while simultaneously being associated with higher administrative costs per capita. Clearly, this tentative analysis does not consider differences in the observable characteristics of LHAs, which may have a major impact.

4.3 Multivariate Analysis on the Relationship Between Transparency and Cost

As mentioned earlier, to assess the relationship between the composite indicators of transparency and costs more robustly, we employ the approach proposed by Di Novi et al. (2018). However, in contrast to the authors, we estimate Equation [1] (Sect. 3.4.2) for four different cost functions (i.e. total costs, administrative costs, the cost of purchasing goods, and the cost of buying non-healthcare-related services) for the year 2013, including the degree of transparency among the determinants of the cost incurred by LHAs. For our purposes, we estimated Equation [1] using a slightly different approach from that proposed by Di Novi et al. (2018), which is based on a stepwise backward elimination technique (at the 5% level of significance). We believe that this approach, although based on statistical significance, potentially excludes variables that in principle could be important to explain the cost variability at the LHA level and this may not allow us to properly expose the impact of transparency on costs, which is the specific objective of our empirical exercise. We also note that our approach is conservative, as more covariates are considered. Thus, as a further exploratory assessment, we performed a stepwise backward elimination technique with a lower level of significance (i.e. 10%) and included in each estimate the controls for POP, CTI_j and D_SSR. As our purpose was limited to assessing whether associations between composite indicators of transparency and costs survive the inclusion of other covariates, we applied an empirical strategy that holds fixed the variables related to population, regional speciality, and the CTI, and we applied a stepwise backward elimination regression.

Tables 6, 7, 8, 9 report the estimates obtained for the four expenditure functions using OLS regression with cluster-robust standard errors at the regional level and stepwise backward elimination at the 10% level of significance. More specifically, Table 6 shows the estimates of the composite indicators of transparency (i.e. CTI, CTI_{In} and CTI_{MaEF}) and total costs. Whereas, Tables 7, 8, and 9 repeat the same

Table 6 Impact of transparency on total expenditure (per capita)

Variables	(1)		(2)		(3)	
	TOTAL_COSTS (log)		TOTAL_COSTS (log)		TOTAL_COSTS (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
Fixed covariates						
Constant	− 0.226	(0.840)	− 0.216	(0.841)	- 0.255	(0.832)
POP (log)	− 0.056	(0.120)	− 0.058	(0.120)	- 0.047	(0.119)
POP $(\log)^2$	0.002	(0.005)	0.002	(0.005)	0.002	(0.005)
CTI	− 0.023**	(0.009)	−		-	
CTI_{In}	−		− 0.001	(0.006)	-	
CTI_{MaEF}	−		−		- 0.024***	(0.008)
D_SSR	− 0.012	(0.010)	− 0.012	(0.010)	- 0.015	(0.010)
Other covariates						
DENSITY (log)	#		#		#	
DEPENDENCY	#		#		#	
INCOME (log)	0.063***	(0.020)	0.062***	(0.020)	0.051***	(0.021)
FOREIGNERS (log)	0.014*	(0.008)	0.016**	(0.008)	0.014*	(0.008)
MUNICIPALITIES (log)	#		#		#	
DOCTORS (log)	0.106**	(0.039)	0.107**	(0.039)	0.095**	(0.039)
PAEDIATRICIANS (log)	#		#		#	
HOSPITAL_BEDS (log)	#		#		#	
EMERGENCY_SERVICE (log)	#		#		#	
HOME_CARE (log)	#		#		#	

Table 6 (continued)

Variables	(1)		(2)		(3)	
	TOTAL_COSTS (log)		TOTAL_COSTS (log)		TOTAL_COSTS (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
FACILITIES (log)	#		#		#	
ADDICTION_SERVICE (log)	#		#		#	
D_RESERVATION	#		#		0.011*	(0.007)
D_MATERNAL	#		#		#	
D_TRANSPORT	#		#		#	
D_REANIMATION	#		#		#	
D_AMBULANCES	#		#		#	
D_SEP	#		#		#	
D_SEMI_SEP	#		#		#	
D_INT	#		#		#	
D_SEMI_INT	0.015*	(0.009)	0.015*	(0.009)	0.016*	(0.009)
D_CENTRAL_H	#		#		#	
D_CENTRAL	#		#		0.010*	(0.006)
D_RECOVERY	#		#		#	
PURCH_ADM_SERVICE (log)	#		#		#	
PURCH_HEALTH_SER (log)	− 0.006**	(0.003)	− 0.006**	(0.003)	- 0.006**	(0.003)
LUMP_SUM_FUND (log)	1.011***	(0.031)	1.011***	(0.031)	1.020***	(0.031)

Table 6 (continued)

Variables	(1)		(2)		(3)	
	TOTAL_COSTS (log)		TOTAL_COSTS (log)		TOTAL_COSTS (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
Observations	143		143		143	
R-squared	0.9477		0.9476		0.9494	
Adj R-squared	0.9437		0.9476		0.9447	
F	F(10, 132)	239.13	F(10, 132)	238.77	F(12, 130)	203.24
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.0327		0.0327		0.0324	
Akaike's information criterion (AIC)	− 561.7505		− 561.5472		− 562.4951	

Source: our elaboration on the data provided by the sources reported in Table 3

Notes: The table shows estimates of the impact of transparency as measured respectively by CTI, CTI_{ln} and CTI_{MaEf} indices on Total expenditures (log). Cluster robust standard errors at the regional level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

[#]Variables removed from regression, as they were not significant at the 10% level

Table 7 Impact of transparency on the administrative expenditure (per capita)

Variables	(1)		(2)		(3)	
	ADM_COSTS (log)		ADM_COSTS (log)		ADM_COSTS (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Fixed covariates						
Constant	4.176	(4.757)	4.120	(4.755)	4.172	(4.758)
POP (log)	− 1.094	(0.707)	− 1.093	(0.707)	- 1.088	(0.708)
POP $(\log)^2$	0.033	(0.028)	0.033	(0.028)	0.033	(0.028)
CTI	0.007**	(0.003)	−		-	
CTI_{In}	−		0.008**	(0.003)	-	
CTI_{MaEf}	−		−		- 0.004	(0.036)
D_SSR	− 0.039	(0.066)	− 0.040	(0.066)	- 0.037	(0.066)
Other covariates						
DENSITY (log)	#		#		#	
DEPENDENCY	#		#		#	
INCOME (log)	#		#		#	
FOREIGNERS (log)	#		#		#	
MUNICIPALITIES (log)	#		#		#	
DOCTORS (log)	− 1.008***	(0.238)	− 0.998***	(0.239)	- 1.012***	(0.237)
PAEDIATRICIANS (log)	#		#		#	
HOSPITAL_BEDS (log)	− 0.032***	(0.012)	− 0.032***	(0.012)	- 0.032***	(0.012)
EMERGENCY_SERVICE (log)	#		#		#	
HOME_CARE (log)	#		#		#	
FACILITIES (log)	0.060*	(0.037)	0.060*	(0.037)	0.060*	(0.037)
ADDICTION_SERVICE (log)	#		#		#	
D_RESERVATION	#		#		#	
D_MATERNAL	#		#		#	
D_TRANSPORT	#		#		#	
D_REANIMATION	#		#		#	
D_AMBULANCES	#		#		#	
D_SEP	− 0.270***	(0.102)	− 0.266***	(0.103)	− 0.271***	(0.102)
D_SEMI_SEP	− 0.181***	(0.066)	− 0.180***	(0.066)	− 0.182**	(0.066)
D_INT	#		#		#	
D_SEMI_INT	− 0.087*	(0.059)	− 0.088*	(0.059)	− 0.086*	(0.059)

Table 7 (continued)

Variables	(1)		(2)		(3)	
	ADM_COSTS (log)		ADM_COSTS (log)		ADM_COSTS (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
D_CENTRAL_H	− 0.268***	(0.066)	− 0.266***	(0.066)	− 0.270***	(0.066)
D_CENTRAL	− 0.170***	(0.049)	− 0.169***	(0.049)	− 0.172***	(0.049)
D_RECOVERY	0.246***	(0.047)	0.247***	(0.047)	0.244***	(0.047)
PURCH_ADM_SERVICE (log)	#		#		#	
PURCH_HEALTH_SER (log)	− 0.238***	(0.060)	− 0.239***	(0.060)	− 0.235***	(0.060)
LUMP_SUM_FUND (log)	0.967***	(0.162)	0.972***	(0.162)	0.966***	(0.162)
Observations	143		143		143	
R-squared	0.8013		0.8015		0.8012	
Adj R-squared	0.7778		0.7781		0.7778	
F	F(15, 127)	34.14	F(15, 127)	34.20	F(15, 127)	34.13
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.1870		0.1869		0.1870	
Akaike's information criterion (AIC)	− 58.672		− 58.862		− 58.643	

Source: our elaboration on the data provided by the sources reported in Table 3

Notes: The table shows estimates of the impact of transparency as measured respectively by CTI, CTI_{ln} and CTI_{MaEf} indices on administrative expenditures (log). Cluster robust standard errors at the regional level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

#Variables removed from regression, as they were not significant at the 10% level

empirical exercise for ADM_COSTS, COST_GOOD and COST_NOT_HEALTH, respectively.

In what follows, as our aim is not to assess the impact of specific covariates on different expenditure functions but only to evaluate whether the associations between costs and transparency survive the inclusion of other covariates, we limit our comments to the latter. In summary, the estimates reported in Tables 6, 7, 8, 9 largely confirm our previous findings on the univariate kernel density estimates. In particular, the results show that for total costs (per capita), the CTI indicators have the expected negative sign. This result implies that, in our sample, increased transparency is significantly associated with a reduction in the total costs for local healthcare facilities. Furthermore, CTI and CTI*MaEf* were both significant; however, CTI*In* was not. Given that the composite indicators CTI_{In} and CTI_{MaEF} capture different aspects of transparency related more to formal compliance requirements (CTI_{In}) and management issues (CTI_{MaEf}), respectively, we considered this result quite plausible. Moreover, we found no significant differences between ORD and SSR. Despite caution owing

Table 8 Impact of transparency on the expenditure of purchasing goods (per capita)

Variables	(1)		(2)		(3)	
	COST_GOOD (log)		COST_GOOD (log)		COST_GOOD (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Fixed covariates						
Constant	− 13.929*	(6.786)	− 13.906*	(6.794)	− 15.068**	(6.769)
POP (log)	1.010	(1.120)	1.121	(1.010)	1.249	(0.995)
POP $(\log)^2$	− 0.048	(0.040)	− 0.047	(0.040)	− 0.052	(0.039)
CTI	− 0.038	(0.055)	–		–	
CTI_{In}	–		− 0.029	(0.050)	–	
CTI_{MaEf}	–		–		− 0.037	(0.053)
D_SSR	− 0.321***	(0.076)	− 0.322***	(0.076)	− 0.316***	(0.077)
Other covariates						
DENSITY (log)	#		#		0.051*	(0.028)
DEPENDENCY	− 0.586*	(0.346)	− 0.613*	(0.369)	− 0.704*	(0.379)
INCOME (log)	#		#		#	
FOREIGNERS (log)	#		#		#	
MUNICIPALITIES (log)	#		#		#	
DOCTORS (log)	#		#		#	
PAEDIATRICIANS (log)	#		#		#	
HOSPITAL_BEDS (log)	− 0.025*	(0.014)	− 0.025*	(0.014)	#	
EMERGENCY_SERVICE (log)	− 0.084***	0.023)	− 0.084***	(0.023)	− 0.061**	(0.026)
HOME_CARE (log)	#		#		#	
FACILITIES (log)	#		#		#	
ADDICTION_SERVICE (log)	− 0.069*	(0.041)	− 0.069*	(0.040)	#	
D_RESERVATION	#		#		#	
D_MATERNAL	#		#		#	
D_TRANSPORT	#		#		#	
D_REANIMATION	#		#		#	
D_AMBULANCES	#		#		#	
D_SEP	− 0.900***	(0.123)	− 0.902***	(0.123)	− 0.986***	(0.104)
D_SEMI_SEP	− 0.122**	(0.060)	− 0.121**	(0.060)	− 0.137*	(0.071)
D_INT	#		#		#	
D_SEMI_INT	#		#		#	

Table 8 (continued)

Variables	(1)		(2)		(3)	
	COST_GOOD (log)		COST_GOOD (log)		COST_GOOD (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
D_CENTRAL_H	#		#		#	
D_CENTRAL	#		#		#	
D_RECOVERY	#		#		#	
PURCH_ADM_SERVICE (log)	#		#		#	
PURCH_HEALTH_SER (log)	− 0.670***	(0.085)	− 0.674***	(0.084)	− 0.702***	(0.088)
LUMP_SUM_FUND (log)	1.443***	(0.257)	1.443***	(0.258)	1.471***	(0.257)
Observations	143		143		143	
R-squared	0.8356		0.8354		0.8335	
Adj R-squared	0.8204		0.8203		0.8196	
F	F(12, 130)	55.07	F(12, 130)	55.00	F(11, 131)	59.63
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.2742		0.2744		0.2749	
Akaike's information criterion (AIC)	48.208		48.349		48.0016	

Source: our elaboration on the data provided by the sources reported in Table 3
Notes: The table shows estimates of the impact of transparency as measured respectively by CTI, CTI_{ln} and CTI_{MaEf} indices on expenditures of purchasing goods (log). Cluster robust standard errors at the regional level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1
#Variables removed from regression, as they were not significant at the 10% level

to the limitations of our sample, it may be interesting to examine the magnitude of the results shown in Table 6. The estimates show that a change of one unit in the CTI transparency indicator leads to a decrease of just over one euro (1.023) in the total cost per capita, considering that the dependent variable is expressed in logarithms.[19] As the average population of an LHA in our sample is approximately 450,000, the results indicate that, on average, a one-unit increase in the CTI indicator potentially results in a minor total cost of approximately half a million euros. Similar results were obtained for CTI_{MaEf} indicators.

Regarding administrative costs (per capita), our expectation of a sign of transparency in administrative costs is uncertain, considering that both directions are reasonable. Previous estimates have shown that the relationship is positive, which means that greater transparency implies higher administrative and bureaucratic costs. This result is confirmed in Table 7, which shows a positive and significant impact of the CTI on administrative costs. As can be seen, transparency has a positive impact

[19] In equivalent terms, one standard deviation increase in the CTI index (equivalent to 0.476) is associated with a reduction in total costs per capita of 0.4869 (0.476 × 1.023) euro.

Table 9 Impact of transparency on the expenditure for non-healthcare services (per capita)

Variables	(1)		(2)		(3)	
	COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Fixed covariates						
Constant	− 12.089*	(6.756)	− 12.001*	(6.730)	− 11.963*	(6.774)
POP (log)	0.484	(1.011)	0.500	(1.006)	0.444	(1.013)
POP $(\log)^2$	− 0.022	(0.040)	− 0.023	(0.039)	− 0.020	(0.040)
CTI	− 0.035	(0.054)	–		–	
CTI_{In}	–		− 0.056	(0.050)	–	
CTI_{MaEf}	–		–		− 0.003	(0.052)
D_SSR	− 0.467***	(0.093)	− 0.464***	(0.093)	− 0.471***	(0.093)
Other covariates						
DENSITY (log)	#		#		#	
DEPENDENCY	#		#		#	
INCOME (log)	#		#		#	
FOREIGNERS (log)	#		#		#	
MUNICIPALITIES (log)	#		#		#	
DOCTORS (log)	#		#		#	
PAEDIATRICIANS (log)	0.399**	(0.165)	0.394**	(0.164)	0.402**	(0.165)
HOSPITAL_BEDS (log)	#		#		#	
EMERGENCY_SERVICE (log)	− 0.047**	(0.023)	− 0.047**	(0.023)	− 0.046**	(0.023)
HOME_CARE (log)	#		#		#	

Table 9 (continued)

Variables	(1)		(2)		(3)	
	COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
FACILITIES (log)	#		#		#	
ADDICTION_SERVICE (log)	#		#		#	
D_RESERVATION	#		#		#	
D_MATERNAL	#		#		#	
D_TRANSPORT	#		#		#	
D_REANIMATION	#		#		#	
D_AMBULANCES	#		#		#	
D_SEP	− 1.602***	(0.142)	− 1.609***	(0.142)	− 1.603**	(0.143)
D_SEMI_SEP	0.188**	(0.093)	0.181**	(0.093)	0.191**	(0.093)
D_INT	#		#		#	
D_SEMI_INT	− 0.162*	(0.092)	− 0.162*	(0.091)	− 0.169*	(0.093)
D_CENTRAL_H	0.197**	(0.092)	0.192**	(0.092)	0.201**	(0.092)
D_CENTRAL	0.233***	(0.066)	0.231***	(0.066)	0.237***	(0.066)
D_RECOVERY	− 0.368***	(0.065)	− 0.373***	(0.065)	− 0.361***	(0.065)
PURCH_ADM_SERVICE (log)	0.060**	(0.025)	0.060**	(0.025)	0.058**	(0.025)
PURCH_HEALTH_SER (log)	− 0.611***	(0.091)	− 0.610***	(0.090)	− 0.619***	(0.092)
LUMP_SUM_FUND (log)	1.925***	(0.233)	1.901***	(0.234)	1.934***	(0.233)

Table 9 (continued)

Variables	(1)		(2)		(3)	
	COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)		COST_NOT_HEALTH (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Observations	143		143		143	
R-squared	0.8984		0.8991		0.8981	
Adj R-squared	0.8864		0.8872		0.8861	
F	F(15, 127)	74.89	F(15, 127)	75.45	F(15, 127)	74.62
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.2698		0.2698		0.2702	
Akaike's information criterion (AIC)	46.1521		45.1939		46.608	

Source: our elaboration on the data provided by the sources reported in Table 3

Notes: The table shows estimates of the impact of transparency as measured respectively by CTI, CTI_{ln} and CTI_{MaEf} indices on expenditures of purchasing non-healthcare services (log). Cluster robust standard errors at the regional level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

[#]Variables removed from regression, as they were not significant at the 10% level

on the performance of the LHAs, albeit with a reduced score, but it is significantly expensive in terms of administrative costs. In Table 7, we also find that, while CTI_{In} is positive and significant, the CTI_{MaEf} index, although positive, does not have a significant impact on administrative costs. Regarding the two composite indices, we believe that this result is reasonable and indirectly provides evidence of the robustness of our results. Again, using the usual caution, it may be interesting to examine the magnitude of the results shown in Table 7. The estimates show that a change of one unit in the CTI transparency indicator is associated with an increase of approximately one euro (1.007) in administrative costs per capita, considering that the dependent variable is expressed in logarithms. Similar results (1.008) were obtained for CTI_{In} indicators. This result would imply that an LHA moving from the bottom quintile (equal to 0.2963) to the median value of the CTI index (equal to 0.9349) is associated with higher administrative costs of about 0.64 euro per capita [(0.9349–0.2963) × 1.007].

Tables 8 and 9 confirm that transparency, as captured by our composite indicators, does not seem to have a major impact on COST_GOOD and COST_NOT_HEALTH. Specifically, Table 8 shows that the cost of purchasing goods (per capita) has the expected sign, but is not significant, even if there is a significant difference between ORD and SSR. For the last cost function, in Table 9, we find that the cost of buying non-healthcare-related services (per capita) has the expected negative sign, but is not significant. Instead, there is a significant difference between the ORD and SSR. Both these results are rather surprising and unexpected, given that the functions of purchasing goods and services are those most prone to potential corruption, and for which our expectation was that transparency could have a significant impact. This led us to assess our results with further caution and the need for further analysis with more extensive and consolidated data.

4.4 Robustness Check

As a further robustness check of the previous results, we used the lagged cost variables for 2014. This additional exercise also allowed us to assess whether the previously identified impact of transparency persisted on costs in the following year. The results of this further empirical exercise are shown in Table 10, which summarises the estimates from Tables 6, 7, 8, and 9 using per-capita costs in 2014 as dependent variables.[20] The estimates in Table 10 qualitatively overlap with those previously obtained, confirming the robustness of our findings.

In summary, the analyses carried out consistently show that greater transparency is associated with a better capability of LHAs to contain total health expenditure, while requiring larger administrative costs. However, for the sake of our analysis, we must consider the wide heterogeneity in displaying the data among the different LHAs, some problems related to the incompleteness of information, and finally, the high grade of LHA managers' discretion. As valuable as the impact of transparency could be, it is worth noting that it might not be a 'free lunch'.

[20] To save space, Table 10 reports only fixed covariates. Full estimates are available from the authors on request.

Table 10 Robustness checks on lagged variables

Variables	(1)		(2)		(3)	
	LAG_TOTAL_COSTS (log)		LAG_TOTAL_COSTS (log)		LAG_TOTAL_COSTS (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
Constant	− 0.440	(0.258)	− 0.416	(0.337)	− 0.413	(0.241)
POP (log)	− 0.050	(0.99)	− 0.043	(0.101)	− 0.043	(0.101)
POP (log)^2	0.003	(0.007)	0.003	(0.007)	0.003	(0.007)
CTI	− 0.018**	(0.007)	–		–	
CTI_{In}	–		− 0.001	(0.003)	–	
CTI_{MaEF}	–		–		− 0.028***	(0.009)
D_SSR	0.007	(0.009)	0.007	(0.009)	0.007	(0.009)
Other controls	Yes		Yes		Yes	
Observations	143		143		143	
R-squared	0.9494		0.9493		0.9612	
Adj R-squared	0.9468		0.9467		0.9589	
F	F(10, 132)	337.08	F(8, 134)	414.90	F(7, 135)	361.19
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.0328		0.0328		0.0331	
Akaike's information criterion (AIC)	− 560.9483		− 559.8988		− 559.3566	

Table 10 (continued)

	LAG_ADM_COSTS (log)		LAG_ ADM_COSTS (log)		LAG_ ADM_COSTS (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Constant	2.426	(2.031)	2.501	(2.013)	2.505	(1.937)
POP (log)	0.137	(0.180)	0.130	(0.179)	0.130	(0.081)
POP $(\log)^2$	0.014	(0.063)	0.010	(0.065)	0.017	(0.063)
CTI	0.040**	(0.019)	–		–	
CTI_{In}	–		0.042*	(0.017)	–	
CTI_{MaEF}	–		–		0.001	(0.021)
D_SSR	0.010	(0.055)	0.011	(0.054)	0.010	(0.055)
Other controls	Yes		Yes		Yes	
Observations	143		143		143	
R-squared	0.7262		0.7273		0.7278	
Adj R-squared	0.7032		0.7044		0.7050	
F	F(11, 31)	31.59	F(11, 131)	31.77	F(11, 131)	31.85
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.2228		0.2230		0.2235	

Table 10 (continued)

	LAG_ADM_COSTS (log)		LAG_ ADM_COSTS (log)		LAG_ ADM_COSTS (log)	
	Coeff	S.E	Coeff	S.E	Coeff	S.E
Akaike's information criterion (AIC)	− 61.243		− 59.937		− 59.597	
	LAG_COST_GOOD (log)		LAG_COST_GOOD (log)		LAG_COST_GOOD (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
Constant	− 11.401**	(5.200)	− 11.332**	(5.188)	− 10.913*	(5.316)
POP (log)	0.931	(0.813)	0.929	(0.814)	0.911	(0.819)
POP $(\log)^2$	− 0.032	(0.063)	− 0.031	(0.064)	− 0.031	(0.064)
CTI	− 0.011	(0.033)	−		−	
CTI_{In}	−		− 0.019	(0.103)	−	
CTI_{MaEF}	−		−		− 0.031	(0.073)
D_SSR	− 0.228**	(0.103)	− 0.231**	(0.104)	− 0.230***	(0.103)
Other controls	Yes		Yes		Yes	
Observations	143		143		143	
R-squared	0.5956		0.5993		0.5993	
Adj R-squared	0.5683		0.5721		0.5721	
F	F(12, 130)	55.07	F(12, 130)	55.00	F(11, 131)	59.63
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.4318		0.4337		0.4317	
Akaike's information criterion (AIC)	53.014		53.151		53.256	

Table 10 (continued)

	LAG_ COST_NOT_HEALTH (log)		LAG_ COST_NOT_HEALTH (log)		LAG_ COST_NOT_HEALTH (log)	
	Coeff	SE	Coeff	SE	Coeff	SE
Constant	− 16.822***	(5.004)	− 17.001***	(4.888)	− 16.909.963*	(4.901)
POP (log)	0.382	(0.079)	0.374	(0.076)	0.381	(0.082)
POP $(log)^2$	− 0.004	(0.016)	− 0.003	(0.015)	− 0.003	(0.015)
CTI	− 0.048	(0.030)	–		–	
CTI_{In}	–		− 0.032	(0.042)	–	
CTI_{MaEF}	–		–		− 0.101	(0.081)
D_SSR	− 0.378***	(0.066)	− 0.381***	(0.065)	− 0.381***	(0.065)
Other controls	Yes		Yes		Yes	
Observations	143		143		143	
R-squared	0.6071		0.5947		0.5956	
Adj R-squared	0.5837		0.5672		0.5683	
F	F(8, 134)	25.93	F(9, 133)	21.68	F(9, 133)	21.77
Prob > F	0.0000		0.0000		0.0000	
Root MSE	0.4347		0.4334		0.4342	
Akaike's information criterion (AIC)	76.886		76.550		75.256	

Source: our elaboration on the data provided by the sources reported in Table 3

Notes: The table shows estimates of the impact of transparency as measured respectively by CTI, CTI_{In} and CTI_{MaEf} indices on lagged cost variables. Cluster robust standard errors at the regional level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

In addition, our results are consistent with the idea that transparency is generally associated with better performance of LHAs in containing total healthcare costs while imposing larger administrative burdens. Our analysis confirms that transparency is important. However, fulfilling transparency obligations is costly in terms of administrative burden; thus, it is important to evaluate its effect on public administration performance. In this respect, the stability of rules and commitments and their consolidation and accountability would not only promote the efficacy of transparency and decrease the costs of its design and application but also have an impact on public spending.

5 Concluding Remarks

This study aims to assess whether and to what extent transparency affects public healthcare costs. For this purpose, we first built a composite indicator of transparency, already proposed in the literature in the field, to assess the differences in transparency and integrity between Italian LHAs, and then used multivariate regression to explore the relationship between the performance of different cost functions at the LHA level and the transparency index.

Among the proposed indicators of transparency, Galli et al. (2017) built an interesting composite indicator (CTI) based on the transparency obligations required by the public administration of the 2013 Italian legislation. The CTI has several properties that make it particularly useful for assessing transparency in the Italian NHS. First, the index is replicable in any context in which the public administration is called upon to engage in the active disclosure of information through regulated obligations. Moreover, Galli et al. (2017) showed that the CTI is robust and strongly correlated with the quality of institutions and the performance of public bodies (Galli et al. 2017). Finally, CTI has the advantage of quantitatively describing the level of transparency of public authorities as well as the two main characteristics of public action that are particularly important in the Italian public healthcare sector: 'integrity' (which includes items on income, disclosure of assets, and conflict of interest for both politicians and senior public officials) and 'performance' (which includes items on the management of public assets, timeliness of public payments, and quality of public services).

To the best of our knowledge, no previous study has analysed the performance of LHAs in terms of transparency issues. Italy constitutes a case study, considering its high degree of NHS decentralisation and the presence of a recent regulation that introduced an evaluation system for the implementation of strict transparency obligations. Overall, our work shows that cost reductions in public administration, cost efficiency, and containment of public healthcare expenditure are not only related to the reduction and consolidation of public entities, but that working on transparency and accountability issues can also lead to this.

In our empirical exercise, the measure of the transparency of Italian LHAs in 2013 through the CTI and its two sub-indicators, referring to *Integrity* (CTI_{In}) and *Performance* (CTI_{MaEf}), following the same methodology proposed by Galli et al. (2017), was built on a completely new first-hand dataset that included information on the integrity and management of LHAs' activities published on their respective websites

(in the Transparent Administration section). Finally, we investigated whether transparency matters in the performance of different cost functions at the LHA level using a stepwise estimator to examine the relationship between anti-corruption policies and their impact on performance, following the approach proposed by Di Novi et al. (2018). This approach has the advantage of providing a choice of regressors based on an optimality criterion. It should be noted, however, that the use of the stepwise estimator may cause bias owing to the elimination of marginally significant variables.

Our results showed a wide difference in transparency and integrity among LHAs that does not always follow the classic north–south divide in Italy. In addition, our results are consistent with the idea that transparency is generally associated with better performance of LHAs in the containment of total healthcare costs while imposing a larger administrative burden. This result holds true for both the ORD and the SSR.

Although our study contributes to the literature and provides relevant health policy insights, we also identified some limitations and avenues for further research. First, the cross-sectional nature of our analysis makes it impossible to control for unobserved heterogeneity. However, as in previous recent analyses on the same topic (Galli et al. 2020; Albanese et al. 2021), the possibility of expanding our dataset is limited by the inability to compare CTI index to subsequent periods, owing to changes in Italian legislation. Therefore, our results only show an association between transparency and healthcare expenditure, which nevertheless appears robust.

Another limitation in estimating the empirical model of the impact of transparency on the performance of LHAs was the selection of the performance cost measures. Indeed, as in Di Novi et al. (2018), our analysis focused only on costs not directly related to the provision of health services, such as administrative costs, cost of goods, and non-health costs. However, it is reasonable to assume that transparency obligations are more directly related to these costs than to health-related costs.

Despite these limitations, we believe that the results of our study provide practical insight into both the measurement of LHA transparency and its main relationships with performance and may have important implications for the accountability of the Italian NHS and the containment of public health expenditure, improving the use of public resources, and increasing citizens' trust in public institutions.

Our findings are also relevant from a policy perspective as they are consistent with the idea that transparency is generally associated with better performance of the LHAs in the containment of total health expenditure, but its implementation imposes administrative costs, which the policy maker should bear in mind in order to develop less burdensome transparency measures, as they might not be a 'free lunch'. In this respect, the stability of rules and commitments and their consolidation and accountability would not only promote the efficacy of transparency and decrease the costs of its design and application but also have an impact on public spending.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40797-023-00229-3.

Acknowledgements We wish to thank two anonymous referees for their careful review, the Associate Editor, Professor Bianca Biagi and the Editor in Chief Professor Alessandro Sapio for their helpful advices. We are also grateful to Emma Galli, Veronica Grembi and Ilde Rizzo for useful comments on an earlier draft of the paper. Carla Scaglioni acknowledges that this paper is a research outcome of the project MIUR

PRIN 2017 – 2017CRLZ3F "PolitiCanti. The Politicisation of Corruption and Anticorruption Strategies in Italy. The usual disclaimers apply.

Funding Open access funding provided by Università degli Studi di Catania within the CRUI-CARE Agreement. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability The data used in this work are available from the authors upon reasonable request.

Declarations

Conflict of Interest The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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