Determinants of Heritage Authorities' Performance: An exploratory study with DEA bootstrapping approach

Finocchiaro Castro, Massimo, Guccio, Calogero and Rizzo, Ilde
Department of Law and Social Science, University of Reggio Calabria, Department of Economics and Quantitative Methods, University of Catania, Department of Economics and Quantitative Methods, University of Catania

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Massimo Finocchiaro Castro, Calogero Guccio and Ilde Rizzo♦

Abstract. Government regulation plays a significant role in the field of heritage conservation. Namely, regulation is aimed at controlling the stock of heritage, restricting or modifying the activities of public as well as private actors. Surprisingly, the literature has neither extensively investigated the performance of the heritage authorities involved in the implementation of conservation policies nor its determinants. In this paper we address this issue, from a theoretical as well as an empirical perspective, using Sicily as a case study. More precisely, we analyze the determinants of the differences in the efficiency levels of conservation activity of the nine Sicilian heritage authorities over the period 1993-2005. Economic and managerial variables are used to distinguish non-discretionary from discretionary causes. The results show that the efficiency scores seem to be only affected by economic factors whereas the managerial variables do not affect the performance of heritage authorities.

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Keywords: Heritage regulation, cultural policy, efficiency analysis.

♦ Department of Law and Social Science, University of Reggio Calabria, via Tommaso Campanella, 38/A - 85100 Reggio Calabria, Italy, *massimo.finocchiaro@unirc.it*; Department of Economics and Quantitative Methods, University of Catania, Corso Italia, 55 - 95121 Catania, Italy, *guccio@unict.it* (corresponding author); Department of Economics and Quantitative Methods, University of Catania, Corso Italia, 55 - 95121 Catania, Italy, *rizzor@unict.it*.

I. INTRODUCTION

Almost everywhere the public sector plays an important role in the conservation of cultural heritage, even if with different quantitative and qualitative characteristics. In this field Government action can follow various patterns using a mix of different tools such as public spending, tax-expenditures and regulation.

The efficiency and effectiveness of heritage conservation policies, i.e. their capability to meet citizens' demand and to score the expected results in terms of 'public interest', crucially depends on the features of the decision-making process and of the actors involved. A crucial role is plaid by heritage authorities, i.e. by those uncharged of implementing conservation policies, because the asymmetrical information characterizing the heritage field. Surprisingly, the literature on the economics of heritage has not extensively investigated their performance and in this paper we try to fill this gap. To fulfill this objective we address this issue, from a theoretical as well as an empirical perspective; Sicilian heritage authorities (*Soprintendenze*) are chosen as a case study to analyze the role of the regulator in the heritage field and to devise some policy implications.

In this paper we extend previous literature on conservation activity, using the production function of heritage authorities defined by Finocchiaro Castro and Rizzo (2009) and trying to evaluate the determinants of their performance. For this purpose we use the efficiency scores, calculated through the application of Data Envelopment Analysis method, as dependent variable and economic as well as managerial factors as independent variables. The determinants are estimated using parametric as well as semi-parametric approaches (Simar and Wilson, 2007).

The empirical results of our analysis show that Sicilian heritage authorities achieve, on average, low efficiency levels that seems to be affected by economic variables (such as the size of the regulated territory, per-capita income, level of education, number of buildings built before 1919) whereas the managerial variables (such as seniority and expertise of the regulator) do not affect the performance. Tentative policy implications stemming from our analysis would suggest to introduce incentives toward efficiency in the decision-making process and to reshape the territorial design of *Soprintendenze* to reduce their costs of production.

The analysis develops as follows: we firstly discuss the main economic characteristics of Government intervention for conservation in section 2 and, then, in section 3 we describe the institutional features of our case study, the *Soprintendenze* in Sicily. In section 4, the methodological issues underlying the measurement of the efficiency of heritage conservation authorities are explored, technical efficiency of Sicilian heritage authorities is estimated and the empirical analysis of its determinants is presented. Section 5 offers some concluding remarks.

II. MAIN FEATURES OF GOVERNMENT INTERVENTION FOR CONSERVATION

1. Government tools

In all the industrialized countries the public sector plays an important role in the conservation of cultural heritage, even if with different quantitative and qualitative characteristics. The analysis of the normative rationale for Government intervention is outside the scope of this paper and the related efficiency and equity arguments are taken for granted;[1] in what follows the attention will be concentrated on the features of public action and on its effects. In fact, though market failure provides a rationale for Government intervention this is not to say that Government action is efficient in providing conservation nor that there is only one way to intervene (Mazza, 2003).

In the heritage field, Government uses direct monetary tools – such as expenditure - as well as indirectly monetary tools – e.g. tax-expenditures -. At the same time, a major role is played by a non monetary instrument such as regulation. In what follows, attention will be concentrated on public spending and regulation.[2]

Public expenditure can be used for many purposes: to purchase goods and services[3] as well as buildings of artistic interest or to provide subsidies and/or loans to cultural institutions (public, private or non profit) or to private owners of historic buildings.

As Peacock and Rizzo (2008) point out, the size, the composition and the institutional features of public spending vary across countries: for instance, state-driven, bureaucratic systems[4] prevail in France and Italy with a larger role for the public sector and the central government while Anglo-Saxon countries follow an arms-length approach, with lower direct expenditure and larger private support (Ploeg van der, 2006). Notwithstanding the size of public cultural spending, Government plays a very relevant role in the cultural heritage field since non monetary tools, such as regulation, which are not accounted for by statistics, affect the allocation of resources in a relevant way.

Regulation is a non monetary tool aimed at restricting or modifying the activities of public as well as private actors in order to control the stock of heritage. Regulation constrains the exercise of property rights in many different ways: for instance, listing historical and archaeological sites, as well as individual buildings, preventing the demolition of a building or a group of buildings; imposing restrictions on the uses to which the building can be put, on its appearance and the way

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[1] A general overview of the pros and cons of the normative justifications for government intervention in the heritage field is provided by Peacock and Rizzo (2008).

[2] Tax expenditures, e.g. tax allowances to incentive private financing are not taken into account because they are not relevant for our case study since they are outside the influence of Regional government.

[3] For example, the salaries for Government experts and staff involved in heritage conservation, the purchasing of consumption goods, equipment for diagnosis, etc. for the restoration activity.

[4] Such a system is state-driven and top-down; bureaucrats and politicians decide how to distribute public funds.

restoration or re-use is carried out; imposing limitations on the use of land affecting heritage buildings. Regulated subjects must comply and penalties are provided for non compliance.[5]

Regulation is a flexible tool, which satisfies the need for quick decisions characterizing the heritage field, and at the same time leaves many degrees of freedom to the decision–maker, since the concept of heritage is not well defined (Rizzo, 2003).

2. Focus on conservation

The principles of cultural heritage conservation internationally recognized have been established through time among conservation professionals and may be found in a great number of international,[6] regional, national, and thematic documents on a variety of topics, such as historic towns, training and education, popular architecture etc.

Different meanings can be assigned to the word 'conservation' with different economic implications (Peacock and Rizzo, 2008). In some cases the concept of conservation aims not only at keeping heritage safe from harm but also at enhancing it through a positive change, in other cases this latter component is almost absent. Conservation choices can exert relevant economic effects because they impinge upon property rights and may also generate a distributional impact. If a conservationist stance is adopted and heritage is simply preserved, its full enjoyment and utilization might be prevented and, therefore, its potential benefits cannot be fully generated. As Rizzo (2002) outlines, restrictions on the use of buildings, their appearance and the way in which restoration and re-use is carried out might undermine the possibility of restoring and revitalizing historical centers which is usually one objective on the political agenda of local authorities. Conservation, therefore, generates costs which depend on the stance adopted by the regulator: apart from the administrative and bureaucratic ones, some of these costs can be foreseen in advance because they are closely connected to the conservation (for example, the requirement to use special materials, qualified operators, etc. to ensure quality) while others are subject to a high degree of uncertainty, as a consequence of an undue 'conservationist' approach to the fabric, well beyond what is justified by the costs-benefits comparison (Pignataro and Rizzo,1997). At the same time, the indirect costs imposed on any activity that interfere with heritage regulation should not be undervalued.

The above mentioned problems mainly arise when the decision-making process is supply-oriented, e.g. mainly driven by the preferences of the experts rather than by society and when the public decision-maker has no incentives to take into account society's preferences. Sicily offers a good example of the occurrence of the above mentioned problems as it will be outlined in the following section.

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[5] In addition to these forms of regulation, which Throsby (1997) defines as *hard regulations*, there are also non-enforceable forms of regulation, i.e. *soft regulations*, mainly applied at international level: Charters, Codes of Practice, Guidelines, etc., as well as listing, such as the Unesco World Heritage List, belong to this type of regulation, are implemented by agreement and not involve penalties.

[6] The list of international documents is almost endless ranging from ICOMOS documents, such as the Venice Chart (1964) or the Nara Document on Authenticity (1999) to the Unesco Vienna Memorandum on Historic Urban Landscapes (2005) or to the 2000 Charter of Krakow (produced by the cooperation of six European countries).

III. INSTITUTIONAL FEATURES AND POLICY TOOLS IN SICILIAN HERITAGE CONSERVATION

Sicily is an Italian region which enjoys full autonomy in the field of heritage policy. Political decisions about heritage policy are taken by the Regional government while their implementation is carried out by nine Heritage *Soprintendenze,* which are responsible for any decision regarding heritage conservation. Their activity offers an interesting case study both for understanding the features of Sicilian conservation policy and for analyzing the role of the regulator in the heritage field.

As it was said before, heritage is a vague and broad concept and, as a consequence, the conservation activities of *Soprintendenze* are discretional, wide-ranging and impinge upon private as well as public decisions. In other research,[7] it has been pointed out that *Soprintendenze* are run by experts, enjoy great freedom not only because of the choice of instruments and their intensity but also because the scope of their activity largely depends on their autonomous evaluation. However, the degree of autonomy enjoyed by *Soprintendenze* is very low at the operational level, for example as far as the management of personnel is concerned.

Following Rizzo (2002), we distinguish two types of *Soprintendenze* activities: passive conservation (PC) and active conservation (AC). The former pertains to the activity of providing rules and of monitoring their implementation, i.e. the regulation activity, for both public and private heritage situated in the territory of competence; the latter refers to direct intervention to provide conservation, i.e. spending activity. Such a distinction might be questioned, since PC and AC activities may be interconnected in some cases[8]; while recognizing the significance of these links, using such a distinction is useful because it recalls the conventional distinction between monetary and non monetary tools (spending and regulation) and, thus, helps to understand the complexity of conservation activities from an economic point of view. Moreover, the distinction allows for empirical investigation by introducing the possibility of devising indicators for each activity.

1. Passive and active conservation activity

Passive conservation (PC) activity implies many different administrative acts, enforceable on both private and public owners, such as:

- *constraints* (limitations on the use of heritage whose strength depends on the type of heritage and includes items such as monumental constraints, prohibition of alterations and land constraints);
- *demolition orders*;

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[7] See Rizzo (2002, 2003).

[8] For instance, research and study activities underlying both can be considered interdependent; a discovery resulting from an archaeological excavation might call for imposing constraints; at the same time, expropriation is prerequisite to direct intervention.

- *authorizations* (consent for carrying out activities such as restoration and rehabilitation of heritage);[9]
- *permission to import and export*.

In some cases, such as authorizations, the above regulatory activity is in response to the owner's demand. In other cases, they can be spontaneous measures to constrain owner's activity (landscape constraints) or punishment for violations (for instance, demolition orders). *Soprintendenze* decisions are taken on the grounds of technical (given that their staff is made up of experts) and administrative grounds and are subject to judicial review only if those affected dispute the decision in court.

Active conservation (AC) refers to direct intervention to provide conservation. AC and involves a wide array of activities such as taking an inventory, performing scientific research, training staff, updating, excavating, and restoring. In other words, AC refers to the activities put in practice by *Soprintendenze* via direct expenditure, mainly through the hiring of external contractors to carry out physical operations and draw up contracts.

The degree of autonomy enjoyed by *Soprintendenze* is very high at the planning level while low at the operational level.[10] No autonomy exists as far as the operation of funds is concerned, given that any expenditure decision – even within the program – has to be approved at the regional level. The only cases in which *Soprintendenze* enjoy financial freedom is in so-called situations of high emergency.

The *Soprintendenze*'s expenditures are constrained by the availability of funds. Diagnostic activity is usually not feasible on a large scale and, therefore, poor information does exist on the health status of heritage. Thus, AC activity cannot be directed where it is most needed, with the likely consequence of reducing the overall effectiveness of the allocation of resources in this sector. *Soprintendenze* performance is not adequately monitored at the Regional level nor evidence emerges that an incentive system exists (in terms of the size of budget or private benefits for bureaucrats, such as career and salary) to induce *Soprintendenze* to fulfill government objectives, however they are defined. As a consequence, conservation would seem to be mainly driven by objectives and preferences of the specialists and experts within the *Soprintendenze* (Finocchiaro Castro and Rizzo, 2009).

2. Policy Implications

Having briefly described the aims and tools of regional government policy in the heritage field, we turn to the implications of this mixture of functions. In what follows, we will raise some issues for further discussion and development and offer few tentative conclusions.

The first question to address is how each *Soprintendenza* establishes a trade-off between the output it is expected to produce (AC and PC) and its constraints. Such a trade-off is likely to take

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[9] The strength of this act depends on the type of heritage and the constraint to which it is subject. For instance, it is more severe if the constraint refers also to the interior of a listed building and less severe if the building is only subject to restrictions on its appearance.

[10] Once the yearly activity program submitted by each *Soprintendenza* is approved at the regional level, no discretionary variation is allowed.

into account exogenous constraints as well as preferences determined, among other things, by existing incentives.

Constraints seem to be different in the two cases. As pointed out above, AC measures are partially constrained by the availability and timing of financial resources assigned by the regional government to each *Soprintendenza*, though empirical evidence shows that, on average, *Soprintendenze* only manage to spend half the resources they obtain (Mignosa, 2005). Specific incentives to stimulate such activity do not enter into play; *Soprintendenze* are not responsible for managing the budget; and, indeed, the fact that the figures describing the budget of each *Soprintendenza* are not easily available (Mignosa, 2005) suggests the lack of consciousness at the regional level for the adoption of any incentive system. Moreover, financial resources are not assigned on grounds of past performance. All things being equal, financial constraints are likely to be less severe for PC activities because, as tools of regulatory activity, their direct spending is less crucial.

At the same time, finding out whether AC is more important than PC for gaining prestige and reputation among specialists is worthwhile. In both cases, research is involved but in AC the restored building or the archaeological excavation is a testimony to the expertise of the *Soprintendenza*'s specialists. Moreover, these specialists have direct interest in any AC activity that offers scope for new discoveries and historical interpretation in their field of expertise, which would allow them to gain professional prestige. Such expertise also tends to prevail when discoveries take place by chance, for instance, during the public construction of a road. The interest of the *Soprintendenza*'s experts may lead to the work being suspended, i.e. to use a regulatory tool, to allow specialists to investigate the discovery, use their findings for scientific work, and enhance their reputations. It might be argued that it is in society's interest to promote knowledge and, therefore, that such procedure is in line with society's welfare. This is not necessarily the case or, at least, how the decision-making process works in practice does not allow for assessing its relationship with society's welfare. In fact, the decisions made by the *Soprintendenza* are usually not evaluated using the criterion of opportunity cost, nor are there institutional forms for representing local preferences; as a consequence, the informational advantage enjoyed by the experts drives decisions. The same argument applies as far as the strength of the regulation put into practice is concerned: to what extent the owners of designated buildings should be imposed restrictions on their use and appearance or the way conservation is carried out are open questions and depend crucially on the discretionary powers of the *Soprintendenza*. No strong evidence exists to assess whether the demand for public intervention is more or less effective in AC than in PC. In the latter, a strong individual component has to be taken into account: authorization, permission, demolition and constraints are divisible in the sense that their benefits and costs affect activities relating to both private and public owned heritage, thus causing an accountability problem. *Soprintendenza*'s performance is likely to be monitored by interested parties (individuals as well as public and private institutions), and delays or poor performance are likely to give rise to some form of protest. While such monitoring is not coupled with specific incentives (such as financial rewards or career benefits) designed by the regional government to stimulate a *Soprintendenza*'s performance (as measured by, for example, the length of bureaucratic procedures and complaints from the public), it is likely to be effective whenever individual bureaucratic responsibility is involved, the concept of bureaucratic risk aversion offering an useful explanatory framework (Mazza and Rizzo, 2000). As previously mentioned, *Soprintendenze* are liable for any damage to heritage due to their action (or inaction) with regard to any third-party work or activity. Public concern may thus provide an incentive to concentrate attention on PC activities, allocating available resources (such as personnel) to those activities subject to stronger external control.

On the other hand, the role of public opinion seems to be less relevant whenever the costs and benefits of a public good rather than a private one are involved. The public is interested in monitoring the *Soprintendenze*'s activity because of its impact on the local economy and on the conservation of local artistic patrimony. Though the role of the public is important because of the close relationship between heritage and local identity, its effectiveness on the decision-making process does not seem evident. Indeed, as it was stressed before, the fact that conservation is devolved to the regional government does not in itself guarantee that local preferences are adequately represented. One possible explanation lies in the fact that the accountability of regional government in Sicily has been very low: lack of real fiscal autonomy coupled with a proportional political system has so far implied a very low degree of political accountability (only in 2001 the voting system changed with the regional governor being elected by voters). The lack of institutional forms for representing local opinion in the decision-making process is likely to limit the beneficial impact of devolution. Nor is *Soprintendenze* performance adequately monitored at the regional level. As mentioned above, no evidence emerges that an incentive system exists to induce *Soprintendenze* to fulfill government objectives, however they are defined. As a consequence, conservation would seem to be mainly driven by objectives and preferences of the specialists and experts within the *Soprintendenze*, without any effective public opinion control.

IV. EMPIRICAL ANALYSIS

1. Methodological issues in efficiency measure

The theoretical literature on efficiency of production originates with the work of Koopmans (1951), Debreu (1951), and Shephard (1953). The first attempt to estimate efficiency has been made by Farrell (1957) and, then, studied in depth by Charnes *et al.* (1978). Following the seminal work by Farrell (1957), the concept of economic efficiency has been articulated into three types: technical, allocative and scale efficiency. Technical efficiency measures the firm's ability to use the available technology in the most effective way. Allocative efficiency depends on prices and measures the firm's ability to make optimal decisions on product mix and resource allocation. Combining measures of technical and allocative efficiency yields a measure of economic efficiency. Scale efficiency measures the optimality of the firm's size.

As a nonparametric approach, Data Envelopment Analysis (DEA) (Fried *et al.*, 2008) is used to derive technical and scale efficiency. DEA method can be applied using either output-based or input-based approach, depending on whether input or output distance function is used. Surprisingly, DEA has been applied to measure the efficiency of art organizations, showing a great degree of flexibility, just in the last ten years. Luksetich and Nold Hughes (1997) investigate, by means of DEA and regression analysis, the efficiency and its determinants of funding activities of a sample of symphonic orchestras in the United States. The efficiency of religious organizations has been studied by Zaleski and Zech (1997). They apply DEA methodology to the U.S. Catholic Church to examine the relative shortage of priests. Finally, two contributions focus on the efficiency analysis of museums. Pignataro and Zanola (2001) analyze the efficiency levels of museums located in two very different Italian regions (Sicily and Piedmont), whereas Basso and Funari (2004) focus on many public Italian museums computing DEA efficiency levels and decomposing the efficiency scores into pure technical and scale components.

In general terms a DEA input-oriented efficiency score θ_i is calculated for each *DMU* solving the following program for *i=1,…., n* (CRS constant return to scale case):

$$\begin{aligned} &\text{Min}_{\lambda,\theta_i} && \boldsymbol{\theta_i} \\ &\text{subject to} && -\boldsymbol{y_i} - \boldsymbol{Y}\lambda \geq 0 \\ & && \boldsymbol{\theta_i x_i} - \boldsymbol{X}\lambda \geq 0 \\ & && \lambda \geq 0 \end{aligned} \qquad (1)$$

where $\boldsymbol{x_i}$ and $\boldsymbol{y_i}$ are respectively the input and output of *i-th DMU* ; $\boldsymbol{X}$ is the matrix of input and $\boldsymbol{Y}$ is the matrix of output of the sample; λ is a $n \times 1$ vector of constant.

The model (1) can be modified to account for VRS (variable return to scale) by adding the convexity constraint: $\boldsymbol{I}'\lambda = 1$.

In this paper, we use DEA method to estimate input-based technical and scale efficiency. The main focus of the study is on the analysis of input-based technical efficiency under variable returns to scale (VRS). However, we also report the technical efficiency scores computed under constant return to scale (CRS).

Simar and Wilson (2000) clarify that traditional DEA methods yields biased estimates of efficiency. Based on homogeneous bootstrap procedure for DEA estimators, proposed by Simar and Wilson (1998), the paper estimates the bias and the confidence intervals of the input-based technical efficiency with VRS.[11] Whereas DEA methods have been widely applied, most researchers have largely turned a blind eye to the statistical properties of the estimators. Ignoring the statistical noise in the estimation can lead to biased DEA estimates and misleading results because all the deviations from the frontier are considered inefficient. Simar and Wilson (2000) argue that bootstrap is the most currently feasible method to establish the statistical property of DEA estimators. Thus we apply homogeneous bootstrap procedure to correct the bias in DEA estimators and to construct their confidence intervals.

The model [1] incorporates only discretionary inputs and does not take into account the presence of environmental variables or factors, also known as non-discretionary inputs, on performance. In this case, the most appropriate approach to use is the so-called two-stage analysis.[12] This technique uses the inefficiency estimates as a dependent variable in the second stage of the analysis to investigate the influence of environmental variables on performance.

[11] Estimates have been obtained using the package FEAR 1.1, developed by Wilson (2007).

Recent literature on two-stage estimation approach shows that the estimates are biased because of serial correlation of efficiency scores and suggests to apply semi-parametric two-stage technique to perform an estimation on non-discretionary inputs.

To correct for bias in the estimates, we employ the following algorithm that replicates Simar and Wilson (2007)'s Algorithm 2. The computation of the efficiency score that solves problem [1] is then considered as an estimate $\hat{\theta}_i$ of the efficiency score θ_i. The maximum likelihood is used in the truncate regression of $\hat{\theta}_i$ on z_i obtaining the maximum likelihood estimates $\hat{\beta}$ and $\hat{\sigma}_\varepsilon$ of β and σ_ε. Then, compute a L_1 bootstrap estimates of β and σ_ε with the following steps:

a) for each DMU *i=1, ….., n*, we compute ε_i from $N(0,\hat{\sigma}_\varepsilon)$ with left truncation at $(1-\hat{\beta}_i z_i)$;

b) compute $\theta_i^* = \hat{\beta} z_i + \varepsilon_i$;

c) employ a data set of pseudo data $x_i{*} = x_i$ and $y_i{*} = y_i \frac{\theta_i}{\theta_i^*}$

d) estimate $\hat{\theta}_i^*$ using $x_i{*}$ and $y_i{*}$

We obtain a *n* set of bootstrap estimate $\Psi_i = \left\{\hat{\theta}_i^*\right\}_{j=1}^{L_1}$

For each *i=1,…., n* compute the bias-corrected estimator $\hat{\hat{\theta}}_i^*$ using Ψ_i and $\hat{\theta}_i$ as follows: $\hat{\hat{\theta}}_i^* = \hat{\theta}_i^* - BI\hat{A}S_i$, where $BI\hat{A}S_i$ is the bootstrap estimator of bias obtained as Simar and Wilson (1998). Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\hat{\theta}}}_i^*$ on z_i to provide an estimate $\hat{\hat{\beta}}$ of β and an estimate $\hat{\hat{\sigma}}$ on $\hat{\sigma}_\varepsilon$.

Loop over the next three steps L_2 times to obtain a set of bootstrap estimate $\Phi_i = \left\{\hat{\theta}_i^*\right\}_{s=1}^{L_2}$

a) for each DMU *i=1, ….., n*, we compute ε_i from $N(0,\hat{\hat{\sigma}}_\varepsilon)$ with left truncation at $(1-\hat{\hat{\beta}}_i z_i)$;

b) again for each DMU *i=1, ….., n*, compute $\theta_i^{*}{*} = \hat{\hat{\beta}} z_i + \varepsilon_i$;

c) maximum likelihood is used in the truncate regression of $\hat{\hat{\theta}}_i$ on z_i to obtain an estimate $\hat{\hat{\beta}}{*}$ of β and an estimate $\hat{\hat{\sigma}}{*}$ on $\hat{\sigma}_\varepsilon$.

Finally, we use the bootstrap values in Φ_i and the original estimates $\hat{\hat{\beta}}$ and $\hat{\hat{\sigma}}$ to construct estimated confidence intervals for each element of β and $\hat{\sigma}_\varepsilon$.

In the following analysis, we employ different techniques in the two-stage analysis of the determinants of *Soprintendenze*'s performance in order to compare parametric to semi-parametric estimation approach.

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[12] For a recent survey of different approach see Cordero-Ferrera et al. (2008).

2. Technical efficiency estimate

The application of DEA to estimate the productivity of a Decision-Making Unit (DMU) calls for some steps to follow. Firstly, we define the production set in order to specify all the feasible combinations of input and output. Consequently, we make some standard assumptions on the production set.[13] Following the contribution of Finocchiaro Castro and Rizzo (2009), we study a production function of *Soprintendenze* given by 1 input – personnel - and 2 outputs - expenditure (AC) and weighted administrative actions (PC).[14] The PC data refer to the number of administrative actions, produced by each *Soprintendenza* as listed in the Official Regional Registry, weighted to take into account the differences in the technical and the administrative difficulty faced in implementing each type of the actions listed.[15] The AC data refer to the expenditures (i.e. payments) of *Soprintendenze* (at 2000 fixed price).

Data on the nine Sicilian *Soprintendenze* come from official Regional sources and refer to the period 1993-2005. Thus, our sample is a balanced panel data with 117 observations. Table 1 shows the descriptive statistics of variables employed.

Table 1 – Descriptive statistics on input and output (cross-sectional - time-series distribution)

Variable			**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs.**
input	**PERSONNEL**	*overall*	236.34	109.36	62.00	510.00	N = 117
		between		107.79	79.92	437.15	n = 9
		within		39.28	104.19	316.50	T = 13
output	**AC**	*overall*	6567.25	3442.81	1407.81	19685.29	N = 117
		between		2990.74	2623.13	12566.51	n = 9
		within		1958.00	583.01	13686.03	T = 13
	PC	*overall*	317.09	455.58	11.43	3863.40	N = 117
		between		186.24	103.32	636.78	n = 9
		within		420.06	296.29	3543.71	T = 13

Source: our computation on data of the Official Registry of *Regione Siciliana*.

The use of panel data in DEA model is widely discussed in the literature.[16] Among the several possible ways to deal with panel data in efficiency DEA models, we have chosen to treat the panel

[13] The standard assumptions are a) production set is convex and closed; b) production requires the use of inputs and both inputs and outputs are strongly disposable; c) observed set of inputs and outputs results from independent draws from a probability density function with bounded support over the production set; d) density function is strictly positive for all points along the frontier; e) any point along the frontier the density is continuous in any direction toward the interior of the production set (Färe *et al*, 1985).

[14] Kneip *et al.* (1998) show that the rate of convergence of Farrell's estimate efficiency score depends on the number of input and output. In particular, the choice of a simple estimation model makes it possible to derive more consistent estimates of efficiency scores.

[15] Weights (ranging from 1 to 5) have been assigned on the grounds of a questionnaire submitted to some experts employed by both the *Soprintendenze* and the *Assessorato ai BB.CC. e P.I.* (Sicilian Region Department of Arts and Education) to take into account the differences in the technical and the administrative difficulty to implement the actions listed. For further details, see Finocchiaro and Rizzo (2009).

[16] The traditional approach to the analysis of efficiency DEA models with panel data is the so-called "window analysis", converting a panel into an overlapping sequence of windows which are then treated as separate cross-sections. However the choice of windows can lead to bias in estimates. An alternative way is to employ the Malmquist index of productivity change. Another possibility is to treat the panel as a single cross-section and pool the observations. In this case, each observation being considered as an independent

as a single cross-section and pool the data, given the slow convergence rates of DEA estimator. This choice is also based on the hypothesis that the conservation activity in Sicily is not affected by relevant technological changes. Consequently, efficiency estimates reflect relative DMU's performance to the invariant technology.[17] Finally, we apply the inspection technique developed by Wilson (1993) to control for possible effect of outliers on efficiency estimate. The results show no evidence of any outlier's effects on the estimate.

Tables 2 reports the estimates of the mean efficiency scores, measured with Farrell (1957) efficiency definition, for each DMU. Following Simar and Wilson (1998), we implement the homogeneous bootstrap procedure to correct the bias in DEA estimators and obtain their confidence intervals.[18]

Table 2 – Efficiency estimate – mean value for each *Soprintendenza*

SOPRINTENDENZE	Pure technical efficiency (VRS - input oriented)					Total technical efficiency (CRS - input oriented)
	Eff. Score mean value	Eff. Bias corr - mean value	Bias - mean value	Lower bound - mean value	Upper Bound - mean value	Eff. Score - mean value
DMU_1	0.378	0.348	0.029	0.320	0.371	0.362
DMU_2	0.717	0.669	0.048	0.626	0.706	0.703
DMU_3	0.467	0.421	0.046	0.383	0.458	0.444
DMU_4	0.495	0.449	0.046	0.405	0.488	0.345
DMU_5	0.492	0.452	0.040	0.413	0.484	0.466
DMU_6	0.568	0.466	0.102	0.395	0.555	0.502
DMU_7	0.807	0.732	0.075	0.667	0.796	0.639
DMU_8	0.602	0.527	0.075	0.474	0.589	0.590
DMU_9	0.445	0.414	0.031	0.384	0.439	0.436
All sample	**0.552**	**0.498**	**0.055**	**0.452**	**0.543**	**0.499**
Mean scale efficiency						***0.903***
Mean scale inefficiency						***0.097***

Source: our computation on data of the Official Registry of *Regione Siciliana*.

Column 2 provides the mean values of DEA efficiency scores, columns 3 and 4 provide the bias-corrected efficiency scores and the bootstrap bias estimates, respectively. Columns 5 and 6 provide the two boundaries of 95% confidence intervals for the bias- corrected efficiency scores. Finally, column 7 reports efficiency scores under CRS. Table 2 shows a poor efficiency level for the whole sample. The bias-corrected efficiency estimates range from 0.348 to 0.732, with an

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one, a single frontier is computed and the relative efficiency of each DMU in each period is calculated. Estache *et al.* (2004) observe that pooling data is a special case of "window analysis" with the advantage of being a non discretionary choice of windows. We follow the latter approach in order to increase the estimation power of the model.

17 We used the Malmquist Index to check for increases in the productivity of DMUs. Our data show that productivity has not significantly changed during the observation period.

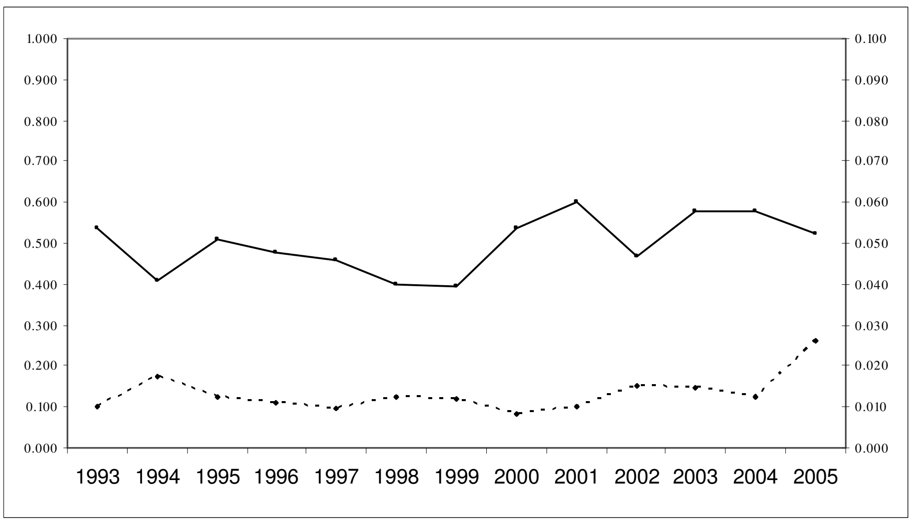
18 The confidence intervals and the bias-corrected efficiency scores have been estimated using the homogeneous bootstrap procedure with 2,000 bootstrap draws as described by Simar and Wilson (1998). We also assume the independence between technical inefficiency and output levels as well as the mix of inputs that are produced,

average value of 0.498. Thus, our results indicate that, on average, each *Soprintendenza* can reduce its input proportionally by 50.2 percent without reducing output, assuming that no technological change has taken place in the observation period. Table 2 shows also that the portion of scale inefficiency (i.e. the penalty suffered when assuming CRS instead of VRS) is quite small (0.097).

The choice between CRS and VRS depends crucially on various factors related to the context and scope of the analysis.[19]

Figure 1 plots the mean and variance of the bias-corrected efficiency estimates for each year of observation.[20] The mean is measured on the left vertical axis, while variance is measured on the right vertical axis. Data show a low variability in the mean of the bias-corrected efficiency scores over the sample period and, overall, a quite low performance at year level. The highest efficiency scores are 2001 (0.600), 2003 (0.579), and 2004 (0.576). It has to be noted that there is no evidence of a time trend in the average efficiency levels. Thus, we find a quite small dispersion of productivity across *Soprintendenze*.

Figure 1 – Mean and variance of efficiency estimate across *Soprintendenze* by year



Source: our computation on data of the Official Registry of *Regione Siciliana*.

Figure 2 describes the scatter plot of sample observations ordered by the bias-corrected efficiency score. The 95% confidence intervals for each DMU are represented by the lower and the upper bound, and original efficiencies are indicated by the circle. It is evident that the original efficiencies are not included in the confidence interval. This result clearly reflects the theory behind the construction of these intervals (Simar and Wilson, 1998).

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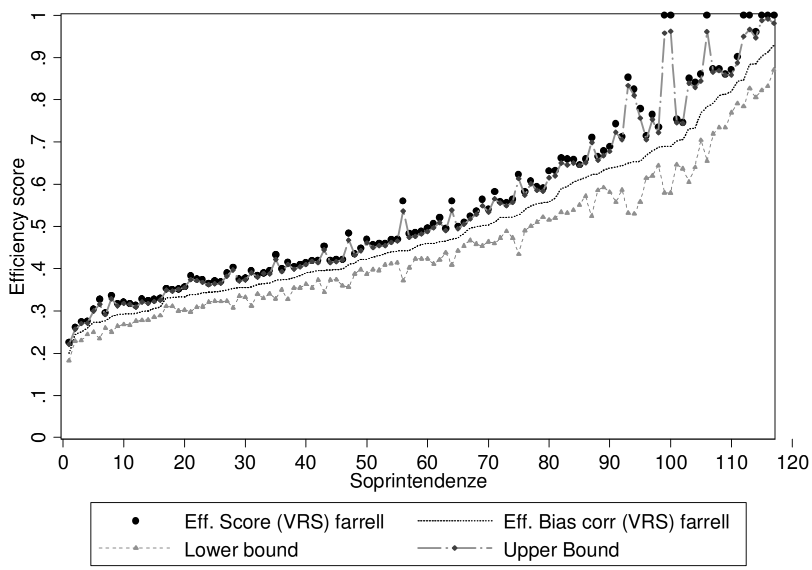
[19] To check for constant returns to scale we estimate the correlation between CRS efficiency scores and Soprintendenze size measured with variables related to the operating scale such as personnel (correlation, 0.294) and population served (correlation, 0.074). In principle the low correlation values justify the use of the VRS. In addition, we calculated the correlation between CRS and VRS that turned out to be very high (0.918).

[20] Solid line shows mean efficiency, measured on the left vertical axis, dashed line shows variance of estimated efficiency, measured on the right vertical axis.

The efficiency ranking of the original DMU efficiencies changes compared with the bias-corrected efficiency ranking, although the difference is quite small. This suggests a relative low level of noise that appears in a little bias correction downward. The relative smaller confidence intervals and minor bias of VRS estimates imply that the results are relatively stable and suggest that other factors, such as environmental variables, could explain the sources of efficiency variations. This issue will be addressed in the following section.

Figure 2 - Confidence intervals and point estimates for VRS



3. The empirical analysis of the determinants of performance in heritage conservation

The standard DEA model incorporates only discretionary inputs, whose quantities can be varied at DMU's need, to investigate the determinants of performance and do not take into account the presence of environmental variables or factors, also known as non-discretionary inputs. However, differences in the levels of non-discretionary inputs may play a relevant role in determining heterogeneity across DMU because non-discretionary and discretionary inputs jointly contribute to each DMU outputs.

To investigate the determinants of the performance of *Soprintendenze* conservation activity, we consider economic as well as managerial variables[21]. The estimated models can be expressed by the following general formulation:

$$\theta_i = f(z_i) + \varepsilon_i \qquad (2)$$

[21] We do not include the stock of heritage as explanatory variable because the official available data on the amounts of heritage under the supervision of each *Soprintendenza* are rather obsolete and partial.

where θ_i is the efficiency scores that resulted from previous stage, z_i is a set of possible non-discretionary inputs and ε_i is a vector of error terms.

The rationale for the selection of environmental variables that can affect the level of efficiency of each *Soprintendenza* is based on various considerations. First, data availability influences the selection of variables; second, almost all the institutional characteristics of the environment in which each *Soprintendenza* usually operates should be included in the analysis.

As far as the economic variables are concerned, supply and demand variables are used. Looking at the supply-side and considering that *Soprintendenze's* outputs are only partially affected by environmental factors and by the geographical features of the area under control, we believe that the only variable affecting the cost of production is the size of each province. Thus, being heritage scattered in the Provincial territory, the size of the area, expressed in squared Kms (***SIZE***), *ceteris paribus*, is likely to affect negatively the cost of producing both AC and PC activities.

In addition, allocations can also be a proxy for the size of each *Soprintendenza*. This is not to say that greater allocation necessarily implies greater heritage[22], but only that the greater the size of the budget the greater the scope of *Soprintendenza* activity. However, in our analysis the use of such a variable is not advisable because the efficiency scores, i.e. the dependent variable, have been calculated using the expenditures that are strongly correlated with allocations.

Looking at the demand, it would be useful to use per capita cultural spending as a proxy for the demand for cultural activities. This variable would give also a measure of cultural environment and, therefore, it might be able to represent the interest of the local community for heritage conservation. So far, we have not found reliable data of per capita cultural spending at provincial level for the entire period of observation. For this reason, income per capita is used as a proxy for the demand of conservation (***INCOME***) on the assumption that higher income per capita implies higher levels of economic activity and, *ceteris paribus*, a more dynamic private construction sector. As a consequence, increases in building and restoration activities call for higher demand of services supplied by *Soprintendenze*. However, income per capita is also a proxy for the socio-economic status of population such as, for instance, education which, in turns, positively affects the demand for heritage. To control for the effect of education, we add the variable ***EDU*** obtained computing the number of graduates on thousand of inhabitants.

Furthermore, it has to be noted that the areas under the competence of *Soprintendenze* in which the concentration of historical buildings is higher represent one of the most relevant source of demand of services provided by *Soprintendenza*, being a significant portion of its activity represented by architectonical and historical constraints. Thus, we use the registered estimate of the number of properties built before 1919 sited in the area of each *Soprintendenza's* competence (***OLD_B***) to capture the abovementioned effect.

As well as the environmental factors, the characteristics of cultural managers can affect the efficiency of *Soprintendenze*. In particular, we include into the analysis a measure of the length of

[22] Guccio and Mazza (2005) point out that socio-political variables affect allocations.

the appointment and of the field of specialization of *Soprintendenti* (e.g. architect, archaeologist, art historian). [23]

The first managerial variable we deal with is the seniority of *Soprintendenti* (***SENIORITY***), i.e. the length of appointment of *Soprintendenti* in monthly terms[24]. The interpretation of the impact of this variable is not straightforward. On the one hand, a long tenure implies more experience and, thus, a positive effect on efficiency; on the other hand, from a public choice perspective, longer tenure would imply more powerful bureaucrats, who would have a greater bargaining power to extract resources from the political decision-maker and would be less accountable. In this case, we may observe a negative impact on efficiency. Finally, a variable representing the expertise of each *Soprintendente* can be used to investigate whether a change in the field of specialization of each *Soprintendente* might affect the efficiency scores. Rizzo (2002) argues that cultural managers may drive *Soprintendenza*'s activities on specific conservation issues according to their own field of interest, showing almost any concerns of efficiency. For this purpose, we introduce a dummy to control for change of the field of specialization when a new *Soprintendente* is appointed (***EXPERTISE***). Table 3 describes the variables employed in the analysis and Table 4 shows the descriptive statistics.

Table 3. Variables employed

Dependent Variable	
EFFICIENCY	Efficiency scores (VRS)
Explanatory Variables	
SIZE	Size of the area of each Province i=1,…,9 (in millions of squared Kms)
EDU	Number of graduates on 1,000 inhabitants in each Province i=1,…,9 in each year j=1,…,13
INCOME	Per capita income in each Province i=1,…,9 (in thousands)
OLD_B	Number of properties built before 1919 in Province i=1,…,9 (in thousands)
SENIORITY	Length of appointment of each *Soprintendente* measured in months
EXPERTISE	Dummy for the changes in expertise of *Soprintendente* (Dummy=1 when a change takes place)

Table 4. Descriptive statistics.

[23] *Soprintendente* is the Provincial Director for Culture (Rizzo and Towse, 2002).
[24] To take into account for possible endogeneity we introduce a lagged variable.

Variable	Mean	St. Dev.	Minimum	Maximum
EFFICIENCY	0.55	0.21	0.23	1
SIZE	2.86	0.95	1.61	4.99
EDU	53.86	13.79	28.41	90.25
INCOME	11.68	2.47	7.08	19.69
OLD_B	23.37	14.14	9.88	52.33
SENIORITY	80.54	86.76	12.00	324.00
EXPERTISE	0.15	0.35	0.00	1.00

Source: our computation of data of the Official Registry of *Regione Siciliana*.

In two-stage approach, researchers usually adopt censored regression techniques (Tobit) or, in a few cases, OLS estimates to take into account the censored nature of dependent variable. The most recent literature shows that the estimates are biased because of serial correlation of efficiency scores and suggests to apply semi-parametric two-stage technique to estimate efficiency scores using non-discretionary inputs (Simar and Wilson, 2007).

Thus, we run an OLS, Tobit, truncated regression with and without a double bootstrap estimation on efficiency scores[25]. According to Simar and Wilson (2007) the truncated regression model provides better statistical inference than the Tobit and OLS regression models but, at the same time, the double bootstrap estimation provides the most robust check[26].

The estimated coefficients show quite similar values confirming the robustness of our empirical analysis. However, it has to be noted that our investigation does not aim at providing a punctual estimate of the marginal effects on performance of non-discretionary inputs but only average effects. Thus, the following comments refer to an overview of the sign of the variables employed.

Looking at the supply side, we notice that the variable ***SIZE*** is significant, showing that the DMU's performance is affected by specific dimension of the area in which the DMU operates. The negative sign seems to indicate that, being heritage scattered in the Provincial territory, the dimension of the area under control, *ceteris paribus*, affects negatively the cost of producing both AC and PC activities. Moving to the demand-side of the production process, our results show that the size of the demand positively affects the efficiency scores. The variables ***INCOME*** and ***OLD_B*** are always significant with positive sign. This confirms that the demand exerts a positive effect on efficiency because of the *stimulus* of the heritage owners on DMUs performance (Finocchiaro Castro and Rizzo, 2009). In contrast, the variable ***EDU*** does not significantly affect the productivity level of *Soprintendenze*.

Finally, none of the managerial variables (***SENIORITY*** and ***EXPERTISE***) is significant in any estimated model. A possible explanation lies on the above mentioned limited operational autonomy of *Soprintendenti* as far as the personnel and management of financial resources are concerned. Hence, the efficiency scores of the Sicilian *Soprintendenze* seem to be affected by the demand and supply variables only.

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[25] See section 4.1.

Table 5. OLS, Censored and Truncated estimates for Efficiency scores (VRS)

Independent variable: Efficiency scores (VRS input oriented)
Functional form: linear
Estimation range: 1993 – 2005
Observation: 117

Variable	(1)	(2)	(3)	(4)
	OLS regression	Tobit regression	Truncated regression	Truncated regression with double bootstrap
	EFFICIENCY	EFFICIENCY	EFFICIENCY	EFFICIENCY
Constant	*0.5604****	*0.5447****	*0.6098****	*0.6183****
	(0.1672)	*(0.1501)*	*(0.1599)*	*(0.1680)*
SIZE	-0.1551**	-0.1592**	-0.1550***	-0.2543***
	(0.0627)	(0.0640)	(0.0597)	(0.0614)
EDU	-0.0080*	-0.0087	-0.0069	-0.0057
	(0.0043)	(0.0051)	(0.0042)	(0.0044)
INCOME	0.0554**	0.0613***	0.0442*	0.0461*
	(0.0227)	(0.0174)	(0.0240)	(0.0245)
OLD_B	0.0102***	0.0104**	0.0099***	0.0097***
	(0.0037)	(0.0043)	(0.0036)	(0.0037)
SENIORITY	-0.0002	-0.0003	-0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
EXPERTISE	0.0093	-0.0009	0.0416	0.0543
	(0.0436)	(0.0541)	(0.0462)	(0.0493)
Observation	117	117	110	110
Fixed effect	no	no	no	no
R-squared	0.3236	-	-	-
F - test	6.26***	-	-	-
LR χ^2	-	$\chi^2(6)= 31.13$***	-	-
Wald χ^2	-		$\chi^2(6)= 28.91$***	-

Notes: standard errors are reported in parentheses. ***, ** and * denote significance at 1, 5 and 10 per cent levels, respectively.

V. CONCLUDING REMARKS

In this paper we focused on the regulation of heritage conservation and its relevant effects on the allocation of resources. Among the several regulation models of heritage conservation, we considered the Sicilian model of heritage authorities as a case study. Sicily offers an interesting example of devolution and the size and importance of its heritage is such that conservation policy is a significant area of activity for the Regional Government.

We contributed to the current literature on the empirical analysis of regulation in the field of heritage conservation in two directions. First, we apply Simar and Wilson (1998) homogeneous bootstrap procedure on a production function, based on the activities carried out by heritage authorities, to correct the bias in DEA estimates and establish their confidence interval. This new procedure sheds some light on the effects of statistical noise on DEA estimates, often ignored by most of the researchers in the field of efficiency analysis.

[26] Given that our sample is a balanced panel we check for panel effect. Breusch-Pagan test rejects the hypothesis of random effects.

Second, we investigated, from both a theoretical and empirical point of view, the determinants of efficiency estimates using economic and managerial variables to distinguish non-discretionary from discretionary inputs. Following the most recent literature on statistical inference in nonparametric DEA models (Simar and Wilson, 2007), we apply a two-stage semi-parametric estimate to explain the sources of efficiency variations of Heritage Authorities. To the best of our knowledge this is the first paper applying this new techniques to the field of heritage conservation.

The results shown, on average, a poor efficiency level for the sample that did not crucially depend on the assumption of VRS instead of CRS. We also reported a slight variability in efficiency scores and, overall, a quite low performance at year level. The patterns of efficiency levels turned out to be clearly non-increasing. This result recalls the well-known *Baumol's disease* effect in the field of heritage conservation (Baumol and Bowen, 1966).

We investigated the determinants of *Soprintendenze*'s efficiency scores applying on economic and managerial variables a double bootstrap procedure (Simar and Wilson, 2007).

Our results shown that the efficiency scores of the Sicilian *Soprintendenze* seem to be affected by demand and supply variables only, whereas the variables related to the organizational features of heritage authorities do not play any effect.

Tentative policy implications stemming from our analysis stress the positive role on efficiency exerted by incentives. As shown by Finocchiaro Castro and Rizzo (2009), given the institutional features of the Sicilian heritage organizational structure, the only *stimulus* depends mainly on demand whereas almost no incentives are built in the decision–making process. Thus, a greater operational autonomy of *Soprintendenti* combined with a systematic assessment of their performance might introduce positive incentives toward efficiency.

Finally, the analysis shows some room for reshaping the territorial design of *Soprintendenze* since the coincidence with the provincial area seems not justified by any sound economic reason and bears negative effects on the costs of production.

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