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HOW EFFICIENT IS THE ITALIAN HOSPITALITY SECTOR? A WINDOW DEA AND TRUNCATED-TOBIT ANALYSIS

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How efficient is the Italian hospitality sector? A window DEA and truncated-Tobit analysis

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Abstract

This paper analyses the Italian regional efficiency of the hospitality sector using a data envelopment analysis (DEA), for the time span 2000-2004. Via a window DEA, pure technical efficiency is computed. The Lombardy region presents the best relative performance. Overall Italian regions denote important sources of inefficiency mostly related to their inputs. Via a truncated-Tobit analysis, the rate of utilisation and regional intrinsic features positively are found to affect hospitality efficiency. Nevertheless, empirical evidence does not support spill-over effects amongst Italian regions.

Keywords: Regional hospitality sector, window DEA, double bootstrap, spatial heterogeneity.
Jel Classification: C14, C24, L83, R11

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1. Introduction

The contribution of tourism demand as a drive of economic growth is well established (see Brida and Pulina, (2010) for a comprehensive literature review). During the second half of 2007, the sub-prime crisis extended to many other sectors of the economy including tourism activity. As World Travel & Tourism Council (WTTC, 2010) reports, global travel and tourism (T&T) economy GDP declined by 4.8% in 2009 and this caused the loss of almost 5 million jobs. Moreover, T&T investment decline by over 12%. Nonetheless, this economic sector still employed over 235 million people worldwide (8.2% of all employment) and generated 9.4% of world GDP.

While tourism demand has been extensively analysed, tourism supply has received less attention (Wanwill, 2007). However, hospitality plays an important role as a revenue generator. Federalberghi & Mercury (2010) emphases that the Italian hospitality sector, expressed in terms of number of hotel rooms, ranks fourth after the United States, Japan and China. Besides, amongst the European countries, Italy has the leadership in terms of hotel dimension and quality (number of stars). Yet, Italian hospitality is characterised by a strong seasonality given that its rate of utilisation (40%) is much lower than the global leading countries (e.g. Japan, 74%; France, 61%; U.S., 60%; Spain, 53%). Such rate of utilization decreased by 6.8% during the period 2000-2004, although tourist arrivals and nights of stay rose by 7.4% and 1.9%, respectively (ISTAT, 2007). Hence, Italy experiences a maturity stage in its hospitality sector and accounts for a relevant world market share in tourism.

On this basis, it seems of interest to examine the economic efficiency of the Italian hospitality sector. This question is particularly important in the light of an increasing awareness of sustainability issues that challenge the need for a further expansion of tourism infrastructure that may exploit finite and no-renewable natural resources (e.g. Bruni et al., 2011).). As a matter of fact, within the time span between 2000 and 2004, supply capacity grew by 7.9%, reaching two million beds-place in 2004 (ISTAT, 2007).

To shed light on these issues, in this paper, a window Data Envelopment Analysis (DEA) is run following the work by Baker et al. (1984) and Charnes et al. (1985). Since the seminal work on DEA by Charnes et al. (1978), empirical research papers have focused on efficiency in the manufacturing sector, health services, educational institutions, the services sector and private organisations such as banks. To date, only a few studies exist on tourism activity and hotel efficiency (see Barros, 2005 and Pulina, Detotto and Paba, 2010 for a literature account). Window-DEA is a non-parametric panel approach that can be viewed as an appropriate tool to quantify the efficiency level of a group of Decision Making Units (DMUs) with respect to its own performance over time, as well as the performance of the relatively most productive decision units within the sample set. By adopting variable return to scale (VRS) pure technical efficiency (PTE) is obtained. This economic indicator relates the performance of each DMU to the estimated production frontier. The frontier consists of all those points in which a relative optimal capacity of transformation of inputs into outputs is achieved. Via a window DEA and a hypothetical homogenous technology, an understanding of how well entrepreneurs process their inputs, with respect to their own past performance as well as their own benchmark, is assessed. It is possible to determine the source of inefficiency as a key element to provide useful management information and formulate policy that enables economic agents to improve their efficiency.

Specifically, a macro investigation is run by analysing Italian hospitality economic efficiency at a regional level and its dynamic evolution over time. Besides, via a double bootstrap procedure and a truncated-Tobit regression is possible to further assess what the main factors that influence the efficiency of the regional hospitality sector are. As a further objective, a spatial heterogeneity investigation is also run to assess possible spill-over effects amongst the Italian regions.

The paper is organised as follows. In the next section a updated literature review is provided. In the third section the methodology adopted is highlighted. The fourth section provides a DEA analysis for the hotel sector from which policy implications are drawn in the final conclusions.

2. An updated literature review

Barros and Alves (2004), Barros (2005), and more recently Pulina, Detotto and Paba (2010) and Assaf and Agbola (2011) provide an extensive literature review on hotel sector efficiency. One of the main features of the reviewed empirical studies is the cross-section dimension and the relative low number of observations.

As a further update to this strand of the literature, similar analytical features have been encountered for. For example, Neves and Lourenço (2009) use a static input-oriented DEA model to determine the efficiency of a sample of worldwide hotel companies during the period 2000-2002. The authors note that the majority of the hotel companies are characterized by decreasing return-to-scale. Furthermore, specialized hotel companies perform better than those characterised by a diversification strategy. Mariarty (2010) applies the DEA method to establish relative technical and scale efficiency of hospitality divisions in New Zealand during the period 1999-2003. He observes that the majority of the hospitality divisions exhibit increasing return-to-scale. Shuai (2010) analyses the impact of internet marketing on hotel performance. It is found that internet marketing tool (e-communication and e-transaction orientations) is positively associated with hotel efficiency. Assaf and Cvelbar (2010) analyse the performance of Slovenian hotels over the period 2005–2007. Bernini and Guizzardi (2010), by employing a stochastic translog production function explore the efficiency of a balanced panel of 414 Italian hotels over the period 1998-2005. They find that efficiency is enhanced by both firms location and the tourism vocation of a destination. A significant contribution to efficiency relates to their location in seaside cities but especially in arts cities. Besides, Italian business corporations are mainly characterised by a relevant use of the labour factor of production and decreasing return-to-scale. Sirirak et al. (2011) find an empirical evidence of the positive influence of ICT adoption on hotel performance in Taiwan. Shuai and Wu (2011) make use of a DEA and a Grey entropy approach to evaluate whether internet marketing affects the operating performance of 48 international hotels in Taiwan for the years 2006 and 2007. Results suggest that hoteliers have to adopt a more strategic approach to exploit the E-market opportunities, first preparing the ground for direct contact with customers. Assaf and Agbola (2011) via a DEA double bootstrap method estimate the performance of a total of 31 Australian hotels for the period 2004-2007. The findings show that larger hotels and those located in cities are more efficient than those in suburban and regional areas.

The majority of the reviewed studies relate to the performance of a sample of hospitality firms. Less attention is paid to the overall and comparative efficiency of a specific geographical area. By running DEA methods on aggregated data, for example, Cracolici et al. (2008) explore tourism competitiveness of Italian provinces for the years 1998 and 2001. They observe a weak decrease of efficiency over the years. Suzuki et al. (2010), extending the work by Cracolici (2008), employ an Euclidean Distance Minimization to investigate Italian provinces efficiency as tourist destinations in 2001. The findings show that the performance of many Italian provinces can be improved considerably. Barros et al. (2011), analyse the determinants of the technical efficiency of leading French tourism regions. They find that the sea, sun and strategy based on the beach endowment, along with the presence of museums and monuments, play a relevant role in explaining efficiency in French regions. Molina-Azorin et al. (2011) via a multilevel approach and hierarchical linear models, show that Spanish hotel performance is highly influenced by location and destination effects where the firm operates.

To date, one of the main shortcomings of recently published studies relates to the use of a relatively low number of observations, but with a few exceptions (e.g. Cracolici (2008); Neves and Lourenço (2009), Bernini and Guizzardi (2010); Suzuki et al. (2011)). The present study stands as a novel example of a robust panel DEA in analysing regional hospitality efficiency and the main causes of economic inefficiency.

3. Methodology: DEA and Post-DEA

In the literature two main DEA models are considered. The DEA-CCR model developed by Charnes et al. (1978), that assumes that all DMUs are operating at CRS, and the DEA-BCC model, developed by Banker et al. (1984), that hypothesises VRS.

A measure of efficiency for a given DMU is linked to an "unknown" production frontier. The efficient production frontier allows one to calculate and compare a firm's efficiency to its own benchmark. From an empirical perspective, two different methodologies may be employed: a non-parametric approach such as the DEA, and a parametric approach, such as the Deterministic Frontier Analysis or the Stochastic Frontier Analysis.

Differently from a parametric approach, that requires an a priori specification of the functional form of the production function as well as an a priori hypothesis on the disturbance term, DEA is a flexible technique that, in a multiple input-output framework, is reduced to a virtual uni-input-output structure. As an additional advantage, the economic variables of interest can be used jointly despite their measure scale (Köksal and Aksu, 2007). Within a given sample of productive units, a subgroup will achieve a relative efficiency equal to 1 (or 100%) and the residual DMU will be considered as inefficient if it has reached a score of less than 1 (or less than 100%). Mathematically, the efficiency (θ) of the DMU *i* is given by the expression (1):

$$\theta_i = \frac{\sum_{n=1}^{N} u_{ni}\, y_{ni}}{\sum_{k=1}^{K} v_{ki}\, x_{ki}} \qquad (1)$$

where y_{ni} is the quantity of output n produced by the DMU i; u_{ni} is the weight of output n for the DMU i; x_{ki} is the quantity of input k employed by the DMU i; v_{ki} is the weight of input k for the DMU i.

The solution of equation (1) is given by either a maximisation or a minimisation approach when either one input or one output is used. However, in the presence of a multivariate input-output framework, the problem can be solved with either an output-oriented method (O-OM), by maximising the numerator while keeping the denominator constant, or an input-oriented (I-OM) method, by minimising the denominator while keeping the numerator constant. Within the O-OM, no DMU in the sample, with the same type of inputs, is able to derive a higher quantity of output. In general, this setting is employed for planning and strategic objectives. For example, it is used when a DMU need to understand whether an expansion of its capacity is feasible, as long as the existing infrastructure has already been used at its maximum capacity given the level of the inputs (Cullinane et al., 2004). Linear programming solves the maximisation problem in the following manner:

$$Max\ \theta_i\left(y_i, x_i, u_i, v_i\right) = \frac{\sum_{n=1}^{N} u_{ni}\, y_{ni}}{\sum_{k=1}^{K} v_{ki}\, x_{ki}} \qquad (2)$$

subject to:

$$\sum_{k=1}^{K} v_{ki}\, x_{ki} = 1 \qquad (3)$$

that is the weighted sum of inputs is constant and set to 1, so as to avoid an infinite number of solutions, and

$$u_{ni} \geq 0, \quad v_{ki} \geq 0 \qquad n = 1,2,\ldots, N \text{ outputs and } k = 1,2, \ldots, K \text{ inputs} \qquad (4)$$

As stated, the problem can be also solved with an I-OM. In this case, no DMU in the sample is able to use a lower quantity of inputs to obtain the same level of output. This setting is appropriate when operational and management objectives are involved; for example, when DMUs are more interested in how to reduce their production costs

(Cullinane et al., 2004). Linear programming solves the minimisation problem in the following manner:

$$Max\,\theta_i\left(y_i, x_i, u_i, v_i\right) = \frac{\sum_{n=1}^{N} u_{ni}\, y_{ni}}{\sum_{k=1}^{K} v_{ki}\, x_{ki}} \qquad (5)$$

subject to:

$$\sum_{n=1}^{N} u_{ni}\, y_{ni} = 1 \qquad (6)$$

that is the weighted sum of outputs is constant and set to one, so as to avoid an infinite number of solutions, and

$$u_{ni} \geq 0, \quad v_{ki} \geq 0 \qquad n = 1,2,\ldots, N \text{ outputs and } k = 1,2, \ldots, K \text{ inputs} \qquad (7)$$

A high value of the input weight (v_{ki}) relates to an underperformance of that specific DMU with respect to all the other inputs employed by the DMU. An output that shows a high value denotes a strength in the production process. An in-depth description of the DEA approach is also provided in Charnes et al. (1978), Ganley and Cubbin (1992) and Thanassoulis (2001).

In this study, the Baker, Charnes and Cooper (BCC) model is adopted, since a preliminary investigation depicted VRS for the most of the regions Hence, as assumption, the productive frontier is characterised by a piece-wise linear and concave shape. The calculated efficiency scores, that do not incorporate the pure scale effects, are defined as PTE. The pure scale inefficiency is given by deviation from the efficiency frontier since resources are not used in an efficient manner.

The DEA window analysis has been further implemented by calculating the ratio between CRS and VRS technical efficiency scores, that gives scale efficiency scores that can be either CRS, DRS or increasing returns to scale (IRS) (see Charnes et al., 1978; Banker et al., 1984; Cullinane et al., 2004). Economic theory states that in the long run the production level can change when inputs, that are no longer fixed, vary in the same proportion. The production function depicts IRS, when inputs are increased by a factor α, the output increases by more than α. CRS are given when inputs are increased by a factor α, the output increases by the same factor. The production function denotes DRS, when inputs are increased by a factor α, the output increases by less than α.

Though DEA has many advantages, it is not possible to directly evaluate factors that influence DMUs' efficiency. As an extension, a parametric specification can be used such as a truncated (Tobit) regression since many of the DEA efficiency scores typically equal to one. However, DEA efficiency scores are characterised by high correlation that leads to bias parameter estimates. Recently, Simar and Wilson (2007) proposed a double bootstrap method that overcomes possible problems of serial correlation amongst the estimated efficiency scores and approximates their asymptotic distribution. They argue that conventional bootstrap techniques used in the post-DEA procedure do not allow for valid inferences. In the hospitality literature, only very recently there have appeared a few studies employing the double-bootstrap procedure (e.g. Assaf et al., 2010; Assaf and Cvelbar, 2010; Assaf and Agbola, 2011; Barros et al., 2011).

Following this methodological strand of the literature, in the present paper, the following pooled-truncated-Tobit specification is used:

$$\theta_{it} = \alpha_o + \alpha\, x_{it} + \varepsilon_{it} \geq 1 \qquad i= 1, \ldots , n \quad t=1\ldots\ldots T \qquad (8)$$

where θ_{it} is the DMU's (*i*) efficiency score at time *t* (DMUs are technically efficient or inefficient when θ_{it} = 1 or θ_{it} > 1, respectively); α_o is the constant term; x_{it} is the vector of factors that are assumed to affect the DMUs' efficiency; α is the vector of parameters to be estimated; ε_{it} is the residual that is assumed to be white noise. The estimators in the Tobit-regression are then substituted with the double bootstrap estimators to compute the standard errors and confidence intervals for the coefficients estimates. Specifically, this method refers to the Algorithm # 2 proposed by Simar and Wilson (2007). First, the DEA input-oriented is run for the DMUs under investigation. Second, Equation (8) is estimated by using the maximum likelihood method to obtain estimates of the parameters and standard errors. Third, for each DMU the following loop is repeated L_1 times (in this case 10 thousand times): a) for each DMU, ε_{itb} is drawn from the $N(0,\hat{\sigma}_{\varepsilon})$ distribution with left truncation at $(1-\hat{\alpha}x_{itb})$, with $b = 1,\ldots,L_1$; b) again, for each DMU, $\theta^{*}_{itb} = \hat{\alpha}_0 + \hat{\alpha}_1\ x_{it} + \varepsilon_{itb}$ is computed; c) a new pseudo data set is defined where $x^*_{it} = x_{it}$ and $y^*_{itb} = y_{it}$ $(\hat{\theta}_{it} / \theta^*_{itb})$; d) using the constructed pseudo data set, the input-oriented DEA is run to compute efficiency estimates for all the DMUs $(\hat{\theta}^*_{itb})$. Fourth, the bias-corrected efficiency scores are computed as follows: $\hat{\hat{\theta}}_{it} = 2\hat{\theta}_{it} - \sum_{b=1}^{L_1} \hat{\theta}^*_{itb}$. Fifth, the maximum likelihood method is used to estimate the Tobit-regression of the bias-corrected efficiency scores, that provides with marginal effects of the explanatory variables ($\hat{\hat{\alpha}}_0, \hat{\hat{\alpha}}_1$) and estimated standard deviation of the residuals ($\hat{\hat{\sigma}}_\varepsilon$). Sixth, again for each DMU the following bootstrapping loop is repeated L_2 times (again, 10 thousand times): i) for each DMU, ε_{its} is drawn from the $N(0, \hat{\hat{\sigma}}_\varepsilon)$ distribution with left truncation at $(1 - \hat{\hat{\alpha}} x_{\text{its}})$, with $s=1,...L_2$; ii) for each DMU, $\theta^{**}_{its} = \hat{\alpha}_{0s} + \hat{\alpha}_{1s} x_{it} + \varepsilon_{its}$ is computed; iii) the maximum likelihood method is employed to estimate the Tobit-regression of θ^{**}_{its} that provides with a new set of marginal effects of the explanatory variables and standard errors. Such a loop produces a set of $\hat{\alpha}_{0s}$, $\hat{\alpha}_{1s}$ and $\hat{\hat{\sigma}}_{\varepsilon s}$ estimates. Hence, as a final step, the L_2 bootstrap estimates $\{(\hat{\alpha}_{0s}, \hat{\alpha}_{1s}, \hat{\hat{\sigma}}_{\varepsilon s})\}$ and the estimates of the marginal effects ($\hat{\hat{\alpha}}_0, \hat{\hat{\alpha}}_1$) and the estimated standard deviation of the residuals ($\hat{\hat{\sigma}}_\varepsilon$) are used to construct estimated confidence intervals for each of the unknown element in (8) (see also Balcombe et al., 2008; Assaf and Agbola et al., 2011).

4. Italian regions economic efficiency

4.1 Window DEA results

At the macro level, a comparison of efficiency is provided amongst all of the 20 Italian regions. One region, Trentino Alto Adige, is reported as two provinces by the Italian National Statistics Office (ISTAT) and this analysis follows the national classification; thus, 19 regions and two autonomous provinces (Trento and Bozen) are considered resulting in 21 DMUs (see Figure 1).

Figure 1

Given the availability of official statistic data, updated in December 2010, a time span of five years (2000-2004) is considered. Over-fit problems are avoided as the minimum number of DMUs is more than twice the total number of inputs and outputs in the DEA (Min et al., 2008).

The DEA approach allows one to derive a virtual input and output computed within a multi-factor framework. The choice of inputs and outputs is important in the application of DEA. In the present study, sales revenue and value added generated are employed as outputs. These measures are recognised to be good indicators of financial efficiency (e.g. Wang et al., 2006; Min et al., 2008). Given the highly labour-intensive nature of the hospitality sector, labour costs are used as an input together with fix investments as physical capital production factor. Barros (2005) provides an extensive literature review on the type of inputs and outputs employed within a tourism DEA approach.

To run the analysis, the software package Frontier Analyst 3.1.5 is used. The selection of the length of the window is an important issue in window DEA because the results may depend on the number of windows employed. In the present analysis, the following formulas adapted from Sun (1988) are applied. Given *n* DMUS and *k* periods, the length of window is given by the following:

$$p = \begin{cases} \frac{k+1}{2} & when \quad k \quad is \quad odd \\ \frac{k+1}{2} \pm \frac{1}{2} & when \quad k \quad is \quad even \end{cases} \qquad (9)$$

In this case, as twenty-one regions and five years' worth of data are used, for a total of 105 observations, the chosen window length is three years and three separate windows are constructed as shown in Table 1; hence, the number of observations reduces to 63 (21 regions over three separate windows).

Table 1

The first row (with values of 97.1%, 98.0% and 88.3%) shows the relative technical efficiency of the Abruzzo region in 2000, 2001 and 2002, respectively. The second row (with values of 95.3%, 88.3% and 93.2%) shows the relative technical efficiency of Abruzzo in 2001, 2002 and 2003, respectively, and so on. The same results, read by column, represent the stability of efficiency scores both in absolute terms as well as in terms of the relative performance of that region with respect to the other regions in the sample. It is worthwhile noting that two regions present a few "extreme mismatch", that is a greater than 10% points annual change, that might be due to misreporting of data or computational errors. Examples of misreporting are also found in Charnes et al., (1985) and Cullinane et al. (2004). The last columns show the mean, standard deviation (SD) and coefficient of variation (CV) for each region. The latter is calculated as the ratio between the standard deviation and the mean.

Overall, from Table 1 an increasing efficiency score emerges for Emilia-Romagna, Lazio, Sardinia, Umbria and Veneto. Reading the results by column, the best performance was achieved consistently by Lombardy; however, in 2003, the most efficient regions included Liguria, Molise and Piedmont.

Following Pulina *et al.* (2010), a further step is to test the relationship that exists between the mean efficiency and its volatility measured in terms of the CV. A negative correlation between the mean and the CV is expected as high efficiency mean is most likely to be associated with a low volatility. One reason for this negative correlation is that the CV tends to zero as the mean approaches 100. High CVs occur in regions such as Aosta Valley and Sicily that also have relatively low means. Spearman's test is then carried out in order to test whether the DMUs are characterised by homoscedasticity (as a null hypothesis $\rho = 0$) or heteroscedasticity (as an alternative hypothesis $\rho \neq 0$). The calculated ρ for the Italian regions (Table 1) equals -0.67. This value, in absolute terms, is higher than the corresponding critical value (0.43), at the two-tailed 5% level of significance. Hence, the null hypothesis can be rejected and the Italian regions are characterised by a non-constant variance at the cross-sectional level.

A synthesis of the main results achieved from the DEA analysis is provided in Figure 1 and Figure 2. The former presents a static analysis of the regional economic efficiency by comparing the last year to the trend performance across the time span under investigation. Clockwise, the top right quadrant depicts the "moving ahead" regions, that denotes a score efficiency higher than both the trend average score and the average score for 2004. Results show that eight regions (namely Lombardy, Veneto, Umbria, Lazio, Piedmont, Emilia Romagna, Toscany and Liguria) belong to these virtuous group, though only Lombardy is the peer that show the highest level of pure technical efficiency in each year (Table 1). The bottom right quadrant includes the "catching up" regions, that reach a score efficiency less than the trend and higher than the average score for 2004. Sardinia and Marche are the sole regions that belongs to this group. The bottom left quadrant depicts the "falling further behind" regions that experience an average score less both than the trend and the average score in 2004. Seven regions belong to this group namely: Aosta Valley, Sicily, Apulia, Trento, Basilicata, Calabria, and Bozen. Finally, the top left quadrant includes the "loosing momentum" regions that denote a score higher than the trend and less that the average score in 2004. The regions of Campania, Friuli Venezia Giulia, Abruzzo, Piedmont and Molise fall into this category.

Figure 2 provides a dynamic picture of each of the Italian regions performance.

Figure 2

The majority of the regions follow either in the "moving ahead" or "falling further behind" quadrant. Besides, there is a stable peer group that includes Lombardy (as the peer) and Veneto, and a stable "falling further behind" group that includes Aosta Valley, Apulia, Basilicata, Trento and Sicily. All the other regions can be considered in a transition phase. For example, Bozen and Calabria that were catching-up regions within the first window have become "falling further behind" DMUs within the last window. Umbria that in the first window was in the "loosing momentum" quadrant has improved its performance and in the second and third window has fallen into the "moving ahead" quadrant. Marche and Sardinia that were "falling further behind" regions have become "catching up" DMUs within the last window. Lazio and Emilia Romagna regained a top performance after having lost momentum within the second window of analysis. Abruzzo, Piedmont and Molise that were "moving ahead" regions have fallen into the "loosing momentum" quadrant within the last window of investigation.

The window DEA analysis has been implemented by calculating the scale efficiency scores that can be either CRS, IRS or DRS. Table 2 depicts the share of regions denoting IRS and DRS, respectively. It emerges that share of regions characterised by IRS has increased over time, while the share of regions that present DRS has remarkably decreased. Hence, in the long run these firms typically have a relatively small capacity.

Table 2

Although the DEA approach does not allow one to gain a full understand the factors of inefficiency, variations in outputs and inputs can be calculated in order to achieve the necessary improvement to obtain the score within the benchmark efficiency frontier. Table 3 provides useful information on possible ways to improve efficiency.

Table 3

On the one hand, in the great part of the Italian regions, potential improvements can be achieved via a consistent decrease in terms of capital costs (*K*) and labour costs (*LC*). On the other hand, important improvements have been achieved in terms of sales revenue (*SR*) and gross value added (*GVA*) in the last year under investigation. This is especially true for the Bozen and Trento provinces.

4.2 Post-DEA results

Following the statistical steps proposed in the previous methodological section, a double bootstrapping method is followed and a pooled-truncated regression is applied. To this aim the software library FEAR 1.15, for the statistical package R, by Wilson (2008) is used. The relevant regression equation is given by the following:

$$\theta_{it} = \alpha_0 + \alpha_1 NRU_{it} + \alpha_2 CVNUR_{it} + \alpha_3 DART_{it} + \varepsilon_{it}$$
$$i = 1, \dots, n \quad t = 1 \dots T \qquad (10)$$

where θ_{it} is the DMU's (*i*) (in)efficiency score at time *t*; a_0 is the constant term; $\alpha_1, \alpha_2, \alpha_3$ are the parameters to be estimated. *NRU* is the net rate of utilisation of bed places, that proxies the capacity of fully utilise establishments during the opening period. Usually highest levels coincide with regions that are characterised by a good performance in the tourism activity, and a negative sign is expected. In other words, high levels of *NRU* are associated to low levels of (in)efficiency θ. *CVNRU* is the annual coefficient of variation of the net rate of utilisation to pick up the market volatility. It is calculated for each region as the ratio of the standard deviation of the monthly net rate of utilisation and the annual average of *NRU*. High values of *CVNRU* indicate the presence of seasonality in the hotel demand. Hence, the relationship between θ and *CVNUR* is expected to be positive. Usually, art cities reach high level of tourism industry specialization; hence, *DART* is a dummy variable that explicitly takes into account the effects that well-known arts city (namely Rome, Florence and Venice) have on regional hospitality sector efficiency. Hence, a negative sign is expected. Finally, e_{it} is the residual that is assumed to be white noise.

Main results are reported in Table 4.

Table 4

Notably, all the variables explain Italian hospitality sector economic efficiency. Specifically, an increase in the net rate of utilisation causes an increase in the pure technical efficiency. Besides, on average, regions such as Lazio, Veneto and Tuscany tend to be more efficient than the other Italian regions.

4.3 Spatial econometric analysis

Spill-over effect investigation of aggregated, or individual, efficiency is a new branch of research in the empirical analysis. In a post-DEA framework, Helfand and Levine (2004) and Sampaio de Souza *et al.* (2005) find spatial effects due to the existence of some functional relationship between DMUs' efficiency in two distinct points in space. In a similar way, in the present study, the existence of spatial autocorrelation between regional DEA scores is tested by applying the Moran's I test. Spill-over effects can operate through different channels. For instance, tourism hot spots can lead to positive effect to neighbours, increasing their technical efficiency. Furthermore, technical efficiency can be spread through "learning by watching" or best practice imitation. In this sense, the presence of a cluster of homogeneous regions, characterized by similar level of technical efficiency, is expected.

The analysis consists of two phases: first, DEA approach is run for each year considered; second, the Moran's I test is performed in each year. The Moran's I test is calculated as follows (Anselin, 1988):

$$I = \frac{n}{S_0} \frac{z'Wz}{z'z} \quad (11)$$

where *n* is the number of units, *z* is the vector of *n* observations in deviation from the mean of the variable of interest, *W* represents the spatial weight matrix and S_0 is the sum of all components of the matrix *W*. Under the null hypothesis, the expected value of Moran's I test values:

$$E(I) = -(n-1)^{-1} \quad (12)$$

In this study, the inverse of the distance between the centroids is taken as a spatial weight. Table 5 reports the test statistics and the respective associated *p*-values.

Table 5

Empirical evidence of the presence of spatial effects is rather mixed. In four cases out of five, the null hypothesis of absence of spatial autocorrelation cannot be rejected; only in the last year of the sample, spatial effects between DMUs' scores efficiency are detected. Probably, spatial effects take longer span of time to emerge. In order to overcome the limitations of the previous test, the Moran's I test is also performed on the average DEA scores of the period, yet the null hypothesis of absence of spatial autocorrelation cannot be rejected (see last row of Table 5).

5. Conclusions

This paper has employed a DEA analysis to evaluate the efficiency of the hospitality sector in Italy, over the period 2000-2004. Assessing pure technical efficiency in this economic sector has an important role in regional planning and policy evaluation. Tourism activity and, hence, hospitality has a key role in the Italian economy, though still little is known on its performance.

Via a window DEA, this paper has investigated the economic efficiency of the Italian hospitality sector at a regional level. This approach has provided a comparison of a DMU with respect to its own past performance as well as the performance of the peer group. Overall, the Italian regions show a relevant economic inefficient performance throughout the period under investigation. The relatively most efficient region is Lombardy.

The key potential improvements that the hospitality sector in Italy can achieve are based on the decrease of labour and capital costs, though over time efficiency improvements have been gained in terms of sales revenue and added value. From the truncated-Tobit analysis, it has emerged that various factors contribute to the level of Italian hospitality inefficiency. Poor utilisation of infrastructure and high seasonal volatility have appeared to be the main sources of economic inefficiency. The econometric investigation has further highlighted that only well-know arts cities, namely Florence, Rome and Venice drive the economic performance of the hospitality sector in their regions. Besides, the Moran's I test has shown the lack of spill-over effects amongst Italian regions.

These findings have underlined important features of the Italian hospitality sector. While the supply of new infrastructure has continued to grow, Italian regions have shown to be economically inefficient. Such an outcome has also confirmed the empirical findings by Suzuki et al. (2010) for the Italian provinces. The over-investment mainly designed to fulfil the high season demand is one of the main sources of inefficiency. This may turn into a large source of inefficiency and lack of competitiveness. Additionally, the work force has less incentive to perform efficiently since it is employed for a short period of the year. Though most of the Italian regions are characterised by cities with an outstanding arts and historical heritage (e.g. Bari, Bologna, Genova, Palermo, Turin), yet this unique cultural capital is not exploited as the driver of tourism supply performance. One of the reasons may be due to the low profile marketing campaigns that are mostly run at a regional level, rather than by a central body able to activate a virtuous path of growth in decentralised areas and less-known arts cities. Such a hypothesis has been further confirmed by the spatial heterogeneity test that has shown no spill-over effects amongst the Italian regions.

This is especially relevant for policy makers that should consider synergic and complementary tourism policy for Italy as a whole. This paper has drawn attention to the need to reconsider an all-nation strategic approach to the tourism activity. Though facing a maturity stage, Italy is still able to operate in the market place as one of the big players thanks also to its outstanding environmental and cultural heritage. However, in a dynamic and globalised economy, characterised by emerging destinations, there is the need to establish a strong central body that, with a clear vision of the market challenges, may provide a substantive boost to regain and maintain its actual position.

References

ANSELIN L. (1988) *Spatial Econometrics: Methods and Models*. Kluwer Academic Publishers, Dordrecht.

ASSAF A.G. and CVELBAR L.K. (2010) The performance of the Slovenian hotel industry: evaluation post-privatisation, *International Journal of Tourism Research*, **12**(5), 462–471.

ASSAF A.G., DEERY M. and JAGO L. (2010) Evaluating the Performance and Scale Characteristics of the Australian Restaurant Industry, *Journal of Hospitality & Tourism Research*, DOI: 10.1177/1096348010380598.

ASSAF A.G. and AGBOLA F.W. (2011) Modelling the performance of Australian hotels: a DEA double bootstrap approach, *Tourism Economics*, **17**(1), 73–89.

BALCOMBE, K., FRASER I., LATRUFFE L., RAHMAN M. and SMITH L. (2008) An application of the DEA double bootstrap to examine sources of efficiency in Bangladesh rice farming, *Applied Economics*, **40**, 1919-1925.

BANKER P.C., CHARNES, A. and COOPER, W.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis, *Management Science*, **30**, 1078-1092.

BARROS P.C. and ALVES F.P. (2004) Productivity in the tourism industry. *IAER*, August, **10**(3), Technical University of Lisbon, Portugal.

BARROS P.C. (2005). Measuring efficiency in the hotel sector, *Annals of Tourism Research*, **32**(2), 456-477.

BARROS P.C., BOTTI L., PEYPOCH N., ROBINOT E., SOLONANDRASANA B. and ASSAF G. (2011) Performance of French destinations: Tourism attraction perspectives, *Tourism Management*, **32**(1), 141-146.

BERNINI C. and GUIZZARDI A. (2010) Internal and locational factors affecting hotel industry efficiency: evidence from Italian business corporations, *Tourism Economics*, **16**(4), 883-913.

BRIDA J.G. and PULINA M. (2010) A literature review on tourism and economic growth. Working Paper, 2010-17; CRENoS, Cagliari & Sassari University.

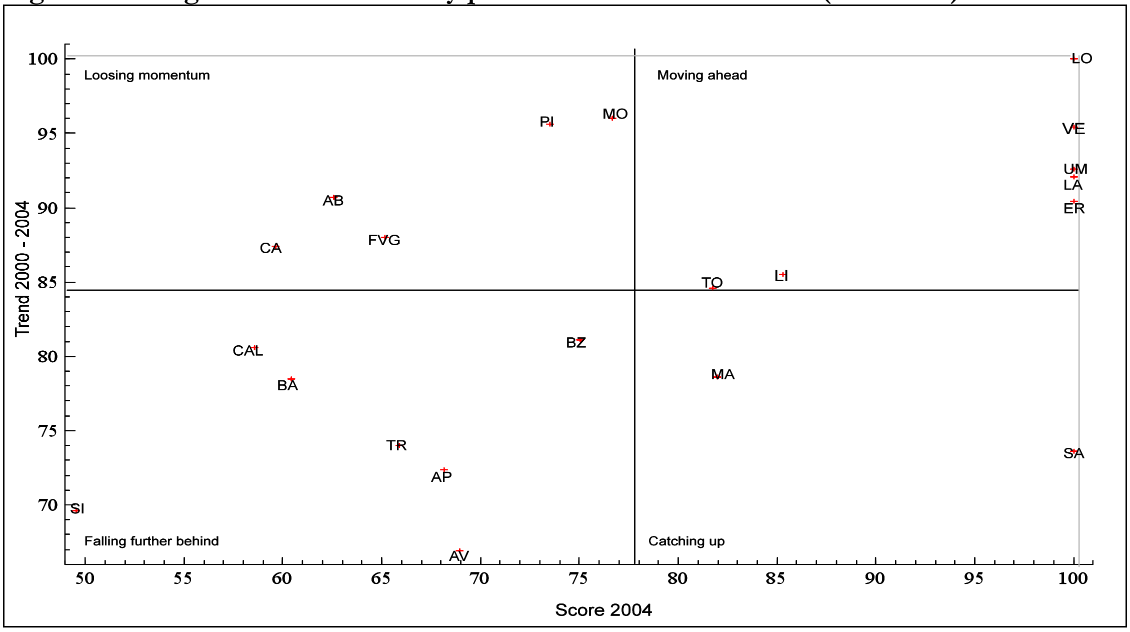
BRUNI M.E., GUERRIERO F. and PATITUCCI V. (2011) Benchmarking Sustainable Development via Data envelopment Analysis: An Italian case study, *International Journal of Environmental Resources,* **5**(1), 47-56.

CHARNES A., COOPER W.W. and RHODES E. (1978) Measuring the efficiency of decision making units, *European Journal of Operational Research*, **2**, 429-444.
CHARNES A., CLARK C.T., COOPER W.W. and GOLANY B. (1985) A developmental study of data envelopment analysis in measuring the efficiency of maintenance units in the U.S. air forces, *Annals of Operations Research*, **2**, 95-112.
CRACOLICI M.F. (2008) Assessment of tourism competitiveness by analysing destination efficiency, *Tourism Economics*, **14**(2), 325-342.
CULLINANE K., SONG D-W. and WANG T-F. (2004). An application of DEA windows analysis to container port production efficiency, *Review of Network Economy*, **32**, 184-206.
FEDERALBERGHI-MERCURY (2010). Sesto rapporto sul sistema alberghiero in Italia. www.federalberghi.it. (accessed on 10 January 2011).
HELFAND S.M. and LEVINE E.S. (2004) Farm size and the determinants of productive efficiency in the Brazilian Center-West, *Agricultural Economics*, **31**, 241–249.
ISTAT (2011). Sistema di indicatori territoriali. http://sitis.istat.it/sitis/html/index.htm (accessed on 20 December 2010).
MORIARTY J.P. (2010) Have structural issues placed New Zealand's hospitality industry beyond price? *Tourism Economics*, **16**(3), 695-713.
MOLINA-AZORIN J.F., PEREIRA-MOLINER J. and CLAVER-CORTÉS E. (2011) The importance of the firm and destination effects to explain firm performance, *Tourism Management*, **32**(1), 22-28.
NEVES J.C. and LOURENÇO S. (2009) Using data envelopment analysis to select strategies that improve the performance of hotel companies, *International Journal of Contemporary Hospitality Management*, **21**(6), 698-712.
PULINA M., DETOTTO C. and PABA A. (2010) An investigation into the relationship between size and efficiency of the Italian hospitality sector: A window DEA approach, *European Journal of Operational Research*, **20**(4), 613–620.
SAMPAIO DE SOUZA M.C., CRIBARI-NETO F. and STOSIC B. D. (2005) Explaining DEA technical efficiency scores in an outlier corrected environment: the case of public services in Brazilian municipalities, *Brazilian Review of Econometrics*, **25**, 289–315.
SHUAI J-J. (2009) Web content and its influence on operational performance-case of the hotel industry, *Industrial Engineering and*

Engineering Management, IEEM, International Conference, 8-11 December 2009, 885-889. doi: 10.1109/IEEM.2009.5372884.
SHUAI J-J. and WU W-W. (2011) Evaluating the Influence of E-Marketing on Hotel Performance by DEA and Grey Entropy, *Expert Systems with Applications*, doi:10.1016/j.eswa.2011.01.086.
SIMAR L. and WILSON P.W. (2007) Estimation and inference in two-stage, semi-parametric models of production processes, *Journal of Econometrics*, **13**(6), 31–64.
SIRIRAK S., ISLAM N. and KHANG D.B. (2011) Does ICT Adoption Enhance Hotel Performance? *Journal of Hospitality and Tourism Technology*, 2(1).
SUZUKI S., NIJKAMP P. and RIETVELD P. (2010) Regional efficiency improvement by means of data envelopment analysis through Euclidean distance minimization including fixed input factors: An application to tourist regions in Italy. *Papers in Regional Science*, DOI: 10.1111/j.1435-5957.2010.00316.
WANHILL S. (2007) What do Economists do? Their contribution to understanding tourism. The 6th DeHaan Tourism Management Conference, The Economics of Tourism, Business School, Nottingham University, UK.
WILSON P.W. (2008) FEAR: A software package for frontier efficiency analysis with R, *Socio-Economic Planning Sciences*, **42**, 247-254.
WTTC (2010) *Progress and priorities* 2009-10.
http://www.wttc.org/bin/pdf/original_pdf_file/pandp_final2_low_res.pdf

APPENDIX

Fig.1 Italian regions: static efficiency performance 2004 and trend (2000-2004)



Notes: "Moving ahead": Molise (MO), Lombardy (LO), Liguria (LI), Veneto (VE), Lazio (LA), Piedmont (PI), Umbria (UM), Marche (MA), Emilia Romagna (ER) and Toscany (TO); "Catching up" Sardinia (SA); "Falling further behind" Apulia (AP), Sicily (SI), Trento (TR), Calabria (CA), Aosta Valley (AV), Bozen (BZ) and Campania (CA); "Loosing Momentum" Friuli Venezia Giulia (FVG), Basilicata (BA) and Abruzzo (AB).

Table 1: Regional Efficiency: a window DEA approach (VRS)

	YEARS					STATISTICS		
REGIONS	2000	2001	2002	2003	2004	Mean	SD	CV
Abruzzo	97.1	98.0	88.3					
		95.3	88.3	93.2				
			97.2*	96.2	62.6	90.7	10.5	0.116
Aosta Valley	84.7	81.5	63.5					
		71.3*	63.5	52.1				
			62.0	54.7	69.0	66.9	10.4	0.155
Apulia	80.7	59.3	77.8					
		59.3	77.8	67.5				
			90.3*	70.7	68.2	72.4	9.6	0.133
Basilicata	86.3	-	78.6					
		-	78.6	80.3				
			78.6	86.3	60.4	78.5	8.0	0.102
Bozen	77.4	85.7	90.7					
		85.7	90.7	69.9				
			84.8	70.0	75.1	81.1	7.7	0.095
Calabria	74.6	79.6	96.7					
		79.6	96.7	68.1				
			99.8	72.4	58.6	80.6	13.5	0.167
Campania	89.6	94.6	100					
		94.6	100	75.9				
			100	72.3	59.6	87.4	13.8	0.158
Emilia Romagna	84.1	96.4	92.8					
		100	92.1	78.5				
			90.5	79.0	100	90.4	7.8	0.086
Friuli Venezia Giulia	89.5	82.6	93.7					
		82.5	93.7	90.3				
			94.1	100	65.2	88.0	9.6	0.110
Lazio	98.6	96.2	95.8					
		96.2	95.4	76.1				
			94.5	76.1	100	92.1	8.7	0.095
Liguria	100	91.8	69.0					
		89.4	68.9	100				
			65.6	100	85.3	85.5	13.5	0.157
Lombardy	100	100	100					
		100	100	100				

			100	100	100	100	0.0	0.000
Marche	90.1	79.9	69.9					
		73.8	67.3	88.4				
			68.6	87.9	82.0	78.6	8.5	0.108
Molise	87.7	100	100					
		100	100	100				
			100	100	76.7	96.0	7.8	0.082
Piedmont	87.1	100	100					
		100	100	100				
			100	100	73.5	95.6	8.8	0.092
Sardinia	66.5	74.5	70.7					
		74.5	70.7	62.6				
			75.6	67.3	100	73.6	10.2	0.138
Sicily	87.2	77.8	69.8					
		79.8	69.7	63.4				
			65.9	63.0	49.6	69.6	10.4	0.150
Toscany	99.2	84.8	82.2					
		85.5	81.4	82.1				
			79.4	84.7	81.8	84.6	5.5	0.065
Trento	80.4	68.8	84.6					
		68.8	84.6	64.0				
			82.5	66.0	65.9	74.0	8.3	0.112
Umbria	77.7	100	84.7					
		100	84.7	98.8				
			89.1	98.8	100	92.6	8.2	0.088
Veneto	93.9	92.3	91.0					
		95.5	95.6	97.5				
			98.5	94.9	100	95.4	2.7	0.029
Italy	87.3	87.2	85.7					
		86.6	85.7	81.4		84.5	3.1	0.037
			86.5	82.9	77.8			

*Note: in 2001 the Basilicata region has not been included in the analysis since official data are missing, which does not affect the DEA overall analysis. *"extreme mismatch" (over 10% points change); SD = standard deviation; CV = coefficient of variation.

Table 2: Percentage of regions showing IRS and DRS – Window DEA (VRS) – (2000-2004)

	2000	2001	2002	2003	2004
Italy (IRS; DRS)	47.6; 42;9	57.1; 19.0	76.2; 4.8		
		66.7; 4.8	81.0; 0.0	52.4; 28.6	
			81.0; 0.0	66.7; 9.5	66.7; 4.8

Table 3: Italian regions: total potential improvements (%) in terms of Sales Revenue (SR), Gross Value Added (GVA), Labour Costs (LC) and Fixed Investments (K); window DEA (VRS) - (2000-2004)

	Variables-years																			
Regions	SR00	GVA00	LC00	K00	SR01	GVA01	LC01	K01	SR02	GVA02	LC02	K02	SR03	GVA03	LC03	K03	SR04	GVA04	LC04	K04
Abruzzo	0.0	26.6	-2.9	-2.9	0.0	1.4	-2.0	-2.0	0.0	0.0	-11.7	-53.9								
					0.0	0.0	-4.7	-4.7	0.0	0.0	-11.7	-53.9	0.0	4.3	-6.8	-6.8				
									0.0	0.0	-2.8	-64.3	0.0	12.4	-3.8	-3.8	0.0	0.0	-37.4	-40.5
Aosta Valley	13.5	0.0	-15.3	-15.3	4.8	0.0	-32.7	-18.5	7.1	0.0	-36.5	-38.7								
					6.8	0.0	-28.7	-28.7	7.1	0.0	-36.5	-38.7	0.0	0.0	-47.9	-47.9				
									0.0	0.0	-38.0	-38.0	0.0	4.3	-45.3	-45.3	0.0	0.0	-31.1	-44.0
Apulia	0.0	0.9	-19.3	-19.3	0.0	0.0	-40.7	-58.5	0.0	0.0	-22.2	-70.8								
					0.0	0.0	-40.7	-58.5	0.0	0.0	-22.2	-70.8	0.0	0.0	-32.5	-32.5				
									0.0	0.0	-9.7	-66.4	0.0	0.0	-29.3	-40.8	0.0	0.0	-31.9	-57.6
Basilicata	0.2	23.2	-13.7	-13.7	-	-	-	-	0.8	0.0	-21.4	-65.8								
					-	-	-	-	0.8	0.0	-21.4	-65.8	0.0	4.2	-19.7	-77.2				
									0.0	0.0	-21.4	-63.4	0.0	0.0	-13.7	-68.3	0.0	0.0	-39.6	-83.5
Bozen	42.5	0.0	-22.6	-22.6	64.0	0.0	-14.3	-23.1	54.4	0.0	-9.3	-21.3								
					64.0	0.0	-14.3	-23.1	54.4	0.0	-9.3	-21.3	26.2	0.0	-30.1	-90.9				
									0.0	0.0	-15.3	-62.7	0.0	0.0	-30.0	-94.6	0.0	0.0	-25.0	-52.6
Calabria	0.0	0.0	-25.4	-63.6	0.0	0.0	-20.4	-86.3	7.6	0.0	-3.3	-61.2								
					0.0	0.0	-20.4	-86.3	7.6	0.0	-3.3	-61.2	0.0	0.0	-31.9	-68.6				
									0.0	0.0	-0.3	-68.7	0.0	0.0	-27.6	-72.5	0.0	0.0	-41.4	-46.6
Campania	0.0	1.3	-10.4	-10.4	12.1	0.0	-5.4	-5.4	0.0	0.0	0.0	0.0								
					12.1	0.0	-5.4	-5.4	0.0	0.0	0.0	0.0	11.0	0.0	-24.2	-24.2				

									0.0	0.0	0.0	0.0	0.0	0.0	-27.7	-30.9	0.0	0.0	-40.4	-40.4
Emilia Romagna	2.4	0.0	-15.9	-28.4	3.8	0.0	-3.6	-3.6	7.8	0.0	-7.2	-7.2								
					0.0	0.0	0.0	0.0	11.2	0.0	-7.9	-7.9	0.0	0.0	-21.6	-21.6				
									0.0	0.0	-9.6	-9.6	0.0	0.0	-21.0	-24.9	0.0	0.0	0.0	0.0
Friuli Venezia Giulia	0.0	10.4	-10.5	-10.5	0.0	0.0	-17.4	-17.4	26.1	0.0	-6.3	-57.3								
					0.0	0.0	-17.5	-17.5	26.1	0.0	-6.3	-57.3	0.0	0.0	-21.6	-21.6				
									0.0	0.0	-5.9	-74.5	0.0	0.0	0.0	0.0	0.0	0.0	-34.8	-34.8
Lazio	0.0	13.5	-1.4	-42.3	9.3	0.0	-3.8	-3.8	1.3	0.0	-4.2	-4.2								
					9.3	0.0	-3.8	-3.8	3.2	0.0	-4.6	-4.6	0.0	19.6	-9.7	-53.2				
									0.0	0.0	-5.5	-5.5	0.0	1.2	-23.9	-23.9	0.0	0.0	0.0	0.0
Liguria	0.0	0.0	0.0	0.0	0.0	2.1	-8.2	-8.2	7.2	0.0	-31.0	-31.0								
					0.0	0.0	-10.6	-10.6	7.6	0.0	-31.1	-31.1	0.0	0.0	0.0	0.0				
									0.0	0.0	-34.4	-34.4	0.0	0.0	0.0	0.0	0.0	0.0	-14.7	-40.7
Lombardy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marche	0.0	0.0	-9.9	-9.9	0.0	11.0	-20.1	-20.1	0.0	3.0	-30.1	-30.1								
					0.0	0.0	-26.2	-26.2	0.0	0.0	-32.7	-32.7	0.0	0.0	0.0	0.0				
									0.0	0.8	-31.4	-31.4	0.0	7.9	-12.1	-12.1	0.0	0.0	-18.1	-19.5
Molise	1.3	0.0	-12.3	-12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								
					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	-11.7	-11.7				
									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	-23.3	-51.2
Piedmont	9.1	0.0	-12.9	-12.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								

					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	-26.5	-26.5
Sardinia	0.0	1.0	-33.5	-34.8	7.3	0.0	-25.5	-43.9	3.3	0.0	-29.3	-51.8								
					7.3	0.0	-25.5	-43.9	3.3	0.0	-29.3	-51.8	0.0	0.0	0.0	0.0				
									0.0	0.0	-24.4	-62.3	0.0	0.0	-32.7	-47.8	0.0	0.0	0.0	0.0
Sicily	0.0	5.4	-12.8	-12.8	16.5	0.0	-22.2	-22.2	7.5	0.0	-30.2	-30.2								
					8.6	0.1	-0.2	-0.5	7.7	0.0	-30.3	-30.3	0.0	0.0	-37.4	-37.4				
									0.0	0.0	-34.1	-34.1	0.0	0.0	-37.0	-37.1	0.0	2.5	-50.4	-50.4
Toscany	0.0	0.0	-0.8	-0.8	11.2	0.0	-15.2	-15.2	14.6	0.0	-17.8	-17.8								
					12.1	0.0	-14.5	-14.5	19.6	0.0	-18.6	-18.6	1.8	0.0	-36.6	-36.6				
									0.0	0.0	-20.7	-20.7	4.9	0.0	-15.3	-38.3	0.0	0.0	-18.2	-18.2
Trento	21.9	0.0	-19.6	-19.6	0.3	0.0	-31.2	-31.2	28.1	0.0	-15.4	-44.6								
					0.4	0.0	-31.2	-31.2	28.1	0.0	-15.4	-44.6	2.0	0.0	-17.9	-17.9				
									0.0	0.0	-17.5	-64.6	0.0	0.0	-34.0	-91.6	0.0	0.0	-34.1	-79.3
Umbria	0.0	0.0	-22.3	-56.5	0.0	0.0	0.0	0.0	0.0	0.0	-15.3	-66.6								
					0.0	0.0	0.0	0.0	0.0	0.0	-15.3	-66.6	2.5	0.0	-36.0	-90.9				
									0.0	0.0	-10.9	-69.6	0.0	0.9	-1.2	-1.2	0.0	0.0	0.0	0.0
Veneto	9.5	0.0	-6.1	-6.1	4.8	0.0	-7.7	-7.7	0.0	0.0	-9.0	-9.0								
					4.1	0.0	-4.5	-4.5	0.0	0.0	-4.4	-19.2	0.0	0.6	-1.2	-1.2				
									0.0	0.0	-1.5	-45.8	0.9	0.0	-5.1	-5.1	0.0	0.0	0.0	0.0
Italy	4.8	3.9	-12.7	-18.8	6.7	0.7	-13.5	-18.4	7.9	0.2	-13.9	-29.8								
					6.2	0.0	-12.4	-18.0	8.4	0.0	-13.9	-30.5	2.1	1.9	-18.4	-30.5				
									0.0	0.0	-13.5	-38.9	0.3	1.3	-17.1	-30.4	0.1	0.2	-22.2	-32.7

Table 4: Pooled-censured-Tobit result (n= 105)

Variables	Coefficient	Confidence Intervals
Constant	**-28.733 *****	**(99%) = [-62.640, -27.687]**
NRU	**-0.047 ****	**(95%) = [-0.116, -0.030]**
CV-NRU	**0.050 *****	**(99%) = [+0.006, +0.105]**
DART (reference group: no well-known art cities)	**-1.557 *****	**(99%) = [-3.178, -1.556]**

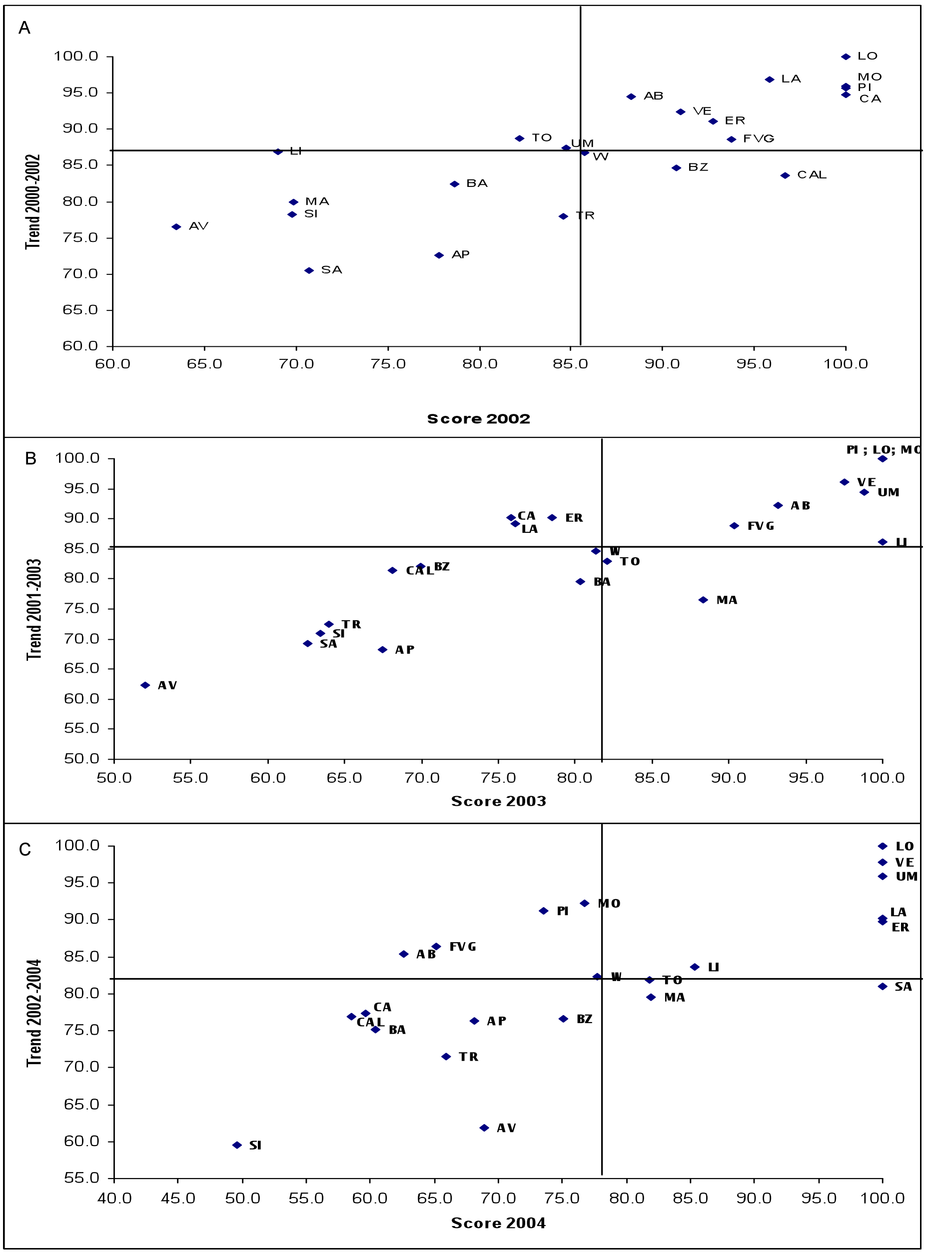
Note: Number of iteration = 10,000.

Table 5: Results of Moran's I test

Year	Moran I statistics	p-value
2000	0.078	0.130
2001	-0.031	0.633
2002	-0.083	0.427
2003	-0.051	0.505
2004	0.219	0.015
Average (00-04)	0.083	0.117

Note: DEA scores are calculated with variable return to scale and output oriented.

Fig.2: Italian regions: dynamic efficiency performance (last window year and window trend)



Notes: Molise (MO), Lombardy (LO), Liguria (LI), Veneto (VE), Lazio (LA), Piedmont (PI), Umbria (UM), Marche (MA), Emilia Romagna (ER), Toscany (TO) Sardinia (SA) Apulia (AP), Sicily (SI), Trento (TR), Calabria (CA), Aosta Valley (AV), Bozen (BZ), Campania (CA), Friuli Venezia Giulia (FVG), Basilicata (BA), Abruzzo (AB), Italian average (W).

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