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# A data envelopment analysis of the Italian judicial efficiency

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**Abstract**

In recent years, the Italian judicial system has been at the center of both the political debate and policy actions aiming at modifying the territorial structure and the organization of the courts as well as the procedural processes. The measures adopted concerned the reorganization of the magistrates' career and the reform of judicial districts.

However, despite the several reforms adopted, the Italian judicial system does not reach yet the European standards, principally for the so called *magistrate-duration procedures binomial*, according to which the number of magistrates is above the European average level and the time of legal trials is too long compared with most European countries. Hence, key words such as *performance, effectiveness* and in particular *efficiency* are worthy of attention. In this framework, our paper analyzes the efficiency of Italian judicial districts, using a *Data Envelopment Analysis* approach.

## 1. Introduction

In recent years, the Italian judicial system has been at the center of both the political debate and administrative measures aiming at modifying the territorial structure and the organization of the courts as well as the procedural processes. Important measures have regarded the reorganization of the magistrates' career (Mastella's reform - Law n. 111 of July 30, 2007) or the reform of judicial districts (Decree Law of 7 September 2012, n. 155 and 156) that reconsidered the territorial organization of the judicial offices through the abolition of 31 tribunal and prosecutor offices, 220 separate offices and 667 peace courts.

However, despite the consistent measures adopted, the Italian judicial system does not reach yet the European standards, principally for the so called *magistrate-duration procedures binomial*. In fact, as pointed out by the European Commission for the Efficiency of Justice (CEPEJ) and according to the European Judicial System database (see Bianco *et al.*, 2007), Italy has a number of magistrates well above the European average as well as the length of the trials.

Therefore, key words such as *performance, effectiveness* and in particular *efficiency* are worthy of attention. In this framework, our paper analyzes the efficiency of Italian judicial districts, using a *Data Envelopment Analysis* (DEA - Charnes *et al.*, 1978) approach. Furthermore, the quality and the quantitative amount of statistical information about the Italian judicial system are extremely poor and the studies developed until now recur usually to proxies in order to measure the performance of the judicial system (see Giacomelli & Menon, 2013). So, the present analysis, being funded on a peculiar database provided by the Italian Ministry of Justice and by the Higher Judiciary Council, contributes to shed lights on the judicial system of this country, on which few empirical studies, and especially on efficiency, have been conducted.

The paper unfolds as follows: in Section 2 the dataset and a descriptive analysis are presented; in Section 3 different DEA models are compared in order to highlight the advantages of using a specification rather than another for the evaluation of the Italian judicial efficiency; in Section 4 results concerning the Italian judicial system efficiency are presented by focusing on the comparison among different *returns to scale* specifications; in Section 5 a *principal component analysis* (PCA) is carried out for the study of the geographical differences of the Italian judicial system productivity. Finally, Section 6 concludes.

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## 2. The data

The data are referred to Italian justice system,[1] subdivided in Ordinary courts (*Tribunali Ordinari*) and Appeal courts (*Corti d'Appello*), for the period 2005-2011. In the methodological sections 4 and 5 we focus on a more restricted period 2009-2011 for which data are available for all the territorial specification considered. A valuable contribution in collecting data has been given by the Higher Judiciary Council (*Consiglio Superiore della Magistratura*), which provided us – for the restricted period - with data characterized by the task of magistrates, *judges* or *prosecutors*, offices and territorial districts.

The deployment of judicial offices in Italy is rather capillary. Actually, 179 magistrates of peace (for minor litigations), 136 Ordinary courts, 26 districts with an Appeal court per each, and one Supreme court placed in Rome exist.

In order to frame both the input factors and outputs of the judicial system, we first define three sorts of outputs according to the time dedicated to them and to the category of trial to which they belong, civil or criminal. In particular, we consider *enrolled* trials, those just began, *unresolved* trials, those not yet ended and *resolved* trials, those concluded. Secondly, as input variables, we consider the number of magistrates (according to the functional task) and the wiretapping expenses.

The efficiency analysis of the judicial system is particularly felt in Italy because of the lengthy trials. Actually, the Italian Institute for Political, Economic and Social Studies surveyed that the 62% of the Italians complain about the long time required for the trials resolution (EURISPES, 2009) and the World Bank (see Palgrave, 2010) indicated Italy as the country with the longest time of trials resolution within OCSE. For this reason, we consider also an output time weighted variable. In particular, the longer is the time required the more the resolved trials are "reduced" by the weight adopted.

A relevant question is if such long processes of justice are due to an efficiency problem of inputs management of the judicial system or to a congestion for the large number of incoming trials. We cope with such a question by considering the indicators of input-efficiency and returns to scale, as will be seen more in details in the section devoted to the description of the DEA methods employed.

Tables 2 and 4 report the descriptive statistics for the first and the second appeal degree.

Table 1: Ordinary courts descriptive statistics

| Year | Number (National) | Mean | Median | Min | Max | Std.Dev. |
|---|---|---|---|---|---|---|
| | | | ***Input*** | | | |
| | | | **Magistrates (total)** | | | |
| 2009 | **6,774** | 260.54 | 188.5 | 42 | 814 | 208.91 |
| 2010 | **6,553** | 252.04 | 165 | 42 | 817 | 209.8 |
| 2011 | **6,554** | 252.08 | 165 | 42 | 817 | 209.77 |
| | | | *Judges* | | | |
| 2009 | **4,897** | 188.35 | 136.5 | 28 | 610 | 158.26 |
| 2010 | **4,910** | 188.85 | 136.5 | 28 | 613 | 158.64 |
| 2011 | **4,911** | 188.88 | 136.5 | 28 | 613 | 158.61 |
| | | | *Prosecutors* | | | |
| 2009 | **1,877** | 72.19 | 52.5 | 14 | 204 | 51.41 |
| 2010 | **1,883** | 72.42 | 53.5 | 14 | 204 | 51.35 |
| 2011 | **1,883** | 72.42 | 53.5 | 14 | 204 | 51.35 |
| | | | **Interception expenses** | | | |
| 2009 | **255,059,249** | 9,809,971.12 | 26,532,808.00 | 358,908 | 47,926,659 | 13,240,640.93 |
| 2010 | **237,041,484** | 9,116,980.15 | 25,122,030.00 | 374,359 | 39,670,400 | 11,007,736.30 |
| 2011 | **225,987,187** | 8,691,814.88 | 20,993,098.00 | 239,723 | 36,279,033 | 10,245,836.63 |
| | | | ***Output*** | | | |
| | | | **Civil resolved trials** | | | |
| 2009 | **2,800,435** | 107,709.04 | 84,092.00 | 15,129 | 333,878 | 85,748.69 |
| 2010 | **2,742,081** | 105,464.65 | 81,250.00 | 14,515 | 325,187 | 85,172.17 |
| 2011 | **2,702,744** | 103,951.69 | 78,053.00 | 13,222 | 333,126 | 86,554.30 |
| | | | *Weighted* | | | |
| 2009 | **2,638,701** | 99,097.36 | 79,762.41 | 15,059 | 289,254 | 77,963.06 |
| 2010 | **2,584,345** | 97,104.21 | 77,350.60 | 14,456 | 284,615 | 77,582.73 |
| 2011 | **2,552,871** | 98,187.34 | 74,723.51 | 13,160 | 304,158 | 78,943.68 |
| | | | **Penal resolved trials** | | | |
| 2009 | **1,282,581** | 49,330.04 | 37,029.50 | 7,325 | 170,558 | 38,386.30 |
| 2010 | **1,293,001** | 49,730.81 | 37,117.00 | 8,592 | 167,522 | 39,182.95 |
| 2011 | **1,265,022** | 48,654.69 | 35,498.50 | 8,336 | 149,959 | 39,090.62 |
| | | | *Weighted* | | | |
| 2009 | **1,196,007** | 44,893.83 | 35,633.94 | 7,306 | 142,336 | 32,779.09 |
| 2010 | **1,208,552** | 45,574.15 | 35,900.69 | 8,573 | 144,029 | 34,450.00 |
| 2011 | **1,184,284** | 45,549.40 | 34,108.87 | 8,305 | 129,533 | 34,181.84 |

Table 2: The statistics are calculated over 26 districts, physical data are in units, monetary data are in euro

[1]Source: Ministero della Giustizia - Direzione Generale di Statistica e Analisi Organizzativa (https://webstat.giustizia.it/_layouts/15/start.aspx#/SitePages/Home.aspx)

Table 3: Appeals courts descriptive statistics

| Year | Number (National) | Mean | Median | Min | Max | Std.Dev. |
|---|---|---|---|---|---|---|
| | | | ***Input*** | | | |
| | | | **Magistrates (total)** | | | |
| 2009 | **1,569** | 60.35 | 43 | 15 | 196 | 48.3 |
| 2010 | **1,573** | 60.5 | 43 | 15 | 196 | 48.22 |
| 2011 | **1,574** | 60.54 | 43 | 15 | 196 | 48.2 |
| | | | *Judges* | | | |
| 2009 | **1,279** | 49.19 | 34.5 | 11 | 171 | 41.94 |
| 2010 | **1,281** | 49.27 | 34.5 | 11 | 171 | 41.85 |
| 2011 | **1,282** | 49.31 | 34.5 | 11 | 171 | 41.87 |
| | | | *Prosecutors* | | | |
| 2009 | **290** | 11.15 | 8.5 | 4 | 26 | 6.82 |
| 2010 | **292** | 11.23 | 9 | 4 | 26 | 6.78 |
| 2011 | **292** | 11.23 | 9.5 | 4 | 26 | 6.8 |
| | | | **Interception expenses** | | | |
| 2009 | **255,059,249** | 9,809,971.12 | 26,532,808.00 | 358,908 | 47,926,659 | 13,240,640.93 |
| 2010 | **237,041,484** | 9,116,980.15 | 25,122,030.00 | 374,359 | 39,670,400 | 11,007,736.30 |
| 2011 | **225,987,187** | 8,691,814.88 | 20,993,098.00 | 239,723 | 36,279,033 | 10,245,836.63 |
| | | | ***Output*** | | | |
| | | | **Civil resolved trials** | | | |
| 2009 | **141,112** | 5,427.38 | 3,991.00 | 1,695 | 26,348 | 5,561.05 |
| 2010 | **149,838** | 5,763.00 | 3,957.50 | 1,234 | 29,288 | 6,374.90 |
| 2011 | **148,839** | 5,724.58 | 4,058.00 | 1,020 | 27,574 | 5,798.10 |
| | | | *Weighted* | | | |
| 2009 | **128,125** | 4,927.90 | 3,932.53 | 1,688 | 19,691 | 4,200.96 |
| 2010 | **135,681** | 5,218.49 | 3,890.97 | 1,229 | 22,183 | 4,893.22 |
| 2011 | **135,583** | 5,214.71 | 3,926.03 | 1,015 | 20,629 | 4,452.26 |
| | | | **Penal resolved trials** | | | |
| 2009 | **76,751** | 2,951.96 | 2,198.00 | 284 | 10,217 | 2,370.90 |
| 2010 | **81,014** | 3,115.92 | 2,593.00 | 380 | 10,067 | 2,267.46 |
| 2011 | **79,171** | 3,045.04 | 2,839.00 | 359 | 8,029 | 2,080.04 |
| | | | *Weighted* | | | |
| 2009 | **72,914** | 2,804.38 | 2,048.81 | 281 | 9,399 | 2,191.53 |
| 2010 | **76,672** | 2,948.91 | 2,468.16 | 377 | 9,190 | 2,059.02 |
| 2011 | **74,726** | 2,874.07 | 2,715.44 | 359 | 7,100 | 1,870.66 |

Table 4: The statistics are calculated over 26 districts, physical data are in units, monetary data are in euro

As it is easy to see from the comparison of the mean and the median in these tables, the Magistrates input exhibits a relevant concentration in few big districts, whilst the interception expenses are more diffused within small districts. This is because the interception expenses require fixed cost, which are independent of the districts dimension. The differences within districts are quite substantial as the standard deviation is of the same order of magnitude of the minimum between mean and median.

As for the output, also in this case the resolved trials are more concentrated in the big districts. However, such an asymmetry diminishes once we consider this variable weighted by the time employed to resolve the trial. This suggests that big districts suffer from long time for trials resolution.

## 3. Efficiency analysis: DEA method

The DEA methodology (Charnes *et al.*, 1978) is a non-parametric frontier estimation methodology for evaluating relative efficiencies of a decision making unit (DMU) through the comparison with a non-parametric production boundary (*best-practice frontier*), using suitable Linear Programming techniques.

The shape of the frontier is related to the concept of *returns to scale* deriving from the restrictions assumed on the characteristics of the production set, mainly the convexity, needed to identify a frontier.

Technically, consider the case of $N$ DMUs (public authorities) using $K$ inputs to produce (provide) $M$ goods (services), the $i-th$ DMU consumes a quantity of inputs $X = \{x_1, x_2, ..., x_K\}'$ and produces an outputs quantity $Y = \{y_1, y_2, ..., y_M\}'$.

The first proposed DEA model is input-oriented (aiming at minimizing inputs in order to obtain a given quantity of output - current level) and with *constant returns to scale* (CRS model - Charnes *et al.*, 1978) and so formulated as:

$$\begin{aligned} \min_{\theta,\lambda} \quad & \theta \\ \text{s.t.} \; & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & \lambda \geq 0 \end{aligned} \tag{1}$$

where $\theta \leq 1$ is the efficiency score to be obtained (equal to 1 for the DMUs lying on the frontier) and $\lambda$ is the optimal weights vector.

An important extension of this approach was proposed in 1984 by Banker *et al.* (1984) that generalized the original DEA model allowing the production function to exhibit increasing, constant, or diminishing returns to scale. The so called *variable returns to scale* model (VRS) modifies the CRS model by adding a convexity constraint *i.e.*:

$$\begin{aligned} \min_{\theta,\lambda} \quad & \theta \\ \text{s.t.} \; & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & \sum_{i=i}^{N} \lambda = 1 \\ & \lambda \geq 0 \end{aligned} \tag{2}$$

VRS provides a decomposition of CRS Farrell efficiency in two components: one related to scale efficiency and the other one to technical efficiency.

Often, the piece-wise linear form of the frontier determined with DEA could generate weakly efficient DMUs (units located in sections of frontier parallel to axes) causing multiple optimal solutions and so categorizing some units into the same efficiency level of efficient DMUs even if inefficient (further inputs reduction is possible to produce the given output). In this case a second stage (see *e.g.* Ali & Seiford, 1993), optimizing the slack variables[2] (Harrison *et al.*, 2004), is required to determine the possible non-zero slacks and the quantity of inputs to be reduced to reach the frontier. A more rigorous definition of technical efficiency could be provided basing on Koopmans (1951): firm is technically efficient only if it operates on the frontier, and so all associated slacks are zero (Coelli *et al.*, 2005; Cooper *et al.*, 2007).

Using DEA leads, in some cases, to some notable advantages: the possibility to work well with small samples and to handle with multiple inputs and multiple outputs, also having different measurement units without assuming a functional form of the frontier; the ease identification of the scale efficiency; the possibility to compare DMUs against an observed peer or a peer group (benchmark units) in the dataset allowing to make rankings.

We cope with these problems in our research by applying the above mentioned methods in order to answer the question if the long legal trials in Italy depend on technical inefficiency or it is a congestion problem linked to a low resources level with respect to the scale of demanded output in the justice sector. As matter of fact, DEA has been widely applied to analyse efficiency in public sector (for a survey see Liu *et al.*, 2013) and in particular, in our framework, see Lewin *et al.* (1982); Kittelsen & Førsund (1992); Pedraja-Chaparro & Salinas-Jimenez (1996); Yeung & Azevedo (2011); Deyneli (2012); Ferrandino (2012); Santos & Amado (2014); Finocchiaro Castro & Guccio (2014); Falavigna *et al.* (2015); Peyrache & Zago (2016).

## 4. Italian judicial efficiency

In this Section the results of the obtained input efficiency, for the 26 Italian districts separately for each year, are presented. The choice of an input oriented model, and so the identification of a benchmark based on the minimum number of magistrates and minimum wiretapping expenditures, is due to the exogenous nature of the number of processes and to the objective of expenditure reduction.

The efficiency analysis, separated for Ordinary and Appeal courts, has been carried out in different consequential steps. (*i*) In the first step, having as a term of comparison the VRS hypothesis, a CRS-DEA model (see equations (1) and (2) in Section 3) has been implemented in order to measure the global efficiency and to identify benchmark districts. (*ii*) In the second step the choice validated at point *i* is used to investigate about the efficiency in the presence of slacks. A DEA slack model has been used to find possible non-zero slacks and to measure the additional inefficiency and so the further reduction of inputs needed to reach the optimal mix. (*iii*) In the third step a specific analysis on the returns to scale has been conducted by districts.

In order to choice the best DEA model, three inferential tests have been set up (for a detailed discussion see Banker, 1993, 1996): (*i*) to examine the existence of increasing or decreasing returns to scale, (*ii*) to assess if one decision-making sample is statistically more efficient than another one by comparing the efficiency score of two groups and (*iii*) to study the efficiency changes over years.

[2]Slacks describe the magnitude of inefficiency and outlines the overuse of inputs or the underproduction of output.

Three different inputs and outputs approaches have been investigated. In particular, *Model I* considers as inputs the total number of magistrates and the interception expenses and as outputs the number of civil and penal procedures (2 inputs and 2 outputs); *Model II* splits the number of magistrates in *judges* and *prosecutors* (3 inputs and 2 outputs); in *Model III* the number of civil and penal procedures is weighted for the time average stock in order to take workload and processing times into account (3 inputs and 2 weighted outputs).

### *4.1. Ordinary courts efficiency results*

In this subsection the results for Ordinary courts are presented. Firstly, the Kolmogorov-Smirnov test and the test on the equality of the VRS and the CRS average scores are reported. In particular, in Table 5 the null hypothesis of constant returns to scale is tested against the alternative hypothesis of variable returns to scale by using the non-parametric test of Kolmogorov-Smirnov for the three years and models. In all cases the null hypothesis is accepted (p-values $> 0.05$) and so constant returns to scale setting is the most appropriate for representing technology.

Table 5: Ordinary courts efficiency scale test by year and model

| | ***Kolmogorov-Smirnov test*** (alternative hypothesis: TWO-SIDES) | | | | | |
|---|---|---|---|---|---|---|
| | **CRS 09 vs VRS 09** | | **CRS 10 vs VRS 10** | | **CRS 11 vs VRS 11** | |
| | Test statistic | P-value | Test statistic | P-value | Test statistic | P-value |
| **Model I** | 0.231 | 0.493 | 0.192 | 0.722 | 0.269 | 0.303 |
| **Model II** | 0.231 | 0.493 | 0.192 | 0.722 | 0.192 | 0.722 |
| **Model III** | 0.269 | 0.303 | 0.231 | 0.493 | 0.192 | 0.722 |

This finding is confirmed in Table 6 by a second test on the equality of the VRS and the CRS average scores (test statistics lower than 1.960).

Table 6: Ordinary courts VRS vs CRS score mean test by year and model

| | ***Test of mean equality*** | | |
|---|---|---|---|
| | **CRS 09 vs VRS 09** | **CRS 10 vs VRS 10** | **CRS 11 vs VRS 11** |
| | Test statistic | Test statistic | Test statistic |
| **Model I** | 1.118 | 0.979 | 1.077 |
| **Model II** | 1.039 | 0.907 | 0.932 |
| **Model III** | 1.292 | 1.095 | 1.074 |

Table 7 summarizes the efficiency scores obtained with CRS-DEA method for *Models I*, *II*, *III* and for the years under evaluation.[3]

[3]The Appendix A reports DEA-VRS efficiency scores per each district. Furthermore, we perform also an Order-m DEA for evaluating the presence and the effect of extreme values (see Cazals *et al.* (2002), and Daraio & Simar (2005)). Also in this case the robustness of our results is confirmed.

Table 7: Ordinary courts CRS efficiency score by model - years 2009-2010-2011

| *District* | *Model I* | | | *Model II* | | | *Model III* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 |
| ANCONA | 0.906 *s* | 1.000 | 0.915 | 0.933 *s* | 1.000 | 0.937 *s* | 0.953 *s* | 1.000 | 0.964 *s* |
| BARI | 0.942 *s* | 0.900 | 0.914 | 0.944 *s* | 0.910 *s* | 0.932 *s* | 0.963 *s* | 0.905 *s* | 0.814 *s* |
| BOLOGNA | 0.918 *s* | 1.000 | 1.000 | 0.940 *s* | 1.000 | 1.000 | 0.881 *s* | 1.000 | 1.000 |
| BRESCIA | 0.867 *s* | 0.832 | 0.848 | 0.873 *s* | 0.865 *s* | 0.889 *s* | 0.890 *s* | 0.904 *s* | 0.917 *s* |
| CAGLIARI | 0.755 *s* | 0.928 | 0.762 *s* | 0.757 *s* | 0.952 *s* | 0.876 *s* | 0.754 *s* | 0.958 *s* | 0.851 *s* |
| CALTANISSETTA | 0.244 *s* | 0.211 *s* | 0.225 *s* | 0.256 *s* | 0.221 *s* | 0.232 *s* | 0.259 *s* | 0.221 *s* | 0.233 *s* |
| CAMPOBASSO | 0.938 *s* | 1.000 | 1.000 | 0.959 *s* | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| CATANIA | 0.526 *s* | 0.394 *s* | 0.400 *s* | 0.535 *s* | 0.398 *s* | 0.409 *s* | 0.527 *s* | 0.392 *s* | 0.409 *s* |
| CATANZARO | 0.444 *s* | 0.486 | 0.435 | 0.449 *s* | 0.495 *s* | 0.436 *s* | 0.441 *s* | 0.491 *s* | 0.425 *s* |
| FIRENZE | 0.868 *s* | 0.778 | 0.739 | 0.873 *s* | 0.783 *s* | 0.751 *s* | 0.852 *s* | 0.780 | 0.763 *s* |
| GENOVA | 0.646 *s* | 0.663 | 0.668 | 0.659 *s* | 0.665 *s* | 0.669 *s* | 0.667 *s* | 0.700 | 0.693 *s* |
| L'AQUILA | 1.000 | 1.000 | 0.996 *s* | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| MESSINA | 0.432 *s* | 0.475 | 0.532 | 0.454 *s* | 0.497 *s* | 0.550 *s* | 0.458 *s* | 0.504 *s* | 0.552 *s* |
| MILANO | 0.480 *s* | 0.503 | 0.524 | 0.529 *s* | 0.578 *s* | 0.609 *s* | 0.537 *s* | 0.574 *s* | 0.601 *s* |
| NAPOLI | 0.671 *s* | 0.672 | 0.588 | 0.718 *s* | 0.744 *s* | 0.656 *s* | 0.615 *s* | 0.673 *s* | 0.586 *s* |
| PALERMO | 0.291 *s* | 0.304 *s* | 0.315 *s* | 0.308 *s* | 0.320 *s* | 0.340 *s* | 0.298 *s* | 0.313 *s* | 0.331 *s* |
| PERUGIA | 0.921 *s* | 0.791 | 0.789 | 0.972 *s* | 0.811 *s* | 0.814 *s* | 0.992 *s* | 0.835 *s* | 0.848 *s* |
| POTENZA | 0.624 *s* | 0.692 | 0.544 | 0.630 *s* | 0.698 *s* | 0.562 *s* | 0.633 *s* | 0.701 *s* | 0.579 *s* |
| REGGIO CALABRIA | 0.298 *s* | 0.302 *s* | 0.298 *s* | 0.303 *s* | 0.311 *s* | 0.317 *s* | 0.297 *s* | 0.305 *s* | 0.310 *s* |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.894 | 0.880 | 0.827 *s* | 0.896 *s* | 0.896 *s* | 0.870 *s* | 0.936 *s* | 0.934 *s* | 0.894 *s* |
| TORINO | 0.535 *s* | 0.712 | 0.669 | 0.552 *s* | 0.715 *s* | 0.683 *s* | 0.551 *s* | 0.725 *s* | 0.703 *s* |
| TRENTO | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| TRIESTE | 0.571 *s* | 0.651 | 0.612 | 0.586 *s* | 0.671 *s* | 0.627 *s* | 0.593 *s* | 0.687 *s* | 0.643 *s* |
| VENEZIA | 0.808 *s* | 0.778 | 0.811 | 0.821 *s* | 0.780 *s* | 0.816 *s* | 0.826 *s* | 0.799 *s* | 0.831 *s* |

Note: s=Presence of positive slacks.

Table 7 shows that in the considered years, under the hypothesis of constant returns to scale and for all models, 4 districts display as benchmarks in 2009 - Trento, L'Aquila, Lecce and Rome - and 6 in 2010-2011 with the inclusion of Bologna and Campobasso that improve their efficiency level of about 1.5%. While the worst for all years and models are Reggio Calabria, Palermo and Caltanissetta with an efficiency score approximately equal to 0.3.
For inefficient units, further analysis has been carried out to investigate the possible presence of slacks. The "*s*" denotes the inability of districts to reach the efficient frontier with only an equiproportional reduction of the two inputs considered. As an example, it can be seen that in 2009 almost all DMUs present inefficiencies, and it can be stated that, among others, Ancona with an efficiency score equal to 0.906, could achieve the benchmark output level by a proportional reduction of the two inputs but also by an additional contraction of one of the inputs. Such a task implies the reorganization of activities and functions performed by the judicial offices.

Moreover, the analysis on the operative returns to scale of each district (Table 8 and Figure 1) highlights that the *Most productive scale size* (MPSS) districts are not located in a specific area of Italy. In fact, Trento, Rome, L'Aquila, Campobasso and Lecce are the most productive in terms of resource optimization and size of activities. However, considering Ordinary courts, many districts present dimensional dysfunctions specially located in Northern Italy, thus emphasizing the need to reduce the volume of activities. Instead, the districts of Messina and Caltanissetta should increase their activities.

The overall result of CRS suggests that the judicial system should increase inputs in order to process – proportionally - more outputs in a shorter time and to satisfy more the demand for justice represented by the registered procedures. However, it is important to observe that the presence of DRS or IRS in Table 8 suggests a deeper investigation on some specific districts to better understand if the overall result of CRS is valid on average only.

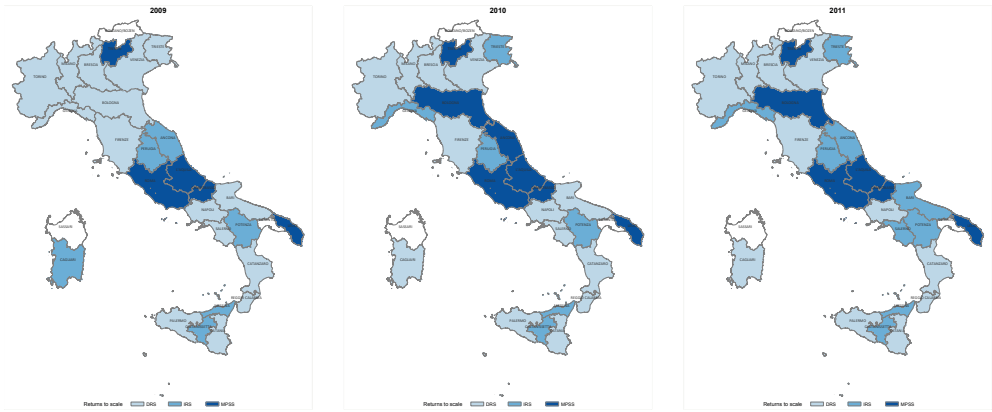
Table 8: Ordinary courts returns to scale by model - years 2009-2010-2011

| *District* | *Model I* | | | *Model II* | | | *Model III* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 |
| ANCONA | IRS | **MPSS** | IRS | IRS | **MPSS** | IRS | IRS | **MPSS** | IRS |
| BARI | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS | IRS |
| BOLOGNA | DRS | **MPSS** | **MPSS** | DRS | **MPSS** | **MPSS** | DRS | **MPSS** | **MPSS** |
| BRESCIA | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| CAGLIARI | IRS | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS |
| CALTANISSETTA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| CAMPOBASSO | IRS | **MPSS** | **MPSS** | IRS | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| CATANIA | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| CATANZARO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| FIRENZE | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| GENOVA | DRS | IRS | IRS | DRS | IRS | IRS | DRS | IRS | IRS |
| L'AQUILA | **MPSS** | **MPSS** | DRS | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| LECCE | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| MESSINA | IRS | DRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| MILANO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| NAPOLI | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| PALERMO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| PERUGIA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| POTENZA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| REGGIO CALABRIA | IRS | IRS | IRS | IRS | DRS | DRS | DRS | DRS | DRS |
| ROMA | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| SALERNO | IRS | IRS | IRS | IRS | IRS | IRS | DRS | DRS | IRS |
| TORINO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| TRENTO | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| TRIESTE | DRS | IRS | IRS | DRS | IRS | IRS | DRS | IRS | IRS |
| VENEZIA | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |

Note: IRS=Increasing returns to scale, DRS=Decreasing returns to scale, MPSS=Most Productive Scale Size.

In Figure 1 we report for simplicity sake only the efficiency map of the most complete *Model III*.[4]

Figure 1: Ordinary courts returns to scale, Model III




(a) 2009 (b) 2010 (c) 2011

Finally, Table 9 shows the results of the test on the changes in CRS efficiency scores over time using a Friedman's test. For all models the test accepted the null hypothesis meaning that the average efficiency of Ordinary courts does not differ significantly over years, remaining around 0.7.

Table 9: Ordinary courts efficiency changes test by model - Friedman test

| | *Friedman test* | |
|---|---|---|
| | Test statistic | P-value |
| **Model I** | 1.432 | 0.489 |
| **Model II** | 1.435 | 0.488 |
| **Model III** | 2.193 | 0.334 |

[4]The others efficiency maps are reported in Appendix B.

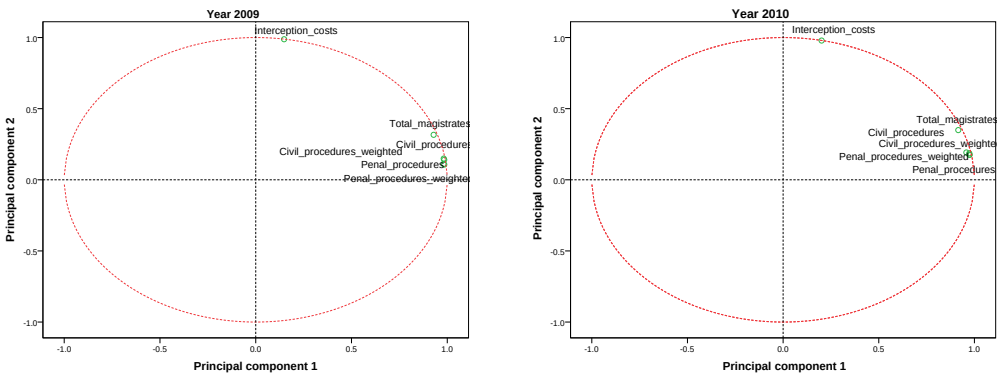
## 5. A deepening on Ordinary courts results

For several districts the possible presence of DRS and IRS contrasts that one of optimality given by CRS. Therefore, in this section this aspect is deepened, by studying in an alternative way the relationship among the inputs and outputs through a Principal Component Analysis (PCA - Manly 1994). PCA allows to highlight any strong correlations among variables within the representation of individual points and variable points. In particular, we intend to study the geographical differences in productivity.

The PCA has been replicated for each year of analysis on a set of six variables.

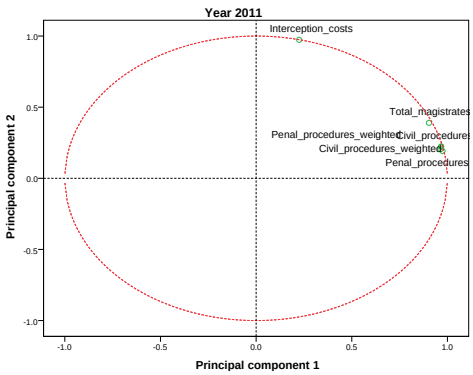
The first PCA has the aim to propose a general view of the phenomenon and so it has been applied on total magistrates, interception expenses, civil and penal procedures defined and weighted. The results are similar for the three years as it can be seen in Figure 2. The first component depends positively on both output variables and total magistrates with a percentage of variance explained of about $77-79\%$, against a $19-22\%$ variance explained by the second component representing the interception costs.

Figure 2: PCA on total magistrates, interception expenses, civil and penal procedures defined and weighted




(a) 2009

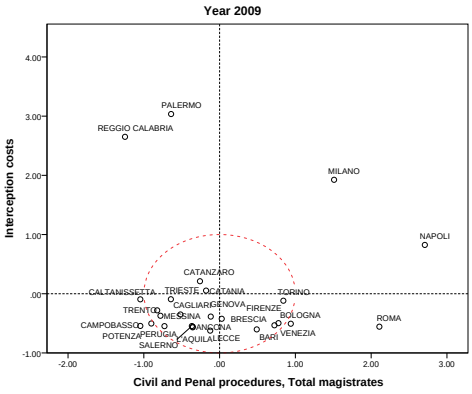
(b) 2010



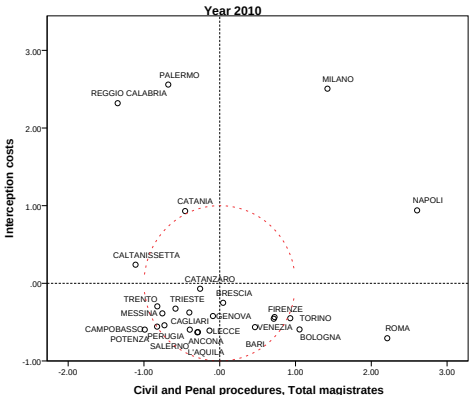

(c) 2011

Moreover, analyzing the points-individual charts in Figure 3 it can be seen that most courts are distributed below the average level associated with the first component and around the average for interception charges. Outliers are the tribunals of Reggio Calabria, Palermo, Milan, Naples and Rome. In particular, Reggio Calabria and Palermo present a high level of interception expenditures and a number of penal and civil procedures below the average level. Differently, the districts of Milan and Naples are characterized by a high level of interception expenditures and a level of penal and civil defined procedures and of magistrates employed above the average. Noteworthy it is the representation of the Rome tribunal, which shows a level of interception expenditures and a number of defined procedures below and above the average of the other courts, respectively.

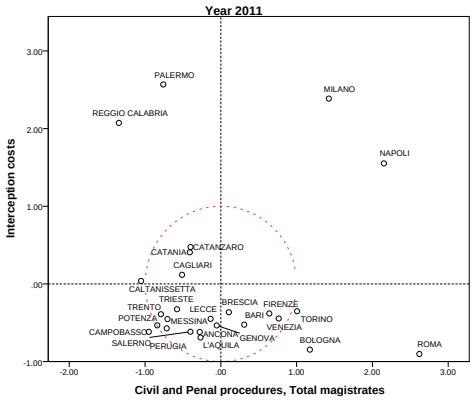
Figure 3: Points-individual charts




(a) 2009




(b) 2010




(c) 2011

The second PCA focuses on the relationship among structural and expenditure indexes in order to analyze what affects the Ordinary courts management. Specifically, the ratios of output variables (defined procedures in civil and penal cases) upon the total number of magistrates (assigned to each court) are conceived as structure indexes. Instead, the interception expenditure input is used to define spending indicators given by the ratio between outputs and the interception expenditure. In any case, both indicators are measures of the input performance (productivity), which motivates our interest in comparing geographical areas in such a respect.

We find very similar results for the geographical areas in the three years considered. Hence, for sake of simplicity we present in Table 10 the last one [5]. The first component is linked to expenditures indexes and the second one to structural indexes.

The North-East of Italy is affected positively by the structure indexes and negatively by the spending index. This underlines that from one side the productivity of the magistrates is high, compared to the average level (particularly due to Trento ordinary court, coherently with the good performances identified by the DEA method), from the other side such good productivity is supported by high expenditures per unit of output. The North-West and Center's geographic areas present a medium-level of structural indexes but different impacts in terms of spending indexes. In particular, the North-West has a poor performance in terms of expenses whilst the Center has an output per expenditure well above the average (Rome and Campobasso for first present high expenses). The South shows a good performance of expenditures per unit of output and a ratio of output per magistrate below the mean. The geographic area of the Isles has the worst output per expenses ratio with the most critical structural index. Then, the Isles have the worst performance from both sides of inputs (magistrates and expenses for interception) and the North-East the best one followed by the Center, North-West and South.

[5] However, for major precision, we adopt the "rotated matrix".

Table 10: PCA rotated matrix (2011)

| | Components (difference from the mean) | |
|---|---|---|
| Indexes | First | Second |
| Civil procedures/Total magistrates | 0.287 | 0.887 |
| Penal procedures/Total magistrates | 0.137 | 0.964 |
| Weighted Civil procedures/Total magistrates | 0.238 | 0.920 |
| Weighted Penal procedures/Total magistrates | 0.105 | 0.963 |
| Civil procedures/Interception expenditures | 0.962 | 0.146 |
| Penal procedures/Interception expenditures | 0.967 | 0.148 |
| Weighted Civil procedures/Interception expenditures | 0.965 | 0.147 |
| Weighted Penal procedures/Interception expenditures | 0.955 | 0.169 |
| Territorial area | First | Second |
| North-East | -0.264 | 0.622 |
| North-West | -0.192 | -0.054 |
| Center | 0.515 | -0.027 |
| South | 0.367 | -0.146 |
| Isles | -0.497 | -0.319 |

Finally, the PCA has been replicated in two different ways in order to investigate whether the previous results for the judicial districts are affected by the geographical areas to which they belong. To this purpose, three PCAs have been implemented with the aim of comparing geographic areas at parity conditions. In particular, we consider per each geographic area the structure and expenditure ratios as weighted average of the specific ratios referred to the several classes of time required to complete the trials ($TCT$: $t = 1, ..T$), indicated in the following Table 11. We identify a *population effect* ($PE$) given by the weights and a *specific effect* ($CE$) given by the ratios to be weighted that are specified by the time to complete the trial.

Table 11: Population and Specific effects

| | Component | |
|---|---|---|
| Time to complete the trials | Civil trials | Penal trials |
| very low | $\leq 250$ | $\leq 150$ |
| low | $\leq 450$ | $\leq 250$ |
| medium | $\leq 650$ | $\leq 350$ |
| high | $\leq 850$ | $\leq 450$ |
| very high | $\geq 850$ | $\geq 450$ |

Then, we build the weighted averages for the different areas by using the same $PE$ or $CE$ and perform a comparison at parity condition of population or specific effect. In the former case, we may investigate if differences in performance are due to the correct allocation of the magistrates or interception expenses through offices (isolated effect), in the latter if there is a difference dependent on productivity (isolated effect). For the $AREA_j$ the two effects are represented by:

$$PE_{t\in TCT}^{AREA(j)} = \frac{x_t^{AREA(j)}}{\sum_{t=1}^{T} x_t^{AREA(j)}}; CE_{t\in TCT}^{AREA(j)} = \frac{y_t^{AREA(j)}}{x_t^{AREA(j)}}, \tag{3}$$

where $i$ runs over the several time-average stocks.
The indexes corresponding to expression 3 are:

*Population index*

$$Index_{PE}^{AREA_j} = \sum_{t=1}^{T} PE_t^{AREA(\hat{j})} \cdot \frac{y_t^{AREA(j)}}{x_t^{AREA(j)}} \tag{4}$$

*Coefficient effect index*

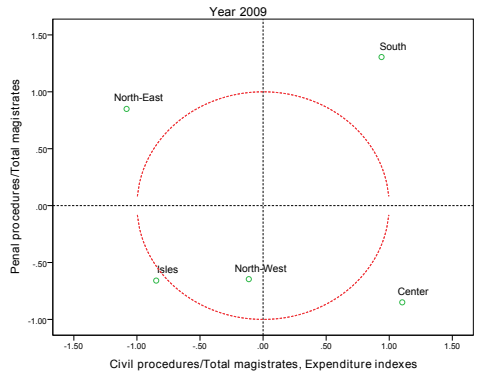
$$Index_{CE}^{AREA_j} = \sum_{t=1}^{T} CE_t^{AREA(\hat{j})} \cdot \frac{x_t^{AREA(j)}}{\sum_{t=1}^{T} x_t^{AREA(j)}} \tag{5}$$

where $\hat{j}$ indicates the geographic area with population (weights) or coefficient effect (specific ratios) retained fixed for the areas to be compared at parity conditions. As usual, we prefer to use a virtual average area where the above mentioned effects are averaged through all areas.

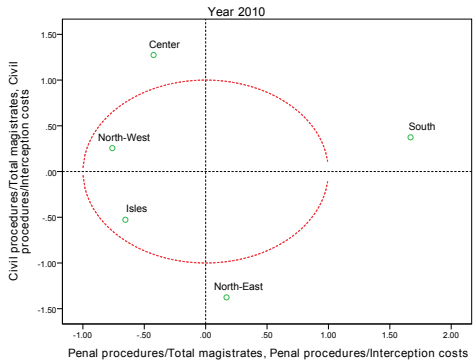
Starting with the population effect, individual points representations allow to compare geographic areas at parity conditions of the distribution of inputs -like magistrates and interception expenses- over trials, on the base of the time required for their conclusion. Hence, we analyze if, net of the inputs distribution effect, some differences with the PCA performed on the actual data occur. In this case, the only remaining effect is that of the productivity. From Figure 4, based on (4), it is possible to discover that the effect of

the productivity does not improve the performance condition of the North East, the North West improves little, the Center and the South improve, whilst the Isles remain definitely in the same condition. Hence, differently from the Center and South, what matters for the good performance of the North East and North West is an appropriate distribution of the resources (magistrates and interception expenses) according to the length of the trials. Surprisingly, once isolated such an effect, the sole effect of productivity does not suffice to ensure a good performance of these areas compared to the Center and the South. As for the Isles, their performance remains unaltered, meaning that the negative performance registered by the actual data is due to an overall poor productivity.

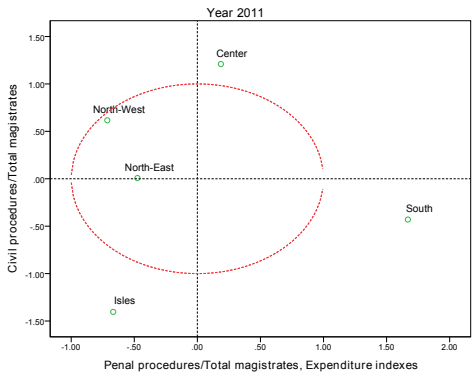
Figure 4: Points-individual charts - population effect




(a) 2009




(b) 2010

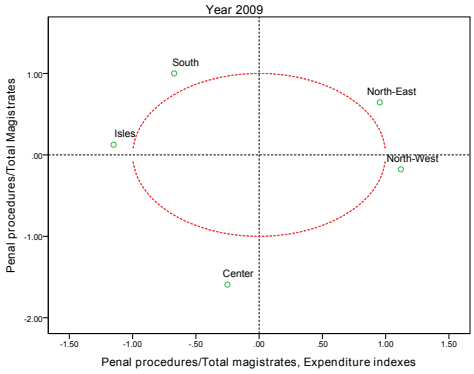



(c) 2011

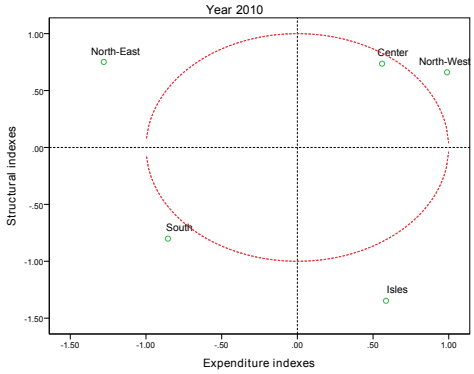
The results obtained isolating the specific ratios effect with formula (5), represented in Figure 5, confirm those reached with the previous PCA. Specifically, compared with the results obtained with actual data, the North East improves its performance, the North West improves little, the South worsens, the Center is conditioned in worse or better according to the year under consideration and the Isles seem to improve but only in the first two years.

Therefore, we may reach a robust conclusion that the good performance of the North East is essentially due to an efficient distribution of the resources according to the time necessary to conclude the trials and not much to the productivity of the used inputs. The same conclusion is valid also for the North West, though in a more tenuous way. Differently, the South is characterized by a good performance of the inputs but with an inefficient repartition on the length of the trials. Analogous situation is that of the Center, though less quantitatively relevant.

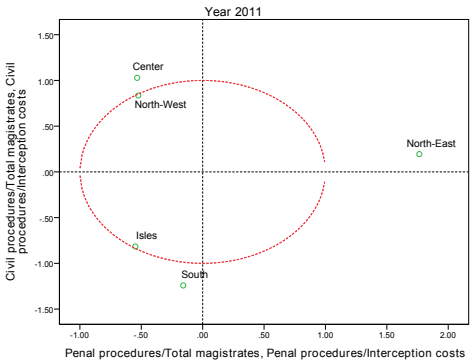
Figure 5: Points-individual charts - coefficient effect




(a) 2009




(b) 2010




(c) 2011

Here below, Table 12 reports the improvements (plus sign) or the detriments (minus sign) due to the population or the coefficient specific effect in comparison with the actual data as indicated by the first and second principal components. As said above, the first component ($PC1$) represents the structural index (magistrate productivity) and the second one ($PC2$) the expenditure index (interception expenditure productivity)

Table 12: Geographic comparisons at parity conditions

| Territorial area | ***Actual values*** | | ***Population effect*** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2009 | | 2010 | | 2011 | |
| | $PC1$ | $PC2$ | $PC1$ | $PC2$ | $PC1$ | $PC2$ | $PC1$ | $PC2$ |
| North East | - | + | - | + | + ($\simeq 0$) | - | - | 0 |
| North West | - | - | - ($\simeq 0$) | - | - | + ($\simeq 0$) | - | + |
| Center | + | - | + | - | - | + | + | + |
| South | + | - | + | + | + | + | + | - |
| Isles | - | - | - | - | - | - | - | - |
| | ***Actual values*** | | ***Coefficient specific effect*** | | | | | |
| | | | 2009 | | 2010 | | 2011 | |
| | $PC1$ | $PC2$ | $PC1$ | $PC2$ | $PC1$ | $PC2$ | $PC1$ | $PC2$ |
| North East | - | + | + | + | - | + | + ($\simeq 0$) | + |
| North West | - | - | + | - ($\simeq 0$) | + | + | - | + |
| Center | + | - | - | - | + | + | - | + |
| South | + | - | - | + | - | - | - | - |
| Isles | - | - | - | + ($\simeq 0$) | + | - | - | - |

Results obtained with data standardized by *population* and *specific coefficient effects* point out that the indications in Table 8 of DRS and IRS for the major part of the North and the South of Italy, respectively, are not in contradiction with the tests in favor of the CRS hypothesis. In fact, DRS in the North are due to a low productivity of the inputs, which is nonetheless compensated by an efficient distribution of the resources through the judicial offices. Instead, for the South IRS is justified by the productivity of the inputs above the mean, which is penalized by an inefficient distribution of the resources.

Therefore, for the South, and in minor part the Center, the remedy for improving the performance of the Ordinary courts is to manage with the distribution of the magistrates and interception expenses in favor of the offices characterized by long trials, rather than to merge the offices, as at a first sight it might seem. As for the North (and some big city of the South), even though the distribution of inputs is efficient, the productivity is low for problems of congestion. Hence, a correct reform should allow a more efficient and territorially diffused subdivision of the judicial offices. The Isles suffer both from a low productivity and, at the same time, also from a not efficient distribution of the inputs, which are therefore the problems to face.

### *5.1. Appeals courts efficiency results*

In order to analyze the several "levels" of the Italian justice, the efficiency has been studied also for the second degree of judgment, the Appeal courts. The results are similar to the Ordinary courts with some differences. As can be seen from the results presented in Table 13, also in this case the Kolmogorov-Smirnov test leads to choose the CRS technology, except for Model I and II in 2010 and this finding is also confirmed in Table 14 where the Test statistic results greater than 1.960.

Table 13: Appeals courts efficiency scale test by year and model

| | ***Kolmogorov-Smirnov test*** (alternative hypothesis: TWO-SIDES) | | | | | |
|---|---|---|---|---|---|---|
| | **CRS 09 vs VRS 09** | | **CRS 10 vs VRS 10** | | **CRS 11 vs VRS 11** | |
| | Test statistic | P-value | Test statistic | P-value | Test statistic | P-value |
| **Model I** | 0.308 | 0.171 | 0.423 | 0.019 | 0.308 | 0.171 |
| **Model II** | 0.308 | 0.171 | 0.385 | 0.043 | 0.308 | 0.171 |
| **Model III** | 0.308 | 0.171 | 0.346 | 0.089 | 0.269 | 0.301 |

Table 14: Appeals courts BCC vs CCR score mean test by year and model

| | ***Test of mean equality*** | | |
|---|---|---|---|
| | **CRS 09 vs VRS 09** | **CRS 10 vs VRS 10** | **CRS 11 vs VRS 11** |
| | Test statistic | Test statistic | Test statistic |
| **Model I** | 1.59 | 2.634 | 1.894 |
| **Model II** | 1.462 | 2.56 | 1.753 |
| **Model III** | 1.596 | 1.473 | 1.573 |

With the aim of understanding the above-mentioned results, and in particular to detect if this is due only to an overall evaluation, other tests have been performed. Another Kolmogorov-Smirnov test has been implemented by comparing Non-Increasing Return to Scale (NIRS) and VRS specifications for the year 2010 by concluding that for Model I the most suitable hypothesis is the VRS and for Model II the NIRS.

To verify if significant changes over years exist, a Friedman test has been set up coherently with the obtained hypotheses of returns to scale. For Appeals courts we find significant changes between the 2009 and the 2011 as shown in Table 15.

Table 15: Appeals courts efficiency changes test by model - Friedman test

| | ***Friedman test*** | |
|---|---|---|
| | Test statistic | P-value |
| **Model I** | 26.547 | 0.0000 |
| **Model II** | 20.191 | 0.0000 |
| **Model III** | 20.242 | 0.0000 |

Finally, to prove if some differences exist between specific couple of years a rank-Wilcoxon test has been implemented. Table 16 shows that there are no significant differences between the performance of the 26 Appeal courts of the first model in the 2009-2010 period. Likewise, the reduction in efficiency observed in the years 2010-2011 for the second and third model is not statistically significant. However, from the comparison between 2009 and 2011, the significant reduction in efficiency, which involves all three models, is evident. Nonetheless relevant is the loss of efficiency observed in the 2009-2010 and 2010-2011 respectively in the last two models and in the first one. In particular, for such models in the afore mentioned years, the upward movement of the productive frontier has led to the lower efficiency scores, valued in relation to the same set of decision-making units and production factors.

Table 16: Appeals courts efficiency changes test by model - Wilcoxon test

| | | *Wilcoxon test* | | |
|---|---|---|---|---|
| | | **CRS_09 vs VRS_10** | **VRS_10 vs CRS_11** | **CRS_09 vs CRS_11** |
| **Model I** | Test statistic | -0,614b | -3,878a | -4,158a |
| | P-value | 0.539 | 0.000 | 0.000 |
| | | **CRS_09 vs NIRS_10** | **NIRS_10 vs CRS_11** | **CRS_09 vs CRS_11** |
| **Model II** | Test statistic | -3,057a | -1,354a | -4,106a |
| | P-value | 0.002 | 0.176 | 0.000 |
| | | **CRS_09 vs CRS_10** | **CRS_10 vs CRS_11** | **CRS_09 vs CRS_11** |
| **Model III** | Test statistic | -3,957a | -0,292a | -3,632a |
| | P-value | 0.000 | 0.77 | 0.000 |

a. Based on positive ranks
b. Based on negative ranks

Under the assumptions of constant returns to scale, the efficient Appeal courts districts (Table 17) are Rome, Lecce and Bari in 2009 and Rome, Lecce and L'Aquila in 2010-2011. Analysing the Italian average efficiency, in the Appeal courts framework, there is a decreasing trend over the years, with a total gap of about 14%.

Table 17: Appeals courts CCR efficiency score by model - years 2009-2010-2011

| ***District*** | ***Model I*** | | | ***Model II*** | | | ***Model III*** | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 |
| ANCONA | 0.944 *s* | 0.790 *s* | 0.884 | 0.974 *s* | 0.753 *s* | 0.894 *s* | 0.935 *s* | 0.746 *s* | 0.906 *s* |
| BARI | 1.000 | 0.835 *s* | 0.988 *s* | 1.000 | 0.858 *s* | 1.000 | 1.000 | 0.866 *s* | 1.000 |
| BOLOGNA | 0.777 *s* | 0.600 *s* | 0.425 *s* | 0.778 *s* | 0.571 *s* | 0.433 *s* | 0.749 *s* | 0.554 *s* | 0.423 *s* |
| BRESCIA | 0.603 *s* | 0.512 *s* | 0.543 *s* | 0.622 *s* | 0.501 *s* | 0.575 *s* | 0.583 *s* | 0.487 *s* | 0.569 *s* |
| CAGLIARI | 0.620 *s* | 0.726 *s* | 0.604 *s* | 0.674 *s* | 0.760 *s* | 0.669 *s* | 0.678 *s* | 0.773 *s* | 0.678 *s* |
| CALTANISSETTA | 0.562 *s* | 0.509 *s* | 0.436 *s* | 0.620 *s* | 0.544 *s* | 0.484 *s* | 0.632 *s* | 0.558 *s* | 0.493 *s* |
| CAMPOBASSO | 0.902 *s* | 0.611 *s* | 0.826 *s* | 0.989 *s* | 0.648 *s* | 0.826 *s* | 1.000 | 0.841 *s* | 1.000 |
| CATANIA | 0.614 *s* | 0.479 *s* | 0.402 *s* | 0.621 *s* | 0.462 *s* | 0.413 *s* | 0.600 *s* | 0.457 *s* | 0.406*s* |
| CATANZARO | 0.513 *s* | 0.461 *s* | 0.458 *s* | 0.607 *s* | 0.546 *s* | 0.543 *s* | 0.591 *s* | 0.539 *s* | 0.539 *s* |
| FIRENZE | 0.722 *s* | 0.567 *s* | 0.454 *s* | 0.739 *s* | 0.557 *s* | 0.471 *s* | 0.748 *s* | 0.561 *s* | 0.470 *s* |
| GENOVA | 0.731 *s* | 0.604 *s* | 0.607 | 0.740 *s* | 0.572 *s* | 0.620 *s* | 0.731 *s* | 0.582 *s* | 0.635 *s* |
| L'AQUILA | 0.969 *s* | 1.000 | 1.000 | 0.970 *s* | 1.000 | 1.000 | 0.994 *s* | 1.000 | 1.000 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| MESSINA | 0.694 *s* | 0.568 *s* | 0.615 *s* | 0.718 *s* | 0.588 *s* | 0.642 *s* | 0.709 *s* | 0.586 *s* | 0.652 *s* |
| MILANO | 0.330 *s* | 0.273 *s* | 0.301 *s* | 0.365 *s* | 0.290 *s* | 0.312 *s* | 0.360 *s* | 0.291 *s* | 0.305 *s* |
| NAPOLI | 0.770 *s* | 0.707 *s* | 0.540 *s* | 0.816 *s* | 0.803 *s* | 0.685 *s* | 0.801 *s* | 0.765 *s* | 0.589*s* |
| PALERMO | 0.553 *s* | 0.523 *s* | 0.435 *s* | 0.587 *s* | 0.543 *s* | 0.469 *s* | 0.588 *s* | 0.548 *s* | 0.470 *s* |
| PERUGIA | 0.878 *s* | 0.624 *s* | 0.809 | 0.926 *s* | 0.659 *s* | 0.865 *s* | 0.939 *s* | 0.674 *s* | 0.900*s* |
| POTENZA | 0.931 *s* | 0.672 *s* | 0.503 *s* | 1.000 | 0.730 *s* | 0.548 *s* | 1.000 | 0.793 *s* | 0.572 *s* |
| REGGIO CALABRIA | 0.752 *s* | 0.491 *s* | 0.389 *s* | 0.762 *s* | 0.501 *s* | 0.417 *s* | 0.765 *s* | 0.499 *s* | 0.412 *s* |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.669 *s* | 0.683 *s* | 0.638 | 0.676 *s* | 0.683 *s* | 0.673 *s* | 0.713 *s* | 0.749 *s* | 0.833 *s* |
| TORINO | 0.615 *s* | 0.427 *s* | 0.389 *s* | 0.687 *s* | 0.423 *s* | 0.406 *s* | 0.663 *s* | 0.426 *s* | 0.404 *s* |
| TRENTO | 0.630 *s* | 0.479 *s* | 0.452 *s* | 0.652 *s* | 0.495 *s* | 0.469 *s* | 0.666 *s* | 0.509 *s* | 0.483 *s* |
| TRIESTE | 0.734 *s* | 0.495 *s* | 0.400 *s* | 0.763 *s* | 0.488 *s* | 0.424 *s* | 0.772 *s* | 0.506 *s* | 0.432 *s* |
| VENEZIA | 0.920 *s* | 0.508 *s* | 0.519 *s* | 0.934 *s* | 0.509 *s* | 0.531 *s* | 0.905 *s* | 0.493 *s* | 0.520 *s* |

Note: s=Presence of positive slacks.

As in the case of the Ordinary courts, by comparing the hypotheses of CRS and VRS, we try to assess if the inefficiency is the result of an inadequate management of productive factors or the effect of an inadequate dimensional scale on which districts are working. In Table 18 and Figure 6[6] it can be seen how the number of districts operating at an optimal size is very small (Rome, Lecce, L'Aquila and Bari) and that the number of districts with IRS is considerably higher than those characterized by DRS, which are, on the other side, represented by the major cities.

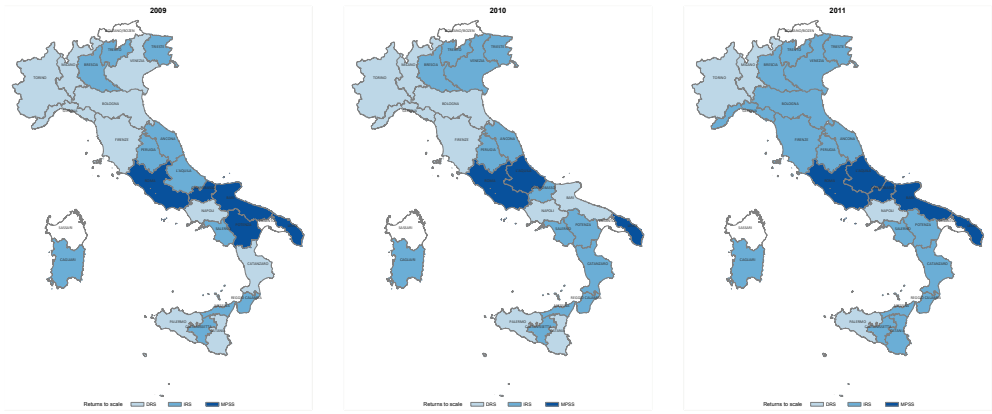
[6]In order not to overload the paper we present only the more complete Model III. Furthermore, since the districts coincide with the Appeal courts, we do not perform the previous PCA analysis because, in such a case, the subdivision of the output/input ratios by the length of the procedures may not be applied to different courts, possibly to merge or split on the base of the return to scale.

Table 18: Ordinary courts returns to scale by model - years 2009-2010-2011

| *District* | *Model I* | | | *Model II* | | | *Model III* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 | 2009 | 2010 | 2011 |
| ANCONA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| BARI | **MPSS** | DRS | IRS | **MPSS** | DRS | **MPSS** | **MPSS** | DRS | **MPSS** |
| BOLOGNA | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS | IRS |
| BRESCIA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| CAGLIARI | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| CALTANISSETTA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| CAMPOBASSO | IRS | IRS | IRS | IRS | IRS | IRS | **MPSS** | IRS | **MPSS** |
| CATANIA | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS | IRS |
| CATANZARO | IRS | IRS | IRS | DRS | IRS | IRS | DRS | IRS | IRS |
| FIRENZE | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS | IRS |
| GENOVA | DRS | DRS | IRS | DRS | DRS | IRS | DRS | DRS | IRS |
| L'AQUILA | IRS | **MPSS** | **MPSS** | IRS | **MPSS** | **MPSS** | IRS | **MPSS** | **MPSS** |
| LECCE | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| MESSINA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| MILANO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| NAPOLI | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| PALERMO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| PERUGIA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| POTENZA | IRS | IRS | IRS | **MPSS** | IRS | IRS | **MPSS** | IRS | IRS |
| REGGIO CALABRIA | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| ROMA | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** | **MPSS** |
| SALERNO | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| TORINO | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS | DRS |
| TRENTO | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| TRIESTE | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS | IRS |
| VENEZIA | DRS | IRS | IRS | DRS | IRS | IRS | DRS | IRS | IRS |

Note: IRS=Increasing returns to scale, DRS=Decreasing returns to scale, MPSS=Most Productive Scale Size.

Figure 6: Appeals courts returns to scale, Model III




(a) 2009 (b) 2010 (c) 2011

Therefore, the major part of the Italian Appeals court should change the size on which they operate by increasing the load of activities. An opposite situation is given by the Venice's Appeal court in 2009, that operates in an over-dimensional scale condition but maintaining an inefficiency level of about 8%. Instead, Milan's Appeals court for all three-year presents an efficiency score around the 35%. However, such a result was rather expected, being the number of procedures per district much smaller in the appeal phase than at its beginning at the Ordinary courts. Therefore, for the IRS Appeal courts it is efficient to increase the number of inputs in case of an increase in the demand of the outputs, whilst for the DRS districts it is to be evaluated if new Appeal courts have to be introduced in order to satisfy the demand of output in a shorter time.

Actually, in Italy, the raise in the demand of output of the judicial sector is becoming an urgent problem to face for the huge number of laws always increasing, which engenders confusion in their application. This is basically due to the increasing number of local authorities, and of their competences, which caused an always more increasing amount of regulations and rules. Alternatively, a more coordinated legislative system should control this problem.

## 6. Conclusions

The combined use of output information on procedures and the amount of interception expenses has allowed implementing an efficiency analysis of the Italian judicial system. This research investigates on judicial inefficiency for several years in which the demand for local justice is evaluated accounting also for the length of the trials. According to our results based on DEA methodology and supported by PCA analysis, an appropriate management of the input factors can pursue the elimination or contraction of technical inefficiencies. Still, the optimal scale analysis may help understand the opportunity of creating new judicial offices or enlarging the actual ones. As for the Ordinary courts, the technical inefficiency found is consistent and stable (not significantly different over years): on average 20 out of 26 districts are inefficient, with an average inefficiency score of 27.2%.

Our results show that the hypothesis of CRS is overall reliable. In the North, notwithstanding the specific productivity of inputs is below the mean, CRS is justified by an efficient allocation of the inputs through the offices by trials length. In the South, the situation is the opposite, with an inefficient distribution of the inputs and a specific productivity of the inputs above the mean. Hence, in order to improve the efficiency and to satisfy a growing demand of justice, new offices would be requested in the North and further resources would be necessary in the South together with a better repartition of the inputs through offices. The Isles suffer from both a low productivity and a not efficient distribution of the inputs on which should be relevant to concentrate the efforts for improving the efficiency.

As for Appeal courts, on average, 23 out of 26 districts were found inefficient in the case of CRS hypothesis and 20 out of 26 under the VRS hypothesis, with a relative inefficiency of 28.8% and 25%, respectively.

Also for the Appeal courts the CRS hypothesis has been overall detected. However, at a deeper investigation, many Appeal courts are IRS being the number of procedures per district much smaller in the appeal phase than at its beginning at the Ordinary courts. In this case an increase in the inputs would allow processing more trials in a shorter time. Instead, for the greater districts of the major cities DRS revealed more appropriate, in which case the creation of new offices is suggested.

## A. Appendix

### *A.1. Ordinary courts*

Table 19: Ordinary courts efficiency score by method and model - year 2009

| | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| Distretti | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 0.906 | 0.909 | 0.933 | 0.936 | 0.126 | 0.411 |
| BARI | 0.942 | 1.000 | 0.944 | 1.000 | 1.000 | 1.000 |
| BOLOGNA | 0.918 | 1.000 | 0.940 | 1.000 | 0.766 | 0.837 |
| BRESCIA | 0.867 | 0.918 | 0.873 | 0.943 | 0.108 | 0.332 |
| CAGLIARI | 0.755 | 0.760 | 0.757 | 0.766 | 0.198 | 0.607 |
| CALTANISSETTA | 0.244 | 0.422 | 0.256 | 0.428 | 0.022 | 0.436 |
| CAMPOBASSO | 0.938 | 1.000 | 0.959 | 1.000 | 0.026 | 1.000 |
| CATANIA | 0.526 | 0.567 | 0.535 | 0.571 | 0.222 | 0.358 |
| CATANZARO | 0.444 | 0.509 | 0.449 | 0.519 | 0.265 | 0.398 |
| FIRENZE | 0.868 | 0.949 | 0.873 | 0.963 | 0.369 | 0.460 |
| GENOVA | 0.646 | 0.663 | 0.659 | 0.672 | 0.123 | 0.303 |
| L'AQUILA | 1.000 | 1.000 | 1.000 | 1.000 | 0.154 | 0.403 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.665 | 0.935 |
| MESSINA | 0.432 | 0.539 | 0.454 | 0.550 | 0.174 | 0.491 |
| MILANO | 0.480 | 0.902 | 0.529 | 0.917 | 0.216 | 0.281 |
| NAPOLI | 0.671 | 1.000 | 0.718 | 1.000 | 1.000 | 1.000 |
| PALERMO | 0.291 | 0.338 | 0.308 | 0.371 | 0.134 | 0.239 |
| PERUGIA | 0.921 | 1.000 | 0.972 | 1.000 | 0.126 | 0.637 |
| POTENZA | 0.624 | 0.712 | 0.630 | 0.715 | 0.143 | 0.643 |
| REGGIO CALABRIA | 0.298 | 0.302 | 0.303 | 0.303 | 0.089 | 0.342 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.894 | 0.899 | 0.896 | 0.900 | 0.251 | 0.464 |
| TORINO | 0.535 | 0.647 | 0.552 | 0.672 | 0.169 | 0.241 |
| TRENTO | 1.000 | 1.000 | 1.000 | 1.000 | 0.046 | 1.000 |
| TRIESTE | 0.571 | 0.574 | 0.586 | 0.590 | 0.034 | 0.357 |
| VENEZIA | 0.808 | 0.901 | 0.821 | 0.906 | 0.246 | 0.338 |

Table 20: Ordinary courts efficiency score by method and model - year 2010

| | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| Distretti | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 1.000 | 1.000 | 1.000 | 1.000 | 0.072 | 0.379 |
| BARI | 0.900 | 1.000 | 0.910 | 1.000 | 1.000 | 1.000 |
| BOLOGNA | 1.000 | 1.000 | 1.000 | 1.000 | 0.439 | 0.524 |
| BRESCIA | 0.832 | 0.876 | 0.865 | 0.908 | 0.039 | 0.279 |
| CAGLIARI | 0.928 | 0.938 | 0.952 | 0.967 | 0.249 | 0.634 |
| CALTANISSETTA | 0.211 | 0.422 | 0.221 | 0.427 | 0.016 | 0.435 |
| CAMPOBASSO | 1.000 | 1.000 | 1.000 | 1.000 | 0.016 | 1.000 |
| CATANIA | 0.394 | 0.475 | 0.398 | 0.487 | 0.172 | 0.307 |
| CATANZARO | 0.486 | 0.487 | 0.495 | 0.495 | 0.276 | 0.404 |
| FIRENZE | 0.778 | 0.810 | 0.783 | 0.818 | 0.230 | 0.327 |
| GENOVA | 0.663 | 0.679 | 0.665 | 0.686 | 0.060 | 0.254 |
| L'AQUILA | 1.000 | 1.000 | 1.000 | 1.000 | 0.087 | 0.347 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.561 | 0.860 |
| MESSINA | 0.475 | 0.536 | 0.497 | 0.546 | 0.207 | 0.520 |
| MILANO | 0.503 | 0.895 | 0.578 | 0.898 | 0.121 | 0.187 |
| NAPOLI | 0.672 | 1.000 | 0.744 | 1.000 | 0.694 | 1.000 |
| PALERMO | 0.893 | 1.000 | 0.320 | 0.395 | 0.098 | 0.206 |
| PERUGIA | 0.791 | 0.871 | 0.811 | 0.878 | 0.050 | 0.590 |
| POTENZA | 0.692 | 0.762 | 0.698 | 0.773 | 0.115 | 0.632 |
| REGGIO CALABRIA | 0.302 | 0.308 | 0.311 | 0.313 | 0.107 | 0.356 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.880 | 0.892 | 0.896 | 0.904 | 0.380 | 0.592 |
| TORINO | 0.712 | 0.750 | 0.715 | 0.765 | 0.085 | 0.164 |
| TRENTO | 1.000 | 1.000 | 1.000 | 1.000 | 0.011 | 1.000 |
| TRIESTE | 0.651 | 0.676 | 0.671 | 0.688 | 0.023 | 0.354 |
| VENEZIA | 0.778 | 0.895 | 0.780 | 0.899 | 0.151 | 0.264 |

Table 21: Ordinary courts efficiency score by method and model - year 2011

| | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| Distretti | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 0.915 | 0.944 | 0.937 | 0.956 | 0.082 | 0.383 |
| BARI | 0.914 | 0.918 | 0.932 | 0.934 | 1.000 | 1.000 |
| BOLOGNA | 1.000 | 1.000 | 1.000 | 1.000 | 0.422 | 0.510 |
| BRESCIA | 0.848 | 0.895 | 0.889 | 0.926 | 0.042 | 0.279 |
| CAGLIARI | 0.762 | 0.963 | 0.876 | 1.000 | 0.400 | 0.741 |
| CALTANISSETTA | 0.225 | 0.422 | 0.232 | 0.427 | 0.020 | 0.434 |
| CAMPOBASSO | 1.000 | 1.000 | 1.000 | 1.000 | 0.034 | 1.000 |
| CATANIA | 0.400 | 0.413 | 0.409 | 0.425 | 0.246 | 0.376 |
| CATANZARO | 0.435 | 0.484 | 0.436 | 0.492 | 0.328 | 0.450 |
| FIRENZE | 0.739 | 0.777 | 0.751 | 0.804 | 0.296 | 0.389 |
| GENOVA | 0.668 | 0.688 | 0.669 | 0.702 | 0.063 | 0.255 |
| L'AQUILA | 0.996 | 1.000 | 1.000 | 1.000 | 0.136 | 0.392 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.529 | 0.826 |
| MESSINA | 0.532 | 0.582 | 0.550 | 0.589 | 0.225 | 0.528 |
| MILANO | 0.524 | 0.882 | 0.609 | 0.888 | 0.133 | 0.196 |
| NAPOLI | 0.588 | 1.000 | 0.656 | 1.000 | 0.763 | 1.000 |
| PALERMO | 0.924 | 1.000 | 0.340 | 0.388 | 0.125 | 0.231 |
| PERUGIA | 0.789 | 0.855 | 0.814 | 0.857 | 0.093 | 0.614 |
| POTENZA | 0.544 | 0.655 | 0.562 | 0.675 | 0.155 | 0.654 |
| REGGIO CALABRIA | 0.298 | 0.312 | 0.317 | 0.317 | 0.135 | 0.380 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.827 | 0.881 | 0.870 | 0.904 | 0.550 | 0.713 |
| TORINO | 0.669 | 0.704 | 0.683 | 0.732 | 0.075 | 0.153 |
| TRENTO | 1.000 | 1.000 | 1.000 | 1.000 | 0.010 | 1.000 |
| TRIESTE | 0.612 | 0.632 | 0.627 | 0.642 | 0.040 | 0.363 |
| VENEZIA | 0.811 | 0.882 | 0.816 | 0.890 | 0.203 | 0.304 |

## *A.2. Appeals courts*

Table 22: Appeals courts efficiency score by method and model - year 2009

| | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| Distretti | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 0.944 | 1.000 | 0.974 | 1.000 | 0.618 | 0.940 |
| BARI | 1.000 | 1.000 | 1.000 | 1.000 | 0.464 | 0.515 |
| BOLOGNA | 0.777 | 0.844 | 0.778 | 0.868 | 0.426 | 0.453 |
| BRESCIA | 0.603 | 0.645 | 0.622 | 0.669 | 0.626 | 0.662 |
| CAGLIARI | 0.620 | 0.777 | 0.674 | 0.829 | 0.184 | 0.562 |
| CALTANISSETTA | 0.562 | 0.885 | 0.620 | 0.938 | 0.016 | 0.668 |
| CAMPOBASSO | 0.902 | 1.000 | 0.989 | 1.000 | 0.056 | 1.000 |
| CATANIA | 0.614 | 0.626 | 0.621 | 0.631 | 0.291 | 0.384 |
| CATANZARO | 0.513 | 0.529 | 0.607 | 0.613 | 0.115 | 0.368 |
| FIRENZE | 0.722 | 0.802 | 0.739 | 0.819 | 0.078 | 0.316 |
| GENOVA | 0.731 | 0.741 | 0.740 | 0.753 | 0.168 | 0.436 |
| L'AQUILA | 0.969 | 1.000 | 0.970 | 1.000 | 1.000 | 1.000 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.186 | 0.639 |
| MESSINA | 0.694 | 0.746 | 0.718 | 0.748 | 0.128 | 0.621 |
| MILANO | 0.330 | 0.379 | 0.365 | 0.386 | 0.166 | 0.200 |
| NAPOLI | 0.770 | 0.924 | 0.816 | 0.935 | 0.703 | 0.772 |
| PALERMO | 0.553 | 0.573 | 0.587 | 0.617 | 0.054 | 0.229 |
| PERUGIA | 0.878 | 0.989 | 0.926 | 0.993 | 0.116 | 0.814 |
| POTENZA | 0.931 | 1.000 | 1.000 | 1.000 | 0.018 | 0.805 |
| REGGIO CALABRIA | 0.752 | 0.776 | 0.762 | 0.789 | 0.188 | 0.582 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.669 | 0.752 | 0.676 | 0.758 | 0.185 | 0.533 |
| TORINO | 0.615 | 0.668 | 0.687 | 0.744 | 0.266 | 0.320 |
| TRENTO | 0.630 | 0.915 | 0.652 | 1.000 | 0.001 | 1.000 |
| TRIESTE | 0.734 | 0.881 | 0.763 | 0.906 | 0.037 | 0.670 |
| VENEZIA | 0.920 | 1.000 | 0.934 | 1.000 | 0.381 | 0.472 |

Table 23: Appeals courts efficiency score by method and model - year 2010

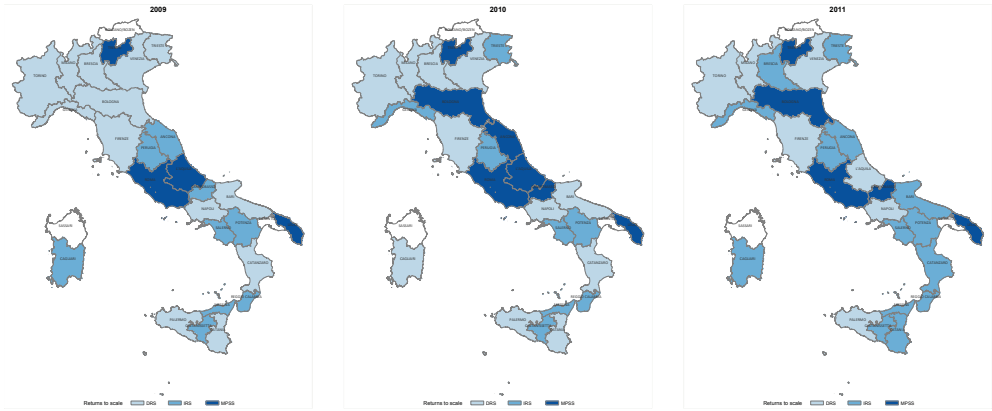
| Distretti | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 0.790 | 0.909 | 0.753 | 0.934 | 1.000 | 1.000 |
| BARI | 0.835 | 0.882 | 0.858 | 0.891 | 0.847 | 1.000 |
| BOLOGNA | 0.600 | 0.928 | 0.571 | 0.951 | 0.694 | 0.826 |
| BRESCIA | 0.512 | 0.600 | 0.501 | 0.582 | 1.000 | 1.000 |
| CAGLIARI | 0.726 | 0.821 | 0.760 | 0.845 | 0.150 | 0.532 |
| CALTANISSETTA | 0.509 | 0.833 | 0.544 | 0.845 | 0.021 | 0.671 |
| CAMPOBASSO | 0.611 | 1.000 | 0.648 | 1.000 | 0.059 | 1.000 |
| CATANIA | 0.479 | 0.486 | 0.462 | 0.470 | 0.393 | 0.429 |
| CATANZARO | 0.461 | 0.503 | 0.546 | 0.587 | 0.129 | 0.381 |
| FIRENZE | 0.567 | 0.708 | 0.557 | 0.726 | 0.111 | 0.322 |
| GENOVA | 0.604 | 0.689 | 0.572 | 0.670 | 0.205 | 0.441 |
| L'AQUILA | 1.000 | 1.000 | 1.000 | 1.000 | 0.854 | 0.968 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.230 | 0.654 |
| MESSINA | 0.568 | 0.720 | 0.588 | 0.729 | 0.135 | 0.624 |
| MILANO | 0.273 | 0.297 | 0.290 | 0.292 | 0.466 | 0.528 |
| NAPOLI | 0.707 | 0.879 | 0.803 | 0.891 | 0.988 | 1.000 |
| PALERMO | 0.523 | 0.588 | 0.543 | 0.625 | 0.063 | 0.231 |
| PERUGIA | 0.624 | 0.915 | 0.659 | 0.925 | 0.311 | 0.844 |
| POTENZA | 0.672 | 0.957 | 0.730 | 0.973 | 0.017 | 0.804 |
| REGGIO CALABRIA | 0.491 | 0.576 | 0.501 | 0.580 | 0.184 | 0.578 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.683 | 0.748 | 0.683 | 0.748 | 0.322 | 0.550 |
| TORINO | 0.427 | 0.532 | 0.423 | 0.520 | 0.798 | 1.000 |
| TRENTO | 0.479 | 0.887 | 0.495 | 1.000 | 0.002 | 1.000 |
| TRIESTE | 0.495 | 0.755 | 0.488 | 0.730 | 0.051 | 0.672 |
| VENEZIA | 0.508 | 0.532 | 0.509 | 0.529 | 0.817 | 0.910 |

Table 24: Appeals courts efficiency score by method and model - year 2011

| Distretti | *Model I* | | *Model II* | | *Model III* | |
|---|---|---|---|---|---|---|
| | DEA CRS | DEA VRS | DEA CRS | DEA VRS | DEA CRS | DEA VRS |
| ANCONA | 0.884 | 0.964 | 0.894 | 1.000 | 1.000 | 1.000 |
| BARI | 0.988 | 0.994 | 1.000 | 1.000 | 0.633 | 0.661 |
| BOLOGNA | 0.425 | 0.437 | 0.433 | 0.441 | 0.458 | 0.486 |
| BRESCIA | 0.543 | 0.612 | 0.575 | 0.635 | 0.598 | 0.635 |
| CAGLIARI | 0.604 | 0.755 | 0.669 | 0.807 | 0.069 | 0.511 |
| CALTANISSETTA | 0.436 | 0.795 | 0.484 | 0.818 | 0.039 | 0.679 |
| CAMPOBASSO | 0.826 | 1.000 | 0.826 | 1.000 | 0.050 | 1.000 |
| CATANIA | 0.402 | 0.436 | 0.413 | 0.443 | 0.328 | 0.409 |
| CATANZARO | 0.458 | 0.508 | 0.543 | 0.593 | 0.108 | 0.361 |
| FIRENZE | 0.454 | 0.467 | 0.471 | 0.483 | 0.121 | 0.323 |
| GENOVA | 0.607 | 0.631 | 0.620 | 0.635 | 0.130 | 0.425 |
| L'AQUILA | 1.000 | 1.000 | 1.000 | 1.000 | 0.342 | 0.871 |
| LECCE | 1.000 | 1.000 | 1.000 | 1.000 | 0.222 | 0.662 |
| MESSINA | 0.615 | 0.727 | 0.642 | 0.737 | 0.142 | 0.629 |
| MILANO | 0.301 | 0.367 | 0.312 | 0.377 | 0.349 | 0.351 |
| NAPOLI | 0.540 | 0.852 | 0.685 | 0.866 | 1.000 | 1.000 |
| PALERMO | 0.435 | 0.452 | 0.469 | 0.490 | 0.054 | 0.231 |
| PERUGIA | 0.809 | 1.000 | 0.865 | 1.000 | 0.384 | 0.878 |
| POTENZA | 0.503 | 0.859 | 0.548 | 0.860 | 0.023 | 0.806 |
| REGGIO CALABRIA | 0.389 | 0.529 | 0.417 | 0.543 | 0.161 | 0.468 |
| ROMA | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| SALERNO | 0.638 | 0.761 | 0.673 | 0.762 | 0.281 | 0.575 |
| TORINO | 0.389 | 0.401 | 0.406 | 0.407 | 0.871 | 0.972 |
| TRENTO | 0.452 | 0.913 | 0.469 | 1.000 | 0.002 | 1.000 |
| TRIESTE | 0.400 | 0.674 | 0.424 | 0.704 | 0.035 | 0.670 |
| VENEZIA | 0.519 | 0.540 | 0.531 | 0.549 | 0.672 | 0.676 |

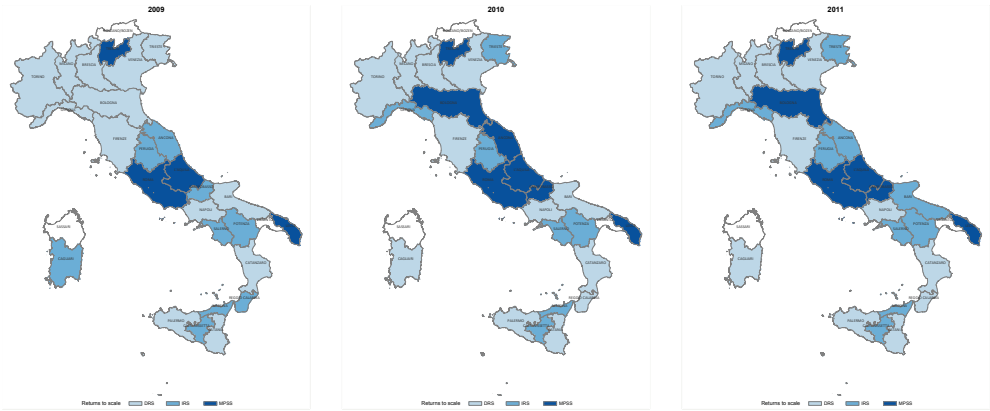
## B. Appendix

Figure 7: Ordinary courts returns to scale, Model I



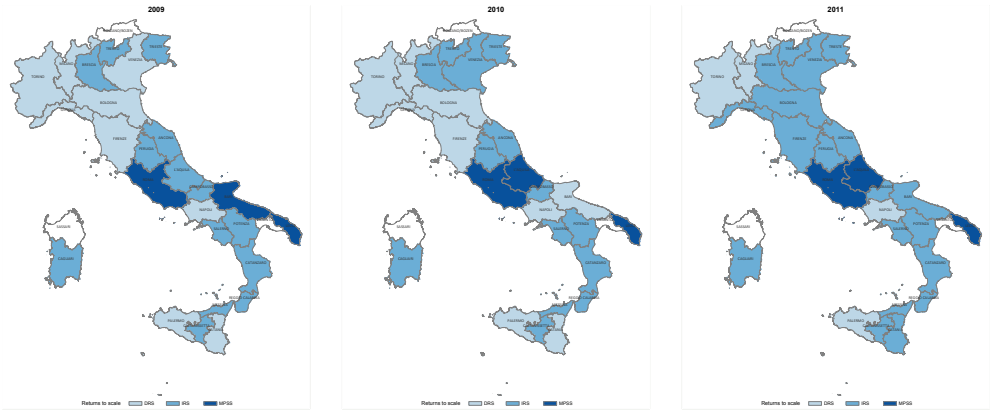

(a) 2009 (b) 2010 (c) 2011

Figure 8: Ordinary courts returns to scale, Model II



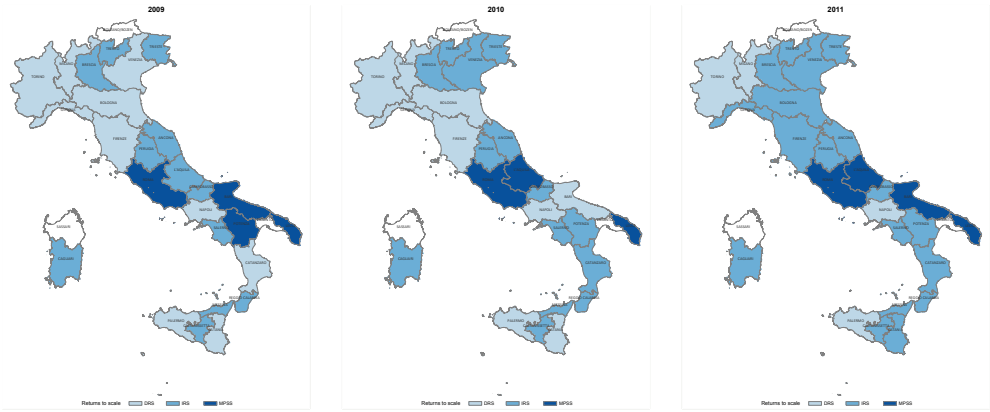

(a) 2009 (b) 2010 (c) 2011

Figure 9: Appeals courts returns to scale, Model I




(a) 2009 (b) 2010 (c) 2011

Figure 10: Appeals courts returns to scale, Model II




(a) 2009 (b) 2010 (c) 2011

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