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Master of Science in Economics

MASTER'S THESIS

PUBLIC SPENDING EFFICIENCY: EVIDENCE FROM TUSCAN MUNICIPALITIES

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Introduction

The efficient use of resources has always been a very debated issue in the economic literature. The empirical analysis of production efficiency has been applied over time to many business areas, both in the private sector and in sectors with a significant public relevance. In this vast area, the evaluation of the efficiency performance achieved by the municipalities has assumed increasing importance. Certainly, the economic and financial crisis of recent years has led to a growing emphasis on the containment of public spending and on the rationalized use of scarce and limited resources, through legislative measures at both national and local level. Even the Tuscan legislator has promoted institutional and administrative reforms to overcome the presence of inefficiency in the municipalities expenditure, in particular in relation to their size. In fact, evidences show that with regards to the smallest municipalities the expenditure inefficiency is mostly related to the not reached scale economies in the provision of public goods and services: for this reason the issue of the local governments optimal size to settle these diseconomies has long been and still is the center of academic and political debate. Given the highly topical feature undoubtedly linked to this topic, in this thesis the study of public expenditure efficiency of Tuscan municipalities is under analysis, with particular attention on the effect of the municipal size. In the scientific literature, there is growing attention to the study of efficiency in the public expenditure municipalities and the use of quantitative tools turns out to be useful to analyze municipal spending and possibly to have suggestion to do it in a better way. The most common way to do an efficiency analysis is through the estimation of the Efficiency Frontier, even if other different approaches to face this topic exist. In particular, in this field there are two alternative techniques: parametric and non-parametric techniques. Among non-parametric techniques, the DEA approach results suitable to an efficiency analysis of the public sector: in fact, DEA avoids assuming specific functional forms of the production frontier and gives intuitive ideas to correct the found inefficiencies. For this reason, in this thesis a DEA approach is used. Furthermore, in compliance with the existing literature, also a second stage analysis has been applied: in fact, the explanation of the efficiency results considering some municipal features can be useful to understand the sources of potential inefficiency in a municipality. In particular, a Tobit regression has been employed.

This thesis is structured as follows. In chapter one, a brief statistical description of the Tuscany situation and of its local governments spending is presented, in order to put into context the efficiency analysis of the Tuscany municipalities public expenditures. Moreover, the legislative measures enacted until now to reduce municipal inefficiency is presented, focusing the attention in particular with regards to the debated issue of the municipal size. In chapter two, there is the attempt to show the state-of-art of the global municipal efficiency literature. First of all, since public efficiency analysis can be done in very different municipal offered services, a brief literature review presents a reach variety of observed samples, methodologies and other additional features. Then, the main quantitative techniques for the efficiency analysis are described, pointing out the peculiarities of the public analysis applications. Furthermore, the main contribution of the literature is presented with regards to the choice of the decision variables, both for the computation of the municipal efficiency scores and for the explanation of its determinants. In chapter three, the main choices regarding the definition of the Tuscan municipalities spending efficiency analysis are described, focusing on the faced critical aspects, step by step. The more relevant decisions regard the definition of the dataset and the inputs and outputs choice. Also the choices of the DEA model to be used and the explanatory variables to use in the Tobit regression are presented. Chapter four is dedicated to the explanation of the obtained DEA and Tobit results: the main peculiar aspects are presented and some elements to improve the municipal efficiency is put in evidence.

I would like to point out that the thesis is strictly linked to my internship at IRPET (Istituto Regionale Programmazione Economica della Toscana). During this constructive experience I could access to the Tuscan data necessary for the analysis and to benefit of the in-depth knowledge of IRPET's staff about Tuscan overview. I would like to thank all the IRPET's staff for their helpful suggestions and comments which have greatly improved the quality of my thesis.

Chapter 1

The municipal expenditure in Tuscany

1.1 A statistical description of Tuscan local governments spending

The municipality is a territorial body recognized at constitutional level, with statutory, regulatory, organizational and administrative, as well as fiscal and financial, autonomy; it represents its own community, takes care of its interests and promotes its development (Artt. 3 and 13, Legislative Decree n. 267/2000). Due to the power of self-government, the municipality has the right to manage itself through its own organs. The functions of exclusive jurisdiction essentially concern the area of services to the citizens and to the community, the planning and the use of the territory and the economic development. Moreover, there are functions on behalf of the State regarding military services, civil registration and electoral services, vital records and statistics.

So, the task of local governments is mainly to provide goods and services to the citizens of a particular geographic area. To do this, each local government doesn't have unlimited resources and has to face a budget constraint. Even more in the last period, the economic and financial crisis and the rigid budget constraints set by the European Union, like the Stability and growth pact and more recently the Fiscal compact, make increasingly important to spend in the most efficient way the available and limited resources, without waste, especially because these resources are tax contributions of the citizens.

In this context, an efficiency analysis could give advices about the goodness of the public spending. In order to give a valid interpretation of the efficiency analysis of the Tuscan municipalities, it is useful to give a brief statistical description of the institutional-territorial organization and to show some stylized facts about its local governments spending. The data used in this analysis come from the available municipal balance sheets, the so-called "Certificati di Bilancio Consuntivo" (see the Appendix B for the structure of these data), referred to year 2011, published by the Home office Ministry (Ministero degli Interni): since for that year there aren't data for two municipalities (Castiglion Fiorentino and Monterotondo Marittimo), the following analysis will consider just 285 municipalities, instead of the effectively present 287.

In 2011 Tuscany counts 3,753,505 inhabitants, divided into municipalities that have an extreme dimensional variability: in fact, Vergemoli, the smallest, has 336 residents while Firenze, the biggest and regional capital, has 373,446 residents. The median dimension of those municipalities is 5,851 inhabitants , while the mean dimension is 13,170: according to Iommi (2013b), this level of mean dimension is due to the presence of too much and fragmented local governments and makes impossible both to reach economies of scale in public services production and to correctly identify the catchment area of those services. To say more, the municipalities that dont't reach the minimum efficient scale, usually identified with the threshold of 10,000 residents (ibidem), are about the 70% of the total. It's worth noting that the extreme dimensional classes have a lower number of municipalities than central classes (Table 1.1).

Table 1.1: Tuscan municipalities population by dimensional classes. 2011

Dimensional class	N°of municipalities	Percentage composition
From 0 to 1.000 inhab.	18	6%
From 1.001 to 2.000 inhab.	40	14%
From 2.001 to 3.000 inhab.	28	10%
From 3.001 to 5.000 inhab.	48	17%
From 5.001 to 10.000 inhab.	63	22%
From 10.001 to 20.000 inhab.	50	18%
From 20.001 to 60.000 inhab.	27	9%
Over 60.000 inhab.	11	4%
TOTAL	285	100%

Source: elaborations of municipal balance sheets

Concerning the administration at the provincial level, Tuscany is divided into ten provinces and each of them has a different number of municipalities: as it can be seen from the table below (Table 1.2), Prato has the lowest number of municipalities, while Firenze has the biggest number.

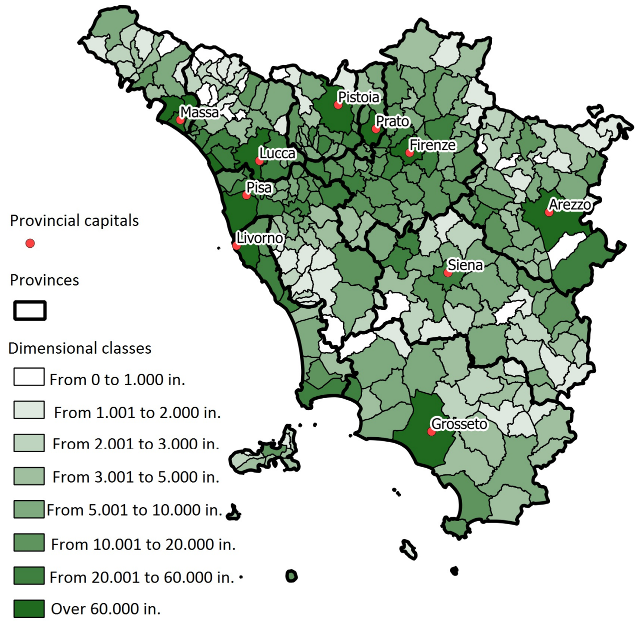
Table 1.2: Tuscan municipalities by provinces. 2011

Province	N°of municipalities
Massa Carrara	17
Lucca	35
Pistoia	22
Firenze	44
Livorno	20
Pisa	39
Arezzo	38
Siena	36
Grosseto	27
Prato	7
TOTAL	285

Source: elaborations of ISTAT data

It's possible to have a graphical intuition of the demographical distribution across provinces looking at the following cartogram (Figure 1.1): the most populated areas coincide with the provinces of Pistoia, Prato and Firenze. In addition, it's evident that the most populated municipalities coincide maily with the provincial capitals. From the cartogram it's also possible to understand the territorial extent of provinces: the province of Grosseto has the widest surface, while Prato the smallest, as confirmed by data; moreover, for density the opposite holds, that is, Prato has the highest level of density, while Grosseto the lowest. In particular, the most densely populated area coincides with the already mentioned Firenze-Prato-Pistoia metropolitan area, along the homonymous plain, surrounded by the mountains.

Figure 1.1: Geographical distribution by dimensional classes. 2011



Sources: elaborations from municipal balance sheets

Furthermore, since each municipality is influenced by the geo-morphological features of its territory, the municipalities "mountain" classification is listed in the table below (Table 1.3). In particular, the "mountain" classification was attributed to Italian municipalities in line with legislation (Law 991/52 and Law 657/57) and distinguishes three categories: Totally mountain, Partially mountain and Non-mountain municipalities. When Law 142/90 was approved, reforming local regulations, the classification of mountain areas was concluded and has remained the same since that date (article 29, paragraph 7). The totally mountain municipalities represent the 40% of the total, while the non-mountain the 45%: since the mountain features are often linked to municipalities with small dimension (see e.g. Iommi, 2013b), this percentage composition can give an additional explanation of the reason why the mean dimension of municipalities presented before is low.

Table 1.3: Tuscan municipalities by mountain classes. 2011

Mountain class	N°of municipalities	Percentage composition
Non-mountain	130	45%
Partially mountain	42	15%
Totally mountain	113	40%
TOTAL	285	100%

Source: elaborations of ISTAT data

To investigate the Tuscan municipalities socio-economic structure as a territorial perspective, the classification by Local Labour Systems is used as an appropriate tool of analysis. Local Labour Systems are places of daily activities of the population that lives and works there: they are territorial units and consist of several adjacent municipalities, geographically and statistically comparable with each other. Local Labour Systems (updated to 2001, ISTAT) are identified on the basis of data measured at the 14th General Census of population: in the table below (Table 1.4) the different systems are listed with the relative number of municipalities. Certainly, Tuscan municipalities are mainly manufacturing systems, followed by urban and tourism systems.

Table 1.4: Tuscan municipalities by local labour systems. 2011

Local labour system	N°of municipalities
Systems without specialization	33
Urban systems	44
Tourism and agricultural vocation systems	43
Manufacturing systems in the textile, leather and clothing	75
Other manufacturing systems made in Italy	40
Heavy manufacturing systems	50
TOTAL	285

Source: elaborations of ISTAT data

Finally, it's worth mentioning another important Tuscan feature: the tourism aspect. In fact, according to Conti (2012), in 2011 Tuscany has achieved greater results than the national mean due to a "gradual competitive repositioning of the tourism system based on the appreciation of its asset vocation". In order to show the degree of municipalities tourism involvement, tourism classes are obtained dividing into quartiles the ordered ratios between tourist presence and population of each municipalities: for tourist presence, data of 2011 contained in a survey of Tuscany Region are used (Table 1.5).

Table 1.5: Tuscan municipalities by tourism classes. 2011

Tourism classes	N°of municipalities
Very low tourism	71
Low tourism	71
Medium tourism	71
High tourism	72
TOTAL	285

Source: elaborations of Tuscany Region data

As regards the public expenditure, the Tuscan municipal administration has achieved commitments for 4.756 million euro, while payment for 3.221 million euro. In the table below (Table 1.6), there is the detailed internal composition of the total expenditure: as it is possible to see, both for commitments and for payment, current expenditures are the most consistent component of the total expenditure; for commitments, capital expenditures represent the other big component.

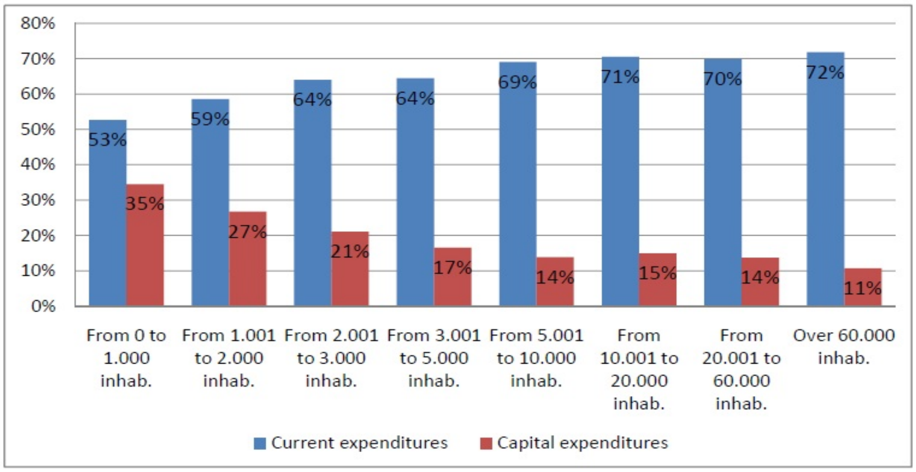
Table 1.6: Total expenditure for Tuscan municipalities. 2011

	Absolute value (million euro)	Percentage composition
Commitments		
Current expenditures	3,321	70%
Capital expenditures	642	13%
Loans refund	432	9%
Services for third parties expenditures	361	8%
TOTAL	4,756	100%
Payment		
Current expenditures	2,411	75%
Capital expenditures	97	3%
Loans refund	407	13%
Services for third parties expenditures	305	9%
TOTAL	3,321	100%

Source: elaborations of municipal balance sheets

Taking into account just commitments from now on, with regards of current and capital expenditures, it's interesting to go into details with respect to the dimensional classes (Figure 1.2): while for small municipalities current and capital expenditures are more or less near, for big municipalities current expenditures are almost four times higher than capital expenditures.

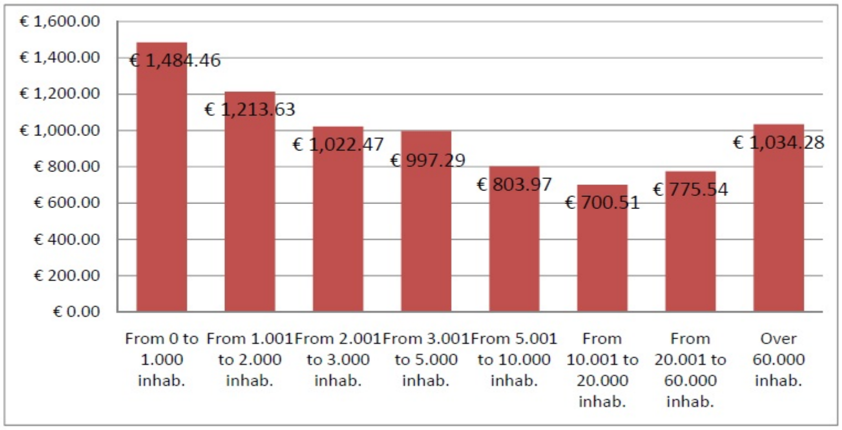
Figure 1.2: Current and capital expenditures by dimensional classes. 2011



Sources: elaborations from municipal balance sheets

There are differences of behaviour among dimensional classes of municipalities also considering per capita total current expenditures, taking into account Commitments. In fact, it's possible to observe in Figure 1.3 that per capita total current expenditures have the typical "U-shaped form" presented in many studies of local finance (see e.g. in IRPET, 2011); this reveals that there are high level of per capita expenditures both for the smallest and for the highest municipalities due to the presence of diseconomies of scale: diseconomies of scale are present in small municipalities because there is a higher incidence of fixed costs, while in big municipalities this is due by the presence of a wider variety of offered services. However, the outlined description must be completed with the mention of the higher variability contained in these extreme classes that have a lower number of municipalities than the central classes.

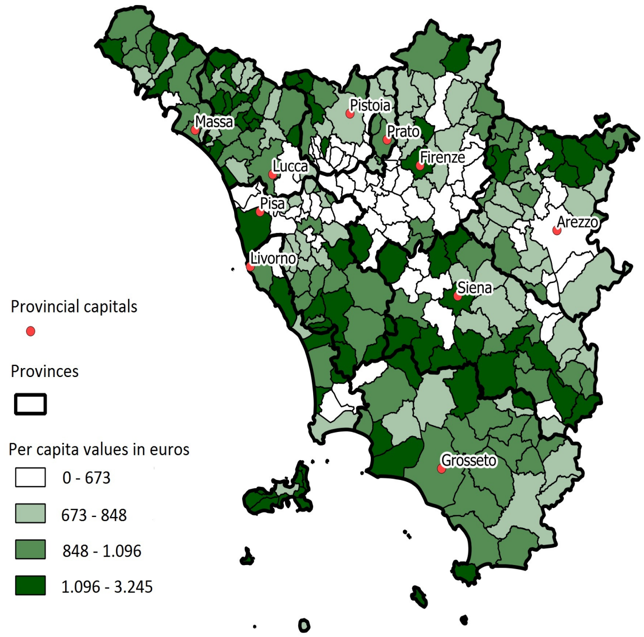
Figure 1.3: Per capita total current expenditures by dimensional classes. 2011



Sources: elaborations from municipal balance sheets

In addition, in order to give an intuitive idea of the geographical distribution of per capita total current expenditures, the following map (Figure 1.4) is reported: it represents the Tuscan Per capita current expenditure, divided in four subgroups, so to identify different levels of expenditure. It's possible to recognize some homogeneous areas and, in particular, the highest level of per capita expenditure is present especially in the provinces of Grosseto, Lucca, Massa Carrara and Livorno, while the lowest level is mainly in the provinces of Pisa, Pistoia, Arezzo and Firenze: these results will be confirmed further in the analysis of the composition of current expenditures by provinces hereinafter.

Figure 1.4: Geographical distribution of current expenditures. 2011



Sources: elaborations from municipal balance sheets

With regards to the composition of the current expenditures by functions (Table 1.7), "General administration" immediately results the function that requires the highest level of resources in the municipalities (both in percentage and in per capita values); after that, in decreasing order of importance, there are the function for "Environmental management" and for "Social Services". In general, it can be said that the biggest items of expenditure correspond to the "fundamental functions" listed in Legislative Decree n. 216/2010: in fact, the functions for "Educational services", "Road maintenance and local mobility" and "Local police" follow the already mentioned functions and together represent the 90% of total current expenditure.

Table 1.7: Current expenditures composition by function. 2011

	Absolute value (million euro)	Percentage composition	Per capita (euro)
General administration	919	28%	244.74
Justice	20	1%	5.37
Local police	212	6%	56.51
Educational services	393	12%	104.63
Cultural services	149	4%	39.66
Sport services	57	2%	15.24
Tourism	21	1%	5.71
Road maintenance and local mobility	314	9%	83.75
Environmental management	593	18%	157.95
Social services	571	17%	152.03
Economic development	45	1%	12.06
Productive services	27	1%	7.16
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

Certainly, it becomes interesting to wonder how the distinction by dimensional class presented above affects the per capita current expenditure in relation to the different municipal functions and it's possible to have a graphical intuition from the following graphics below (Figure 1.5). At first glance, it becomes evident that there are some functions that have the already mentioned "U-shaped form": this is the case of function for General administration, for Road maintenance and local mobility, for Environmental management and for Educational services; especially with regards to small municipalities, high levels of per capita expenditure are connected to lower level of specialization of the administrative staff (that usually are also fewer) and to lower population density. Then, there is an increasing relationship with the population size in the case of not strictly fundamental services, like Cultural services. Instead, it is also present the opposite relationship, as in the case of Tourism. Finally, it can be seen that the smallest municipalities have higher per capita expenditure than others in the function for Productive services, while the biggest municipalities have higher per capita expenditure in the function for Social services: in fact, these last municipalities have a larger amount of resources and so they can grant a richer supply of services.

Figure 1.5: Per capita current expenditures for functions by dimensional classes. 2011

Sources: elaborations from municipal balance sheets

Figure 1.5: Per capita current expenditures for functions by dimensional classes (con't). 2011

Sources: elaborations from balance sheets

With regards to the composition of the Current expenditures by destination, that is by type of expenditure (Table 1.8), the "Services" type results the item that requires the highest level of resources in the municipalities (both in percentage and in per capita values); after that, in decreasing order of importance, there is destination in "Staff" and then in "Transfers". These first consideration suggests that Tuscan municipalities most frequently tends to outsource services, instead of maintaining the direct management.

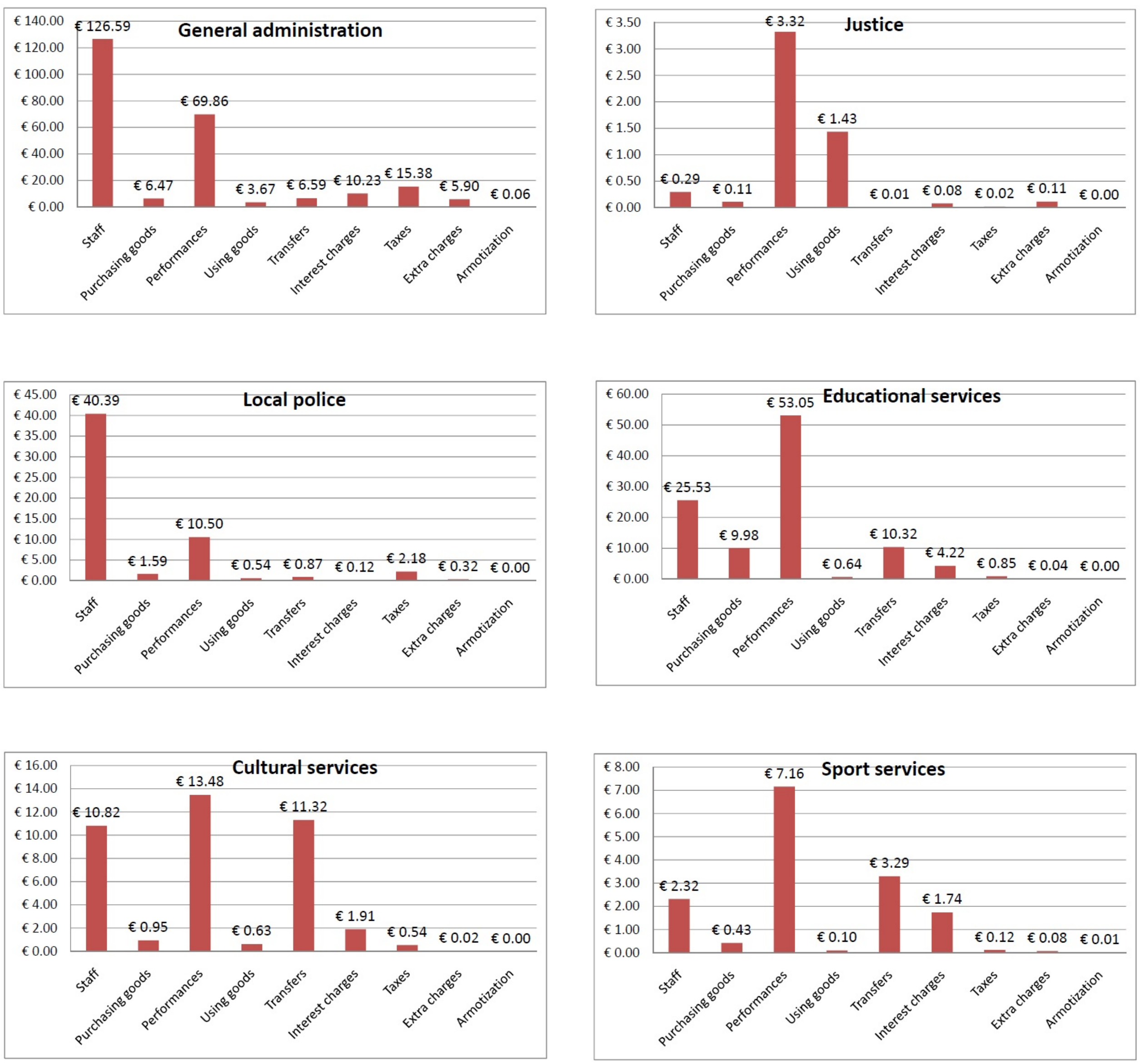
Table 1.8: Current expenditures composition by destination. 2011

	Absolute value (euro)	Percentage composition	Per capita (euro)
Staff	1,067	32%	284.35
Purchasing goods	118	4%	31.50
Services	1,447	44%	385.41
Using goods	37	1%	9.94
Transfers	363	11%	96.62
Interest charges	156	5%	41.55
Taxes	95	3%	25.43
Extra charges	37	1%	9.94
Armotization	0.28	0%	0.08
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

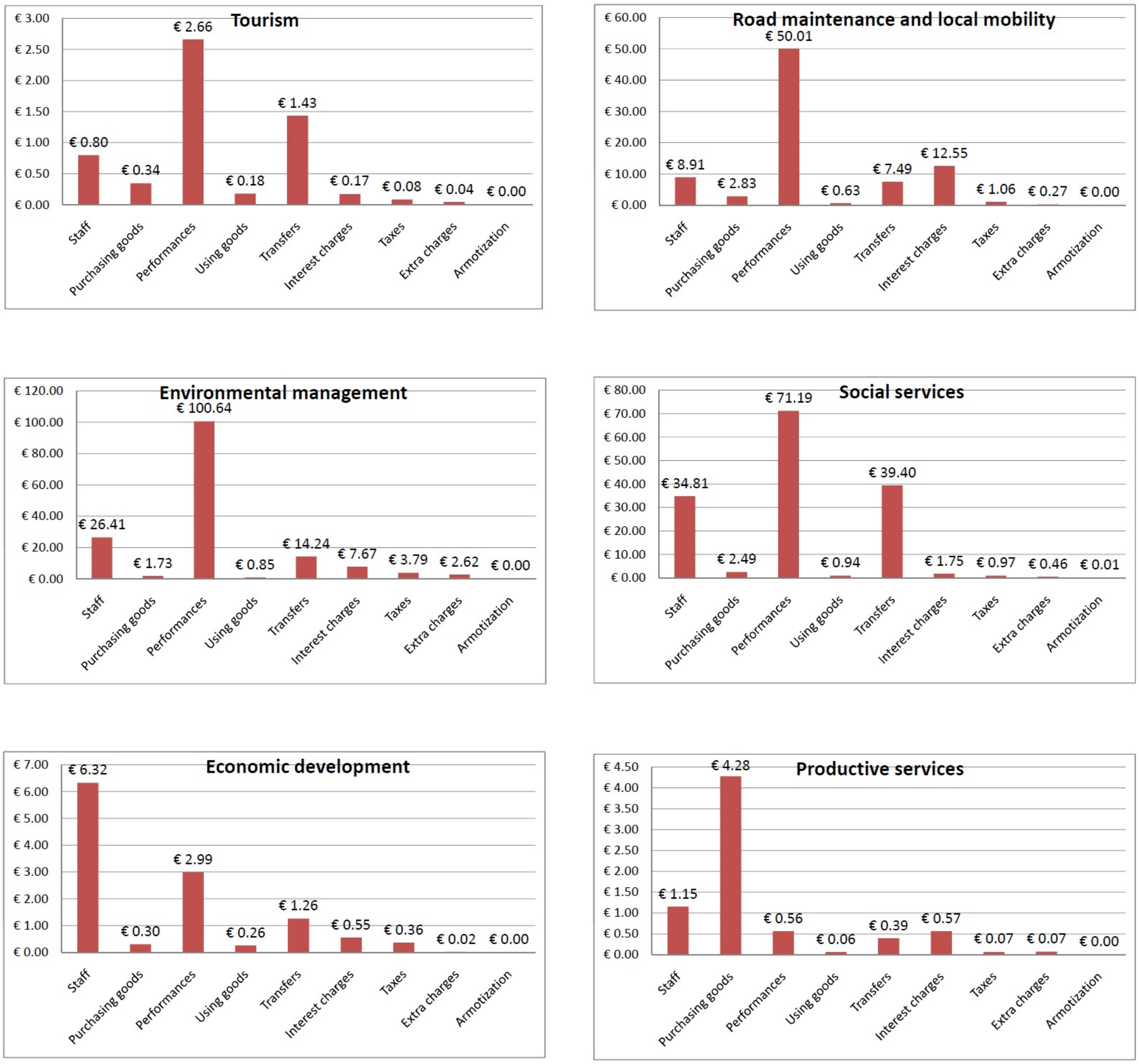
Considering into details, in a graphical way (Figure 1.6), how the prevalence of type of expenditure varies according to the different functions, it becomes evident that the functions for General administration, for Local Police and for Economic development have the greatest level of expenditure for Staff; on the other hand, all the other functions have the prevalence of expenditure for Services, except for Productive services, that has the highest level of expenditure for Purchasing goods. In addition, it's worth mentioning that there are important expenditures for Services especially for the functions for Road maintenance and local mobility and for Environmental management, but also for Educational and Social services.

Figure 1.6: Per capita current expenditures for functions by destination. 2011



Sources: elaborations from municipal balance sheets

Figure 1.6: Per capita current expenditures for functions by destination (con't). 2011



Sources: elaborations from balance sheets

Finally, the following table (Table 1.9) presents the composition of each type of expenditures differentiated by functions. The function for General administration has the highest level of expenditure for Staff, while the function for Environmental management has the highest level of expenditure for Services.

Table 1.9: Composition of expenditure type by functions. 2011

	Staff	Purchasing goods	Services	Using goods	Transfers	Interest charges	Taxes	Extra charges	Armotization
General administation	45%	21%	18%	37%	7%	25%	61%	59%	73%
Justice	0%	0%	1%	14%	0%	0%	0%	1%	0%
Local police	14%	5%	3%	5%	1%	0%	9%	3%	0%
Educational services	9%	32%	14%	6%	11%	10%	3%	0%	4%
Cultural services	4%	3%	3%	6%	12%	5%	2%	0%	0%
Sport services	1%	1%	2%	1%	3%	4%	0%	1%	7%
Tourism	0%	1%	1%	2%	1%	0%	0%	0%	0%
Road maintenance and local mobility	3%	9%	13%	6%	8%	30%	4%	3%	0%
Environmental management	9%	6%	26%	9%	15%	18%	15%	26%	3%
Social services	12%	8%	18%	9%	41%	4%	4%	5%	11%
Economic development	2%	1%	1%	3%	1%	1%	1%	0%	2%
Productive services	0%	14%	0%	1%	0%	1%	0%	1%	0%
	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: elaborations of municipal balance sheets

In order to have a more complete statistical description and to have in mind a better representation of the Tuscan current expenditures, the already mentioned different ways of classification of the involved municipalities are used in the following part: there will be the analysis of the current expenditures composition by provinces, by mountain classes, by local labour systems and by tourism classes.

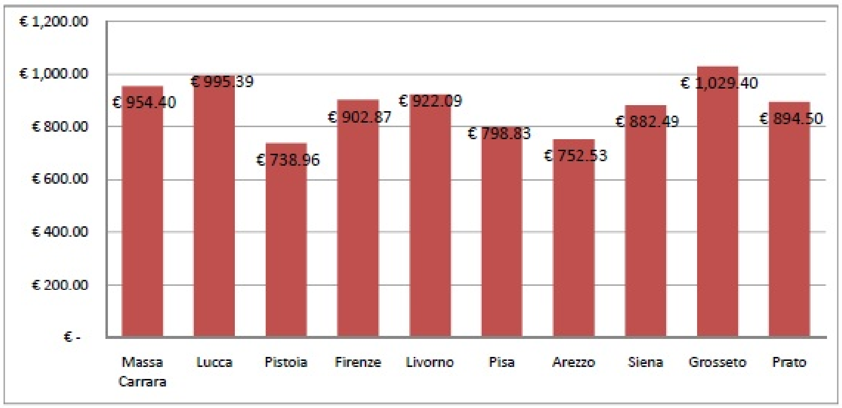
The current expenditures composition by provinces (Table 1.10) confirms what already said before: the highest level of resources in per capita values are used in the provinces of Grosseto, Lucca and Massa Carrara, while the lowest in the provinces of Arezzo, Pisa and Pistoia. These can be considered in an intuitive way through the graph below (Figure 1.7). As expected, the province of Firenze has the highest percentage value of expenditure.

Table 1.10: Current expenditures composition by provinces. 2011

	Absolute value (million euro)	Percentage composition	Per capita (euro)
Massa Carrara	194	6%	954.40
Lucca	396	12%	995.39
Pistoia	217	7%	738.96
Firenze	907	27%	902.87
Livorno	316	10%	922.09
Pisa	338	10%	798.83
Arezzo	253	8%	752.53
Siena	241	7%	882.49
Grosseto	234	7%	1029.40
Prato	224	7%	894.50
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

Figure 1.7: Per capita total current expenditures by provinces. 2011



Sources: elaborations from municipal balance sheets

The next table (Table 1.11) presents how the per capita current expenditure differs for each function according to provinces. In many cases, it is confirmed what it's been presented for per capita total expenditure: the province of Grosseto has the highest level of per capita expenditure in many functions, as well as Arezzo and Pistoia have the lowest. In fact, for General administration and for Economic development Grosseto has the highest per capita expenditure and also, with Massa Carrara, for Environmental management: with regards to this last function, the province of Grosseto can have a higher expenditure because it has the biggest surface and Massa Carrara because it has a difficult territorial geography. On the other hand, Florence has the highest level of expenditure in the functions for Educational and Social services and for Road maintenance and local mobility.

Table 1.11: Current expenditures for each function by provinces. 2011

	General administation	Justice	Local police	Educational services	Cultural services	Sport services
Massa Carrara	248.69	3.60	38.48	86.77	20.64	13.38
Lucca	276.39	4.67	57.36	96.23	51.15	11.00
Pistoia	203.90	3.60	49.16	108.87	34.95	15.27
Firenze	241.08	8.42	76.28	119.55	47.55	16.83
Livorno	274.34	4.20	55.63	105.71	36.92	16.96
Pisa	250.08	5.62	45.74	87.47	28.26	13.53
Arezzo	208.34	3.32	38.43	94.13	24.93	18.13
Siena	267.13	3.82	47.84	117.62	58.00	18.16
Grosseto	277.70	5.06	57.17	101.91	33.15	13.89
Prato	198.92	3.67	51.68	97.57	39.39	11.80

	Tourism	Road maintenance and local mobility	Environmental management	Social services	Economic development	Productive services
Massa Carrara	4.91	86.64	304.89	105.02	9.61	31.77
Lucca	6.54	79.01	237.98	158.13	13.42	3.50
Pistoia	6.09	75.17	106.49	119.77	11.54	4.13
Firenze	2.51	104.69	82.02	186.63	13.07	4.23
Livorno	11.47	98.89	123.93	176.58	11.54	5.92
Pisa	6.33	68.65	150.75	123.98	9.36	9.07
Arezzo	3.41	63.96	138.86	142.27	12.11	4.64
Siena	9.40	75.92	118.43	140.55	9.89	15.73
Grosseto	12.63	62.10	330.47	108.05	19.38	7.88
Prato	1.31	74.66	247.04	158.95	9.40	0.11

Source: elaborations of municipal balance sheets

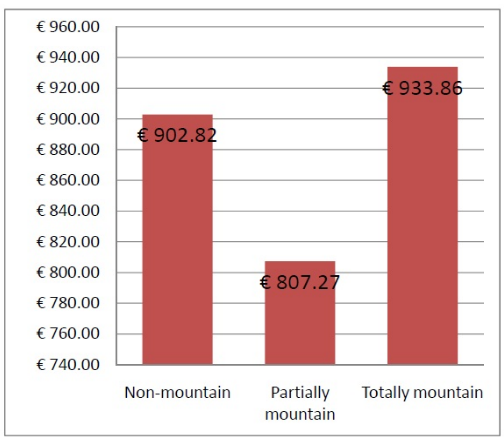
With regards to the composition of current expenditures by mountain class (Table 1.12 and Figure 1.8), there are two evidences: Non-mountain municipalities have the highest percentage value of expenditure, in relation to the fact that they have wider population, while Totally mountain municipalities have the highest per capita value due to the fact that they require special attention in terms of policies in relation to the territorial difficulties.

Table 1.12: Current expenditures composition by mountain classes. 2011

	Absolute value (million euro)	Percentage composition	Per capita (euro)
Non-mountain	2,216	67%	902.82
Partially mountain	688	21%	807.27
Totally mountain	417	13%	933.86
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

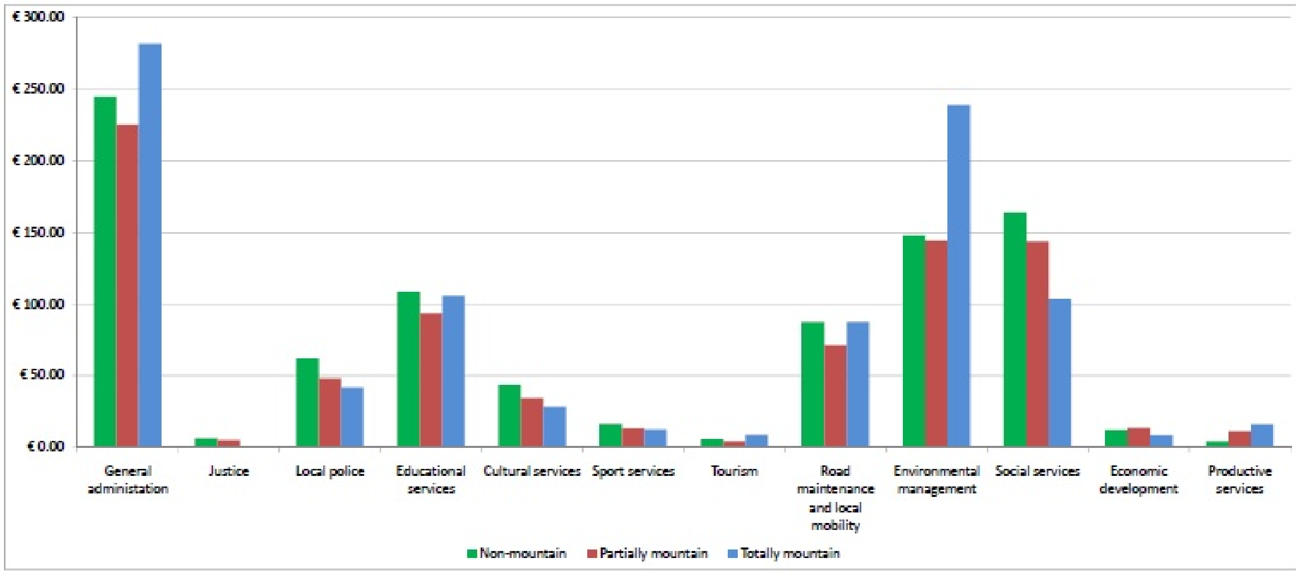
Figure 1.8: Per capita total current expenditures by mountain classes. 2011



Sources: elaborations from municipal balance sheets

The next graphic (Figure 1.9) presents how the per capita current expenditure differs for each function according to mountain classes. Non-mountain municipalities have a higher per capita expenditure especially in the functions for Local police, Cultural and Social services: in particular, to be more detailed, it can be said that for these function moving from the Non-mountain to Totally mountain landscape the per capita expenditure is decreasing. Instead, totally mountain municipalities have higher per capita expenditures in the functions for General administration, Productive services and for Environmental management, as expected.

Figure 1.9: Per capita current expenditures for each function by mountain classes. 2011



Sources: elaborations from municipal balance sheets

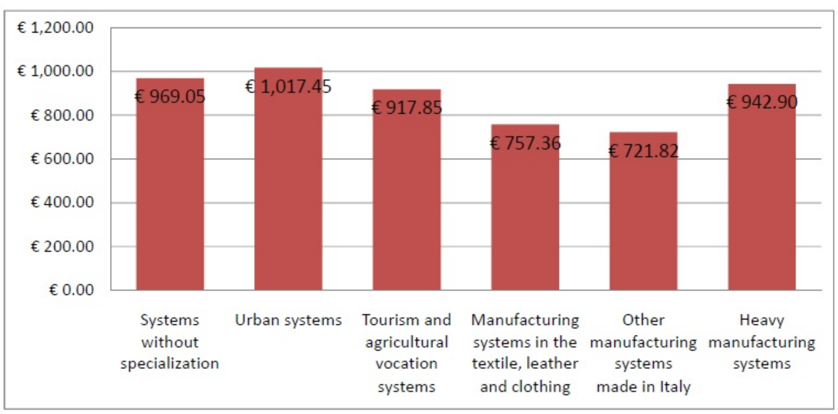
With regards to current expenditure composition by local labour systems (Table 1.13), municipalities belonging to Urban systems use the highest level of resources, both in percentage and in per capita values. Then, in decreasing order of spending, there are municipalities belonging to Manufacturing systems in the textile leather and clothing (that contains the highest number of municipalities) in percentage value, while to Systems without specialization in per capita value, as it's possible to see also graphically (Figure 1.10).

Table 1.13: Current expenditures composition by local labour systems. 2011

	Absolute value (million euro)	Percentage composition	Per capita (euro)
Systems without specialization	100	3%	969.05
Urban systems	1,241	37%	1017.45
Tourism and agricultural vocation systems	476	14%	917.85
Manufacturing systems in the textile, leather and clothing	801	24%	757.36
Other manufacturing systems made in Italy	334	10%	721.82
Heavy manufacturing systems	368	11%	942.90
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

Figure 1.10: Per capita total current expenditures by local labour systems. 2011



Sources: elaborations from municipal balance sheets

The next table (Table 1.14) presents how the per capita current expenditure differs for each function according to Local labour systems. It's very evident that for many functions municipalities belonging to Urban systems have the highest level of per capita expenditure, as presented at general level; in particular, they use the highest level of resources for functions directly linked to the citizen, that are: functions for Educational, Cultural and Social services. In addition, municipalities belonging to Urban systems have the highest per capita expenditure also in functions for Local police and Road maintenance and local mobility. Instead, in functions for Economic development and Productive services, municipalities belonging to Heavy manufacturing systems have the highest spending, as expected. Reasonably, municipalities belonging to tourism and agricultural vocation systems has the biggest per capita expenditure in the function for tourism. Municipalities belonging to tourism and agricultural vocation systems and Heavy manufacturing systems spend more than others in the function for General administration.

Table 1.14: Current expenditures for each function by local labour systems. 2011

Local labour system	General administation	Justice	Local police	Educational services	Cultural services	Sport services
Systems without specialization	279.70	1.23	40.52	106.43	26.46	11.46
Urban systems	264.86	8.87	76.25	119.58	51.88	16.42
Tourism and agricultural vocation systems	284.46	7.13	55.57	97.78	27.60	14.36
Manufacturing systems in the textile, leather and clothing	199.78	2.86	42.92	91.41	36.84	14.01
Other manufacturing systems made in Italy	209.12	4.19	43.58	105.88	30.53	15.63
Heavy manufacturing systems	283.94	1.41	52.44	100.84	39.45	16.62
	Tourism	Road maintenance and local mobility	Environmental management	Social services	Economic development	Productive services
Systems without specialization	8.08	92.03	305.86	76.14	10.29	10.85
Urban systems	4.18	104.62	166.79	179.70	13.98	10.33
Tourism and agricultural vocation systems	10.81	89.14	164.82	154.08	9.50	2.60
Manufacturing systems in the textile, leather and clothing	4.65	61.91	141.41	150.00	9.20	2.37
Other manufacturing systems made in Italy	3.25	73.78	92.13	122.19	13.57	7.98
Heavy manufacturing systems	8.90	80.16	205.12	123.77	15.90	14.34

Source: elaborations of municipal balance sheets

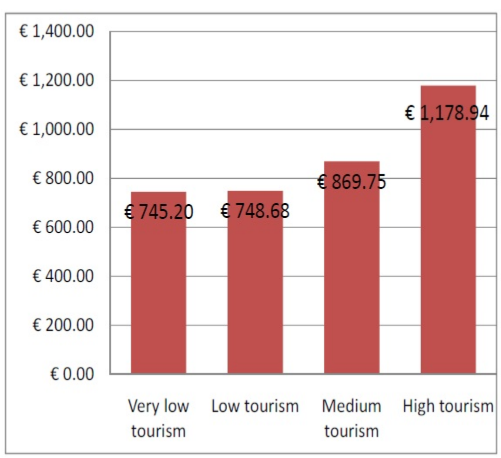
In order to conclude this part of statistical description, the current expenditures composition by tourism classes is presented (Table 1.15), since also tourism, as already mentioned before, may affect the level of expenditure. With regards to the composition of the current expenditures by tourism classes, Very low tourism municipalities use the highest level of resources in percentage values, while in per capita values it's possible to observe, also graphically in an intuitive way (Figure 1.11), that there is an increasing level of spending going from Very low tourism municipalities to High tourism municipalities: in addition, even if in a less marked manner, this happens also if we add to population the average annual tourist presence.

Table 1.15: Current expenditures composition by tourism classes. 2011

	Absolute value (million euro)	Percentage composition	Per capita (euro)
Very low tourism	798	29%	745.20
Low tourism	651	23%	748.68
Medium tourism	745	23%	869.75
High tourism	1,126	25%	1178.94
TOTAL	3,321	100%	

Source: elaborations of municipal balance sheets

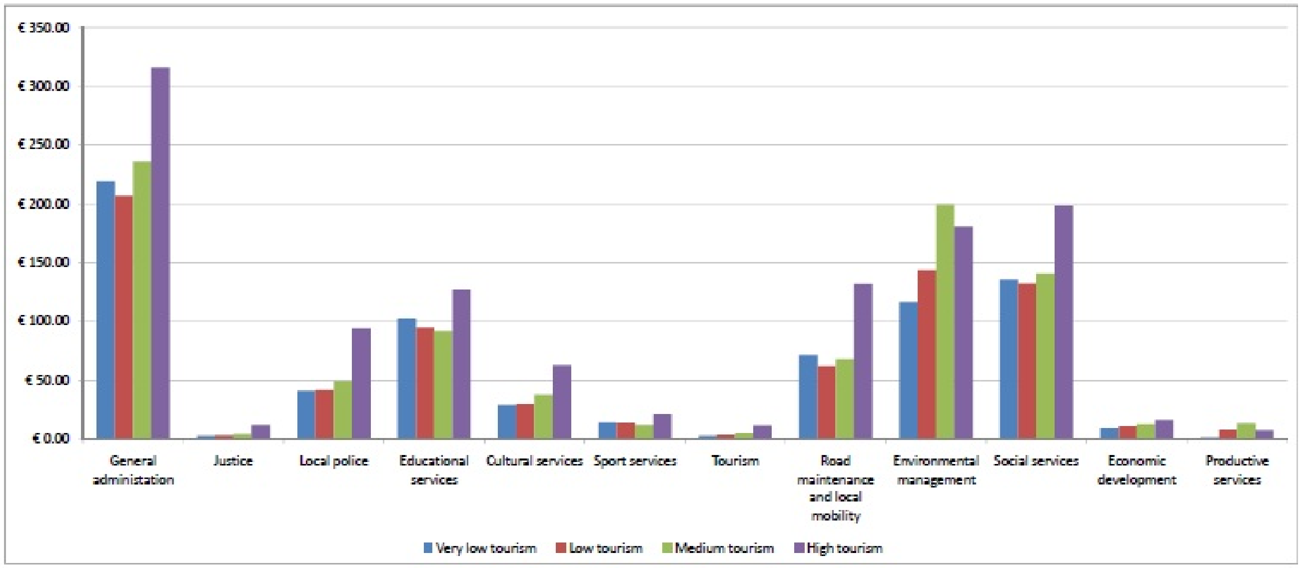
Figure 1.11: Per capita total current expenditures by tourism classes. 2011



Sources: elaborations from municipal balance sheets

The graphical analysis below (Figure 1.12) shows how the tourism classes affect the different expenditure functions. It becomes evident that in almost all functions high tourism class has the highest level of spending: certainly, it's necessary to take into account that these municipalities have to offer services to tourists through higher expenditures. In particular, for functions for Local police, Cultural services and Economic development, it's possible to observe an increasing level of per capita spending going from Very low tourism class to High tourism class.

Figure 1.12: Per capita current expenditures for each function by tourism classes. 2011



Sources: elaborations from municipal balance sheets

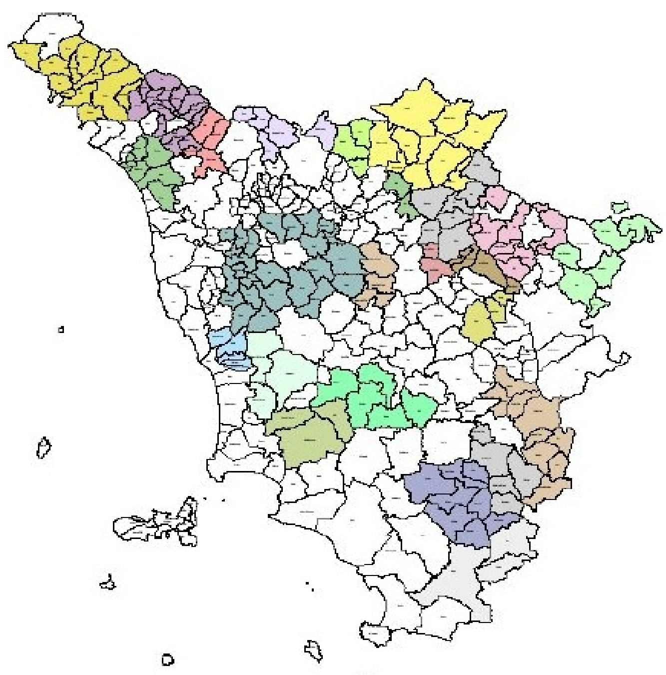
1.2 Legislative measures to reduce local expenditure inefficiency

In Tuscany and, in general, in the national context, the presence of inefficiency in the municipal expenditure is due to at least three aspects: the presence of too much small municipalities, the partial overlapping of functions carried out both by provinces and municipalities and the lack of an unitary management for densely populated metropolitan areas (Iommi, 2012).

With regard to the first aspect, as already mentioned in the previous section (see section 1.1), the inefficiency for small municipalities is related to the not reached economies of scale in the provision of public goods and services: as a consequence, the supply of these services is poorer and focused on the essential functions. The issue of the local governments optimal size to settle these diseconomies has long been the center of academic and political debate. In particular, Tuscany has promoted institutional and administrative reforms to overcome the presence of too much fragmented municipalities and to define appropriate territorial areas for planning and supply of public services: since the seventies, there was the awareness among scholars and regional administrators that too small municipal dimension affected offered public services and that institutional boundaries were de facto already overcome in the everyday life of families and businesses. A brief historical reconstruction of the Tuscan legislative development about this issue is presented below, following the works of Iommi (2013b). Tuscany was one of the first regions to promote municipal cooperation through the experience of the inter-municipal associations set up with the Regional Law No 37/1979, in order to improve the supply of services, first of all health and welfare services, expanding the catchment areas. However, after about ten years of difficult attempts, the inter-municipal associations have been formally repealed due to the complex decision-making and operating mechanisms. After the repeal of the inter-municipal associations, the existing mountain communities, established by Regional Law No 31/1972 linked with the national Law No 1102/1971, have become de facto the coordinators of many small mountain municipalities. Also these realities, after various events about their borders and their composition, were finally repealed, with the possibility, however, to turn themselves into unions of municipalities (in accordance with the Regional Law No 68/2011). With the Regional Law No 40/2001, the regional government has implemented a system of incentives for the joint management of municipal services among small entities, once again in order to promote the dimensional growth of the catchment areas and so to optimise the use of resources. Finally, the most recent intervention in this field is represented by the Regional Law No 68/2011 and its amendments in the Regional Law No 59/2012, born as transposition of the national legislation on the expenditure containment: this law have the objective to develop tools for the exercise of the municipalities fundamental functions and to promote institutional and financial cooperation among local authorities. The law identifies 37 territorial areas of adequate size for the joint exercise of the fundamental functions and

107 out of 287 municipalities obliged immediately to do it, or through signing agreements or through unions of municipalities. The joint exercise is compulsory for municipalities under 5,000 inhabitants and for municipalities that was part of a mountain community under 3,000 inhabitants, while it is optional for the other municipalities that could consider appropriate to do it. In addition, the law provides financial rewards for unions of municipalities and very important contributions to the municipalities that want to proceed with a municipal merger. Up to now, there are 25 unions of municipalities: in the figure below (Figure 1.13) it's possible to observe the geographical position of the unions and in the following table (Table 1.16) there is the detail of the municipalities that belong to each union. Moreover, there are 3 mergers that will become effective from the first of January 2014 and the proposal of 12 mergers (even if 2 of them have been already rejected by a referendum): the details of mergers are listed in Table 1.17.

Figure 1.13: Geographical position of the Unions of Municipalities in Tuscany at 2013



Sources: Tuscany Region

Table 1.16: Detail of the municipalities in each Union at 2013

Unions of Municipalities	Municipalities
Unione dei Comuni Montani del Casentino	Castel Focognano, Castel San Niccolò, Chitignano, Chiusi della Verna, Montemignaio, Ortignano Raggiolo, Poppi, Stia, Talla
Unione dei Comuni del Pratomagno	Castelfranco di Sopra, Castiglion Fibocchi, Loro Ciuffenna, Pian di Sco'
Unione dei Comuni dei Tre Colli	Bucine, Laterina, Pergine Valdarno
Unione Montana dei Comuni della Valtiberina Toscana	Anghiari, Badia Tedalda, Caprese Michelangelo, Monterchi, Sansepolcro, Sestino
Unione dei Comuni Circondario Empolese Valdelsa	Capraia e Limite, Castelfiorentino, Cerreto Guidi, Certaldo, Empoli, Fucecchio, Gambassi Terme, Montaione, Montelupo Fiorentino, Montespertoli, Vinci
Unione Comunale del Chianti Fiorentino	Barberino Val d'Elsa, Tavarnelle Val di Pesa, San Casciano Val di Pesa
Unione di Comuni Fiesole,Vaglia	Fiesole, Vaglia
Unione dei Comuni di Figline ed Incisa in Valdarno	Figline Valdarno, Incisa in Val d'Arno
Unione Montana dei Comuni del Mugello	Barberino di Mugello, Borgo San Lorenzo, Dicomano, Firenzuola, Marradi, Palazzuolo sul Senio, San Piero a Sieve, Scarperia, Vicchio
Unione di Comuni Valdarno e Valdisieve	Londa, Pelago, Pontassieve, Reggello, Rufina, San Godenzo, Rignano sull'Arno
Unione dei Comuni Montani Amiata Grossetana	Arcidosso, Castell'Azzara, Castel del Piano, Cinigiano, Roccalbegna, Santa Fiora, Seggiano, Semproniano
Unione di Comuni Montani Colline del Fiora	Manciano, Pitigliano, Sorano
Unione di Comuni Montana Colline Metallifere	Massa Marittima, Monterotondo Marittimo, Montieri
Unione Comuni Garfagnana	Camporgiano, Careggine, Castiglione di Garfagnana, Fosciandora, Gallicano, Giuncugnano, Minucciano, Molazzana, Piazza al Serchio, Pieve Fosciana, San Romano in Garfagnana, Sillano, Vergemoli, Villa Collemandina
Unione dei Comuni Media Valle del Serchio	Barga, Borgo a Mozzano, Coreglia Antelminelli, Fabbriche di Vallico
Unione dei Comuni della Versilia	Camaiore, Seravezza, Stazzema, Massarosa, Forte dei Marmi, Pietrasanta
Unione di Comuni Montana Lunigiana	Aulla, Bagnone, Casola in Lunigiana, Comano, Filattiera, Fivizzano, Fosdinovo, Licciana Nardi, Mulazzo, Podenzana, Tresana, Villafranca in Lunigiana, Zeri
Unione Montana Alta Val di Cecina	Montecatini Val di Cecina, Monteverdi Marittimo, Pomarance
Unione Colli Marittimi Pisani	Casale Marittimo, Castellina Marittima, Guardistallo, Montescudaio, Riparbella
Unione Valdera	Buti, Bientina, Calcinaia, Capannoli, Casciana Terme, Chianni, Lajatico, Lari, Palaia, Peccioli, Ponsacco, Pontedera, Santa Maria a Monte, Terricciola
Unione dei Comuni della Val di Bisenzio	Cantagallo, Vaiano, Vernio
Unione di Comuni Montani Appennino Pistoiese	Abetone, Cutigliano, Piteglio, Sambuca Pistoiese, San Marcello Pistoiese
Unione dei Comuni Amiata Val d'Orcia	Abbadia San Salvatore, Castiglione d'Orcia, Piancastagnaio, Radicofani, San Quirico d'Orcia
Unione dei Comuni Valdichiana Senese	Cetona, Chianciano Terme, Chiusi, Montepulciano, San Casciano dei Bagni, Sarteano, Sinalunga, Torrita di Siena, Trequanda
Unione dei Comuni della Val di Merse	Chiusdino, Monticiano, Radicondoli, Murlo, Sovicille

Source: Tuscany Region

Table 1.17: Detail of the municipalities mergers at 2013

MERGERS EFFECTIVE SINCE THE 1^{ST} JANUARY 2014	
Fabbriche di Vallico - Vergemoli	
Figline Valdarno - Incisa in Val d'Arno	
Castelfranco di Sopra - Pian di Scò	
PROPOSAL OF MERGERS	
Referendum already done:	
Castel San Niccolò - Montemignaio	Accepted
Casentino	Rejected
Isola d'Elba	Rejected
Referendum on the 6^{th} October 2013:	
Borgo a Mozzano - Pescaglia	
Pratovecchio - Stia	
Capannoli - Palaia - Peccioli	
Aulla - Podenzana	
Crespina - Lorezana	
Villafranca in Lunigiana - Bagnone	
Casciana Terme - Lari	
Campiglia Marittima - Suvereto	
San Piero a Sieve - Scarperia	

Source: Tuscany Region

The regional legislative development on the issue of the revision of the local government levels and functions is clearly to be linked with the provisions taken at national level, both through organic reform measures of local institutions and through emergency measures aimed at public spending containment that usually have changed in a non-organic way the local institutions. The first type of measures is represented by the Law No 142/90 on local autonomy later merged into a consolidated law on local authorities of 2000 (Legislative Decree No. 267/2000), the Bassanini Laws of the nineties on the administrative functions simplification and decentralization, the Reform of Title V of the Constitution of 2001 on local entities autonomy and on the subsidiarity principle and, more recently, by the norms on Fiscal Federalism (first of all, Law No 42/2009) in order to facilitate the link between financial and administrative responsibility; instead, the second type of measures in this last period of economic and financial crisis is represented by the Financial Act for 2010 and 2011, the "Salva Italia" Decree in 2011 (Law No 214/2011) and the "Spending Review" Decree in 2012 (Law No 135/2012).

Regarding the second aspect, the source of inefficiency related to the partial overlapping of functions realized both by provinces and municipalities is to be found in the absence of a specialization in a particular area for each level of local government, so that there is no possibility to achieve better Services and not to waste resources. In these last years, the most recent attempt to overcome this inefficiency is that one started in the already mentioned "Salva Italia" Decree, through a substantial weakening of the provinces on the one hand by means of transfer of functions to the municipalities or regions and on the other hand by the transformation of the system of representation from direct to indirect. However, this measure has met resistance so strong that the government had to develop a new measure, the Decree Law No 188/2012; nonetheless, due to the government crisis occurred at the end of the same year, the Decree was not converted and is therefore lapsed. So, still now the debate on how to tackle this issue is completely open: in fact, on the one hand, there is the purpose of the new government to carry forward the reform of provinces, but on the other hand there is the non-neglegible judgement of unconstitutionality of some rules contained in the aforementioned Decree, declared by the Constitutional Court.

Finally, the inefficiency linked to the lack of an unitary management for densely populated metropolitan areas is due to the inadequacy of the municipal (and sometimes also the provincial) dimension to appropriately respond to an ever closer territorial integration, not only at urban level, but also for the economic activities, for the essential services and for the cultural relations. At normative level, the Metropolitan Cities definition is not yet concluded: the first normative attempt is present in the Law No 142/90, followed by the Legislative Decree No. 267/2000, and more recently in the Law No 42/2009 and in the Decrees related to the measures for local entities reform. The introduction of metropolitan cities has been addressed along with the review of provincial borders and in fact their organization seems very tied to that of the provinces, in the sense that it could represent an alternative to them in the most urbanized areas. At Tuscan level, these measures have been implemented by the Regional Council Resolution No 130/2000: the metropolitan city of Firenze was delimited in an area that coincides with the current provinces of Firenze, Prato and Pistoia. Furthermore, the Regional Law No 68/2011 on the local entities system has been implemented with the reference to the metropolitan city, in the Regional Law No 59/2012.

Chapter 2

Literature review about measuring efficiency of municipal expenditures

2.1 Introduction

The efficient use of resources has always been a very debated issue in the economic literature. The empirical analysis of production efficiency has been applied over time to many business areas, both in the private sector and in sectors with a significant public relevance. In particular, it' s worth clarifying the concept of inefficiency in relation to the public sector. In fact, there may be the widespread view that local governments that have higher level of expenditure are the inefficient ones. Actually, the concept of efficiency in relation to the local governments must be used in relative terms: a municipality (or whatever local entities) is more efficient than another only if, comparing with the latter, it is able to achieve the same final results in terms of provided goods and services (output) using a smaller quantity of resources (input) or better results with the same used resources. In other words, the empirical efficiency analysis of local governments answer the question whether a given quantity of a public output is actually produced technically and allocatively efficient.

The literature about the measurement of efficiency is relatively recent and starts with the seminal contribution of Farrel (1957). The first applications have concerned the analysis of enterprises in productive private sectors: in these fields, the identification of appropriate indicators of input and output and the collection of information on input and final product prices is much smoother than in the context of the public sector. In fact, the evaluation of local spending efficiency derives from the microeconomic theory of production and it's based on the interpretation of local sector activities as production processes, which transform inputs into outputs/outcomes: however, it's very complicated to identify variables that can accurately measure the quantitative and qualitative aspects of the provided services, as well as to find the market price. For these reasons, the literature on the local governments efficiency has been developed just since the Nineties, often stimulated by a perceived need at the institutional level of public finances rebalancing.

The existing literature on municipal efficiency analysis can be divided into two-branches. On the one hand, there are numerous studies on individual public services, as reviewed by Bönisch et al. (2011): solid waste and sewage disposal (Worthington and Dollery, 2001), water (Picazo et al., 2009; Byrnes et al., 2010) and energy provision (von Hirschhausen et al., 2006), hospitals (e.g. Aksezer and Benneyan, 2010; Blank and Valdmanis, 2010), municipal savings banks (Conrad et al. 2009), public libraries (De Witte and Geys, 2009), road maintenance (Kalb, 2009), fire protection (Lan et al., 2009), care for the elderly sector (Borge and Haraldsvik, 2009), local police services (García-Sánchez 2009), public transportation (Walter and Cullmann 2008) or pre-school education (Montén and Thater 2010). De Borger and Kerstens (2000) or Worthington and Dollery (2000) can be considered as a reference for a survey of earlier studies.

On the other hand, there are studies that analyze global municipal efficiency for various countries: Belgium (De Borger and Kerstens, 1996), Finland (Loikkanen and Susiluoto, 2005), Brazil (Sampaio de Sousa et al., 2005), Spain (Balaguer-Coll and Prior 2009; Prieto and Zofio, 2001), Portugal (Afonso and Fernandes, 2008), Japan (Nijkamp and Suzuki, 2009), Germany (Kalb et al., 2011; Geys et al., 2010) and Italy (Boetti et al., 2010; Boetti et al., 2011; Bollino et al., 2012). De Borger and Kerstens (2000) or Worthington and Dollery (2000) again can be considered as a reference for a survey of earlier studies. In particular, this second type of studies sometimes attempts to analyze the relationship between municipal performances and some important topics, like the relevance of the municipal size, the effect of public function decentralization to the municipalities, the impact of fiscal decentralization, the influence of the effects of spatial closeness between municipalities and other aspects. According to many authors, there is an advantage in the use of a comprehensive approach, compared to studies focused on specific functions: it is the ability to take into account the opportunity cost perceived by the municipality in deciding the allocation of resources to different services, the possible synergies of expenditure and the quantification of the total savings of resources.

In the table below (Table 2.1), some relevant contributions of this second group are listed in chronological order of publication. In particular, looking at the used samples, it's worth noting that they often regard municipalities belonging to the same region: this avoids the presence of a higher heterogeneity among units, stemming from different information data at national level.

Table 2.1: Contributions in the municipal global efficiency studies

Author/s	Year	Sample
Vanden Eeckhaut, Tulkens and Jamar	1993	235 Belgian municipalities
De Borger and Kerstens	1996	589 Belgian municipalities
Athanassopoulos and Triantis	1998	172 Greek municiplaities
Worthington	2000	177 municipalities of New South Wales
Prieto and Zofio	2001	209 Spanish municipalities of less of 20.000 inhabitants
Lokkainen and Susiluoto	2005	353 Finnish municipalities
Balaguer-Coll, Prior and Tortosa-Ausina	2007	414 Valencian municipalities
Afonso and Fernandes	2008	51 Lisbon area municipalities
Boetti, Piacenza and Turati	2010-11	262 Italian municipalities from the Italian province of Turin
Bönisch, Haug, Illy and Schreier	2011	46 independent municipalities and 157 municipal associations in Saxony-Anhalt
Bollino, Di Vaio and Polinori	2012	341 municipalities from the Italian region Emilia-Romagna

Following Boetti, Piacenza and Turati (2011), it's possible to define a logical sequence shared by the structure of the analysis of all these works: it consists of four basic steps listed below.

1. Given a certain set of activities assigned to local government, the inputs and outputs are identified and the most appropriate indicators to measure them are chosen taking into account the available information.

2. Then, the choice of technique for estimating the efficiency is defined, evaluating pros and cons for the adoption of each methodology.

3. So, the analysis of efficiency is run and first considerations about the outcome are made; if more than one technique has been used, their results are compared.

4. Finally, some of these studies try to understand what are the underlying causes of estimated efficiency gaps; in most cases, there is a second stage analysis, in which a regression model (usually, Tobit) is specified and includes potential determinants of inefficiency. In fact, it may also be of interest to determine whether some factors, either discretionary or beyond the control of local managers, may affect the performance of municipalities or, in other words, whether efficiency may be affected not only by inadequate management, but also by exogenous factors other than the control of each local government.

In the following section, the main techniques used to assess municipal productive efficiency and its determinants are presented.

2.2 Techniques to assess municipal productive efficiency

Measures of efficiency are based on the ratio of observed output levels to the maximum level that could have been obtained for a given input level. This maximum level constitutes the efficient frontier that will be the benchmark for measuring the relative efficiency of observations. There are multiple techniques to estimate this frontier, surveyed recently by Murillo-Zamorano (2004), and these methods have recently been applied to examine the efficiency of public spending, as introduced in the previous section.

The alternative methods available for the efficiency analysis of production processes differ in the way the efficiency frontier (that is unknown and unobservable) is inferred from data about inputs and outputs of a sample of firms. The main distinction regards two separate, though conceptually similar, theoretical approaches: on the one hand, there is the econometric approach,while on the other hand the mathematical programming approach. These approaches use different techniques to envelop the observed data and therefore make different accommodations for random noise and for flexibility in the structure of the production technology.

The econometric approach specifies a production function and normally recognises that deviation away from this given technology (as measured by the error term) is composed of two parts, one representing randomness (or statistical noise) and the other inefficiency. The usual assumption with the two-component error structure is that the inefficiencies follow an asymmetric half-normal distribution and the random errors are normally distributed. The random error term is generally thought to encompass all events outside the control of the organisation, including both uncontrollable factors directly concerned with the "actual" production function (such as differences in operating environments) and econometric errors (such as misspecification of the production function and measurement error). This type of reasoning has primarily led to the development of the "stochastic frontier approach" (SFA), introduced by Aigner et al. (1977): SFA seeks to take these external factors into account when estimating the efficiency of real world organisations. Following Worthington (2000), the first studies of local government cost efficiency by Deller et al. (1988), Hayes and Chang (1990) and De Borger and Kerstens (1996) have used this approach. The main problem associated with this approach is that considerable structure is imposed upon data from stringent parametric form and distributional assumption.

On the other hand, and in contrast to the econometric approaches which attempt to determine the absolute economic efficiency of organisations against some imposed benchmark, the mathematical programming approach seeks to evaluate the efficiency of an organisation relatively to other organisations in the same industry. The most commonly employed version of this approach is a linear programming tool referred to as "data envelopment analysis", DEA, introduced by the seminal works by Farrell (1957) and popularized by Charnes et al. (1978) and by Banker et al. (1984). DEA essentially calculates the economic efficiency of a given organisation with respect to the performance of other organisations producing the same good or service, rather than against an idealised standard of performance. DEA is a nonstochastic method as it likewise assumes all deviations from the frontier are the result of inefficiency: so, the entire deviation from the frontier is assessed as being the result of inefficiency, since it's both non-parametric and non-stochastic; thus, no accommodation is made for the types of bias resulting from environmental heterogeneity, external shocks, measurement error, omitted variables and so on. However, given its non-parametric basis, it is possible to considerably vary the specification of inputs and outputs and not to specify a particular form. Still following Worthington (ibidem), Vanden Eeckaut et al. (1993) and De Borger and Kerstens (1996) have firstly undertaken work in this area. A less-constrained alternative to DEA often employed in the analysis of economic efficiency in the public sector is known as "free-disposal hull" (FDH), introduced by Deprins et al. (1984). This approach has been applied to local governments for the first time by De Borger et al. (1994) and De Borger and Kerstens (1996).

The methodological literature to date provides inconclusive evidence concerning the sensitivity of local government efficiency rankings to these alternative technologies. It should be emphasised that the stochastic frontier and DEA approaches address different questions, serve different purposes and have different informational requirements: for these reasons, DEA and stochastic frontier should be thought of as a complementary tools in the analysis of local public sector efficiency; for example, in the first istance, the frontier adheres closely to the notion of best-practice efficiency, whereas in the second it refers to an absolute measure of efficiency.

In general, these approaches allow for ignoring the question about how a certain quantity of municipal output results from the political process and if it represents a welfare-maximizing optimum from the perspective of a benevolent social planner: they simply analyze whether either a given output quantity is produced with minimum input (input-oriented approach) or the maximum output is produced with a given input quantity (output-orientation). In particular, DEA allows for both input- and output-oriented models that identify the same set of efficient/inefficient Decision Making Units: these methods provide the same ranking results under constant returns to scale (CRS), but give different values under variable returns to scale (VRS).

In the table below (Table 2.2), the methodologies used in the global efficiency studies are listed in chronological order of publication.

Table 2.2: Methodologies in the municipal global efficiency studies

Author/s	Year	Methodologies
Vanden Eeckhaut, Tulkens and Jamar	1993	FDH and DEA
De Borger and Kerstens	1996	DEA, FDH and 3 parametric frontiers
Athanassopoulos and Triantis	1998	DEA, FDH and SFA
Worthington	2000	DEA, FDH and SFA
Prieto and Zofio	2001	DEA
Lokkainen and Susiluoto	2005	DEA
Balaguer-Coll, Prior and Tortosa-Ausina	2007	DEA and FDH
Afonso and Fernandes	2008	DEA
Boetti, Piacenza and Turati	2010-11	DEA and SFA
Bönisch, Haug, Illy and Schreier	2011	DEA
Bollino, Di Vaio and Polinori	2012	DEA

Often, the authors of the aforementioned studies on global municipal efficiency (see section 2.1) try to understand what are the underlying causes of estimated efficiency gaps and potential determinants of inefficiency.

Regarding the non-parametric approach, in particular DEA, when exogenous variables are taken into account, a two-stage approach is preferred: firstly, efficiency scores are computed; then a regression of that resulting scores on potential exogenous variables is run. Among the studies that regress estimates of efficiency on some explanatory variables in a second stage, several ones have estimated a linear model by ordinary least squares (OLS), but most have specified a censored (Tobit) model: in fact, Tobit specification is motivated by the observation that efficiency estimates can assume values between zero and one in a given application. However, a possible critique that is made to the use of these regression models is linked to the fact that the efficiency scores may be serially correlated: the correlation arises in finite samples from the fact that perturbations of observations lying on the estimate frontier will, in many cases, cause changes in the efficiency estimated for other observation (for more details, Simar and Wilson, 2007).

With regards to the econometric approach, it's possible to use a one-step Stochastic Frontier Analysis to estimate global efficiency and, possibly together, the effect of the exogenous variables.

Moreover, it's worth mentioning that there are few studies that use alternative way to explain the impact of the environmental variable: this is the case of the fuzzy K-means clustering approach used by Athanassopoulos and Triantis (1998), the non-parametric regression and, as a complementary approach, non-parametric density estimation used by Balaguer-Coll et al. (2007) and the Exploratory Spatial Data Analysis (ESDA) used by Bollino et al. (2012).

In the table below (Table 2.3), the ways to explain the underlying causes of estimated efficiency gaps considered in the global efficiency studies are listed in chronological order of publication.

Table 2.3: Ways to explain efficiency gaps in the municipal global efficiency studies

Author/s	Year	Ways to find explanation
Vanden Eeckhaut, Tulkens and Jamar	1993	-
De Borger and Kerstens	1996	Tobit regression for DEA, FDH and SF-mode scores OLS regression for DF and SF-mean scores
Athanassopoulos and Triantis	1998	Fuzzy K-means clustering approach Tobit regression for DEA scores
Worthington	2000	Tobit regression
Prieto and Zofio	2001	-
Lokkainen and Susiluoto	2005	OLS regression
Balaguer-Coll, Prior and Tortosa-Ausina	2007	Nonparametric smoothing techniques
Afonso and Fernandes	2008	-
Boetti, Piacenza and Turati	2010-11	Tobit regression for DEA scores The Battese and Coelli (1995) specification
Bönisch, Haug, Illy and Schreier	2011	Second bootstrap procedure applied to a truncated regression
Bollino, Di Vaio and Polinori	2012	Exploratory Spatial Data Analysis

In this thesis, Data envelopment analysis will be used to analyze municipalities expenditure efficiency and Tobit regression to explain its potential determinants: for more details on these two techniques, see the Appendix A.

2.3 Decision variables in municipal expenditure efficiency

Certainly, a fundamental step in the definition of the municipal efficiency analysis regards the choice of the decision variables, both for the computation of the efficiency scores and for the explanation of its determinants. In the sections below, the main contribution of the literature is presented, firstly with regards to the input/output choice and secondly with regards to the explanatory variables.

2.3.1 Input and output choice

In the analysis of municipal spending efficiency, there are some special features: first of all, the role of the relevant variables and the consequential main orientation approach of the analysis. In other words, the output is often exogenously determined, given the universality of the offered service, while the inputs are the only discretionary variables on which the decision-making unit can act on the basis of some selected criteria: in fact, public administrations have to deal with specific tasks related to the resident population or to the managed territory, taking decisions about the level of expenditure. Then, the decision problem is reduced mainly to a minimization problem, in which the inputs are chosen so as to minimize the cost of providing the services requested: as a consequence, an *input oriented* approach seems to be more appropriate for the assessment of municipal efficiency and in fact it's the most present in the related literature.

As it's possible to find in the literature related to the evaluation of the public sector efficiency, the available data do not generally include information about the prices of factors and therefore it is not possible to distinguish them from the corresponding quantities used: therefore, the procedure usually adopted is based on the use, as input, of the cost associated with the provision of services. This method takes the name of *overall cost efficiency* and allows to evaluate the degree of inefficiency in terms of total cost. The underlying assumption is that all administrations face the same prices in the purchase of factors: this assumption can be justified in the light of the tendency towards homogeneity of the cost of labor and capital for public administration, especially given that most of the studies concern the analysis of municipalities regarding the same regional level. Obviously, in the literature there is a different focus for the various types of local services, depending on what are the main functions legally devolved to municipalities: attention is focused on education services and social care both in Belgium and in Finland (see e.g. in De Borger and Kerstens, 1996; Vanden et al., 1993; Loikkanen and Susiluoto, 2005), on spatial planning in Greece (see e.g. in Athanassopoulos and Triantis, 1998), on construction and maintenance of infrastructure in Australia (see e.g. in Worthington, 2000), on waste collection in Spain (see e.g. in Balaguer-Coll et al., 2007). So, in general, considering the input side, there are just few different decisional possibilities: in fact, usually municipal current expenditure is used, but it can be taken in aggregate or disaggregate way according to the different services and it can be expressed in absolute value or in per capita terms.

Considering the output side, as already mentioned, the measurement of local government performance poses difficult issues. In fact, the performance indicators are typically difficult to construct and may not coincide with the assessment that the user has about the same service. Moreover, in general, just quantitative variables are considered, since qualitative indicators are difficult to be identified.

In addition, in many studies, there is the difficulty of directly measuring some of the municipal production results, so that some performance indicators are surrogate measures of municipal demand and, in other words, often proxies for the relative service are selected: for example, the "total population" is used as a proxy for the various administrative tasks undertaken by municipalities, but it's clearly not a direct output of local production.

In general, in the literature concerning the global efficiency analysis of municipalities, the following outputs are present, listed by the different area of involved services and, in particular, by the six fundamental functions presented before in the section 1.1.

General administration:

- TOTAL POPULATION: this indicator is chosen to reflect the basic administrative services provided to the local population (e.g. maintaining the registers of births, marriages and deaths; issuing identity cards, passports and other certificates; in general, all the functioning of the bureaucracy).

Local police:

- N. OF CRIMES REGISTERED IN THE MUNICIPALITY: this indicator is intended to reflect the importance of police services.

Educational services:

- N. OF STUDENTS enrolled in local primary schools.
- EDUCATION ATTAINMENT: this indicator is proxied by the gross enrollment ratio in nursery and primary education as the number of enrolled students as a percentage of the total number of corresponding school-age people.
- N. OF TEACHING HOURS.

Social services:

- N. OF SENIOR CITIZENS (aged 65 and more): this indicator reflects the supply of social services to the elderly, such as retirement homes, general assistance and medical assistance in public hospitals.
- N. OF BENEFICIARIES OF MINIMAL SUBSISTENCE GRANTS.
- N. OF PEOPLE IN NEEDS OF CARE, that are those under 14 years old - enrolled in nursery, primary and secondary school - and those over 75 years old; or, alternatively, those under 5 and over 65 years old.

Road maintenance and local mobility:

- LENGTH OF ROAD to be maintained by the municipality: this indicator is aimed at proxying municipal competencies in managing existing roads, like through road maintenance, public lights, rather than in building new roads.

- N. OF LIGHTING POINTS: this indicator reflects public street lighting.
- STREET INFRASTRUCTURE SURFACE AREA: this indicator reflects the street cleaning, the access to population centers and surfacing of public roads.
- REGISTERED SURFACE AREA OF PUBLIC PARKS.

Environmental management:

- TONS OF WASTE: this indicator reflects waste collection.
- % OF THE POPULATION SERVED WITH SOLID WASTE COLLECTION.
- % OF THE BUILDINGS WITH SOLID WASTE COLLECTION.
- RECYCLED MATERIALS GIVEN OR SOLID: as a damaging environment translates into negative externalities, the intention is to assess environment protection municipal initiatives.
- % OF THE POPULATION WITH CLEAN WATER.
- % OF THE POPULATION WITH DRAINING WATER SYSTEMS.
- % OF THE POPULATION WITH WATER TREATMENT STATIONS.
- N. OF SEWERS.
- SURFACE OF PUBLIC PARKS.
- GREEN AREAS.

In particular, regarding this last function, it's possible to observe that the main considered services are those related to the water provision and the waste collection.

2.3.2 Explanatory variables for efficiency

As mentioned above, the efficiency scores are regressed on a set of explanatory variables, such as indicators of financial, political and social, economic and structural, which are considered some of the main environmental factors that can influence the local government efficiency.

Among all, the economic variables appear to play the most important role. In particular, the transfers received from higher levels of governments and the local taxes represent the most significant variables. All studies show an inverse relationship between the levels of estimated efficiency and the degree of municipal dependence from the central government transfers. Regarding the impact of local taxation, instead, the empirical evidence does not lead to unequivocal conclusions. In fact, in some studies (see e.g. in De Borger and Kerstens, 1996; Vanden et al., 1993) there is a positive relationship between efficiency scores and level of taxation: from this, it can be deduced that the government's ability to maintain public spending at efficient levels depends on the composition of municipal revenues, in line with the modern literature on fiscal federalism. On the other side (see e.g. in Balaguer-Coll et al., 2007), however, there is an opposite result: the result is explained by the fact that a wider availability of public resources tends to make soft the municipal budget constraint, thus local politicians perceive less the importance of control of expenditure. Moreover, also a variable that proxies the idea of deficit is taken into account and in particular the possible financial vulnerability, defined as the inability of a municipality to face its present and future financial commitments: thus, a negative relationship is supposed.

Regarding socio-economic factors, the per capita income is considered and it negatively affects the efficiency scores: citizens with a higher income may be less motivated to commit themselves in monitoring the spending of the local government, due to a higher opportunity cost of time. However, the level of education gives opposite reasoning: a higher degree of education should motivate a higher participation of the population in the process of collective decision. Also the municipal dimension is used as a possible explanation of the differences in the efficiency scores: in particular, with the increase of the population size the efficiency score increases.

With regards to the geographical variable, a high population density has a positive influence on the efficiency, in the majority of the studies; instead, the municipal distance from its capital province negatively affects efficiency, because the provision of services becomes harder, and also the mountain feature of a municipality affects the efficiency scores, as explained for example in Boetti et al. (2011). Moreover, in this last mentioned study, also the effect of the tourism aspect on the efficiency analysis is pointed out. Finally, even political variables can be useful to understand the efficiency scores gap. In fact, in some studies (see e.g. in Vanden et al., 1993; Athanassopoulos and Triantis, 1998) there is a negative relationship between efficiency and the number of parties; also a negative relationship is related to the proximity of new elections. In addition, in some works the effect of the political colour is considered, however opposite results are obtained.

Chapter 3

The empirical application I: Preliminary considerations

3.1 Choice of data for DEA analysis

In compliance with the existing literature, the first step in the efficiency analysis is to define the data to be used. In particular, the first decision regards the areas of municipal expenditure to be considered. Obviously, it's necessary to say that this choice is strongly influenced by the Italian institutional framework. In fact, in Italy, municipal expenditure is classified into twelve macro-functions, as presented in the chapter 1. However, since the fundamental functions (i.e. "General administration", "Environmental management", "Social Services", "Educational services", "Road maintenance and local mobility" and "Local police") cover about the 90% of the total current expenditure in 2011 and, in addition, there are missing values in the municipal balance sheets for the other six functions, in this analysis just the six fundamental functions will be considered: moreover, they represent not only the most fundamental competencies for the municipal budget, but also for the services provided to the citizens.

Then, the choice of the inputs and the outputs of the model is determinant. As evident to the researchers that have worked on this topic, the definition of these elements is one of the most critical aspect to implement a municipal efficiency analysis. Certainly, on the input side, there are few discretionary items: so, in this context, just municipal current expenditure is used as input indicator, taken in non-aggregate way and expressed in absolute value. Data come from the available municipal balance sheets, referred to year 2011, published by the Home office Ministry (Ministero degli Interni): since for that year there aren't data for two municipalities (Castiglion Fiorentino and Monterotondo Marittimo), the following analysis will consider just 285 municipalities, instead of the effectively present 287.

Regarding the output choice, first of all, the outputs presented in the literature (as shown in section 2.3.1) have been considered and function by function the variables have been selected. In addition, in order to relate services/output consistent with the expenditures, there is the attempt to look for data of 2011. However, before to go into details, it's important to underline the found difficulties in this search. In fact, it has been difficult to find data that directly measure municipal production results: so, just surrogate measures of municipal demand are considered for performance indicators, often used as proxies for the relative services provided to the citizens. In addition, there is no information about qualitative results of the municipal activities: so, just quantitative data can be employed in the analysis. Moreover, the data available for some performance indicators sometimes have missing data with respect to some municipalities and certainly they become useless to be used in the analysis.

Going into details, for the "General administration" function, the municipal balance sheets have been examined in order to get information about the number of administrative operators, but the data are incomplete. So, the only useful data is the resident population, taken from DEMO ISTAT and referred to 2011: the resident population is used as a proxy for the various administrative tasks undertaken by each municipality.

Regarding the function for "Local police", the municipal balance sheets have been examined in order to get information about the number of police officers, but there are missing data, also in this case. Moreover, the number of accidents provided by the Tuscany Region have been considered, as proxy of the police interventions: however, data are available just for the year 2010 and there are missing data for 24 municipalities. So, the only useful data for each municipality are the kilometers of roads and the sum of population and average annual tourist presence. The kilometers of roads are used as proxy of the area that the municipal police has to supervise and data of 2011 are taken from the Regional Observatory; instead, the resident population and the average annual tourist presence are considered as proxy of the potential users of this service: data for resident population are again taken from DEMO ISTAT and referred to 2011, while, for tourist presence, annual data of 2011 contained in a survey of Tuscany Region are used and then divided by 365 days, in order to have the average annual presence.

For the "Educational services" function, the big internal heterogeneity in the expenditure components of this function has to be taken into account: so, despite different outputs are present in the literature, just the school-age population (i.e. the population from 3 to 13 years old) is considered, as the catchment area of the services supplied by the municipality in this field; data referred to 2011 are taken from DEMO ISTAT.

With regards to the function for "Social Services", the municipal balance sheets have been examined in order to get information about the number of applications submitted and fulfilled for kindergarten and school canteens, but still in this case there are missing data for many municipalities. So, micro data of the social services survey for the municipalities of Tuscany (part of a larger survey conducted by ISTAT at national level, referred to 2009) have been considered: even if there are 7 different catchment areas (e.g. for the family, for the crippled, for the elderly, for the immigrants and others), there are missing data for many municipalities, so it's useless to use them. For these reasons, the potential users of this services have been considered, that is the population from 0 to 5 years old to proxy the services for kindergarten and school canteens, the population over 65 years old to proxy the provisions for the elderly and the immigrant population to proxy the serviced to meet the needs of these people: these data are taken from DEMO ISTAT, referred to 2011.

For the "Road maintenance and local mobility" function, the municipal balance sheets have been examined in order to get information about the public lighting, but there are incomplete data. In addition, CO_2 emissions have been considered to proxy traffic area and road users, but the most updated data are referred to 2007. So, the only useful data for each municipality are the already mentioned kilometers of roads and the sum of population and average annual tourist presence, as proxies for maintenance work and number of interventions on the road.

Finally, with regards to the function for "Environmental management", it should be observed that this expenditure turns out to be at a practical level the most complex spending item. In fact, firstly, there is a problem with the imputation of the costs of services: the observed alternatives range from direct production within the municipality (i.e. the so-called in-house provision), to the use of a specific firm (publicly or privately owned), up to the creation of a cooperative company aggregating two or more municipalities in the management of the services. Secondly, there is the fact that sometimes the municipal measures in its area appear to be purely normative and therefore not directly translated into cost items compared to the result perceived by the citizens. Given these considerations, the municipal balance sheets contain information regarding served residential units and quintal of disposed waste, but there is no data for all the municipalities. With regards to green areas, there aren't data at municipal level, except for the provincial capitals. As regards the integrated water system, now the service is managed directly by privates, so the municipality contributes just a little. Finally, the waste disposal service has been considered as a proxy of the function: however, this item presents big problems. In fact, at 2011 [1] in some municipalities the TARSU system (that is, the "Tassa Rifiuti Solidi Urbani") is still applied, while in others TIA system (that is , the "Tariffa Igiene Ambientale")[2] is already operative. One of the main difference between TARSU and TIA lies in the identification of the active subject. In fact, with regards to TARSU, the active subject is identified in the Municipality that, as a Tax Authority, must establish an annual tax, governed by appropriate regulations and applied at the appropriate rate. With regards to TIA, instead, a clear distinction between the local authority (that issues general acts for the establishment and for the determination of the tariff) and the managing institution (that is responsible for the actual implementation of the service for the disposal of waste) becomes evident; essentially, there is a distinction of tasks

[1] Since January 2013 both systems have been repealed by the new tax that has been introduced (i.e. TARES , that is the "Tassa Rifiuti E Servizi").

[2] Introduced with the Legislative Decree No. 22/1997, the so-called "Ronchi" Decree.

between the local authority and the managing institution: it is the latter, in fact, that not only applies but also levies a fee and therefore the local authority loses its connotation of Tax Authority. For this reason, the choice between TIA or TARSU heavily affects the municipal expenditure: in fact, the municipality that applies TIA has always a lower expenditure, because the remuneration goes directly to the entities that provide the services. It's worth observing this decreasing level of expenditure through ARRR data (i.e., "Azienda Regionale Recupero Risorse"). As conclusion, the useful data for this function is just the produced municipal waste expressed in tons, taken from ARRR and referred to 2011: it can be considered as a proxy of the municipal waste disposal service. Obviously, two considerations have to be taken in mind. First of all, the expenditure item for the waste disposal service covers in average the 60% of the total expenditure in the environmental management, while the urban services and the environmental conservation services together cover just the 30%. So, reasonably the municipal waste can be considered in general as the proxy of the environmental management function; moreover, also the high variability in the definition of the expenditure items in the municipal balance sheet has always to be considered. Secondly, the different municipal contracts in the management of the collected and disposal waste services cannot be ignored.

Certainly, given the problematical aspect of the function for "Environmental management", it has been decided to consider two different dataset to run DEA: the first involves all the Tuscan municipalities (as explained before, 285) but excludes the "Environmental management" function, while the second considers all the fundamental functions, but involves just the municipalities that apply TARSU (192 municipalities). In the following, the first dataset will be named DEA1 and the second DEA2.

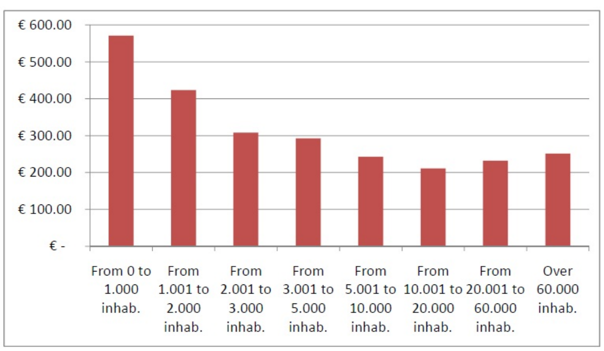
For the determination of the dataset, the critical aspects don't concern only the previous considerations about the input/output choice, but also involve the units under analysis: in fact, it's important to have in the dataset information that makes coherent the DEA analysis with the statistical description presented in chapter 1. In other words, it's necessary to identify, and possibly to eliminate, the heterogeneous units in the dataset to which DEA can be sensitive and that can alter its results: this is the problem of the "outliers". According to Wilson (1993), "outliers are atypical observation. Some outliers are the result of recording or measurement errors and should be corrected (if possible) or deleted from data". The presence of outliers in the used sample of data is a problem that can significantly affect the outcome of the analysis based on nonparametric procedures. For these reasons, in the literature, different procedures are used to detect the presence of outliers and to manage them in the best way: from one hand, some authors prefer to identify possible unusual observations through particular procedures *ex ante*, that is before to run DEA, and after to check the results[3]; on the other hand, there are *ex post* measures, i.e. DEA is immediately implemented and then the sample is adjusted until

[3]For more details, see Bollino et al. (2012).

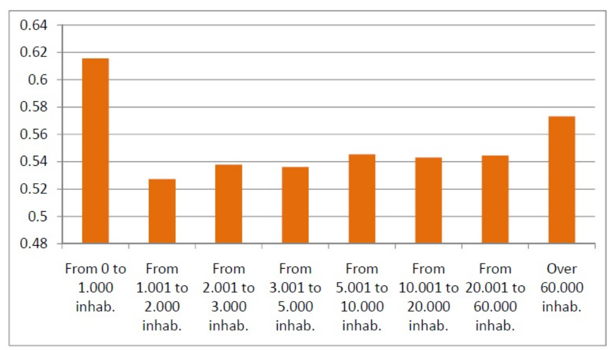
DEA gives consistent results. In this case, in order to evaluate the presence of outliers in the municipalities sample, the second way is preferred. To do this, just the “General administration” function has been considered, in fact it’s enough to have an idea of the coherence of the found results. In particular, the “U-shaped form” of the per capita expenditure distributed according to the dimensional classes for this function (see section 1.1) is compared with the Constant Return to Scale DEA scores[4] distributes according to the same dimensional classes: if DEA results were consistent, the DEA scores would have the reverse form. The idea behind this hypothesis implies that the higher is the per capita level of expenditure among municipalities, the lower is the relative level of efficiency; in particular, in this comparison there is the temporary idea that all the municipalities under analysis are performing at an optimal scale.

Considering the larger sample, that is constituted by 285 municipalities, there is not the expected “U-shaped reverse form” (Figure 3.1). Dropping just Firenze from the sample, the expected form of the distribution immediately appears (Figure 3.2): certainly, Firenze is absolutely out of scale in comparison with all the other municipalities and clearly can alter the DEA results.

Figure 3.1: Comparison between per capita current expenditures and CRS DEA scores. 285 municipalities



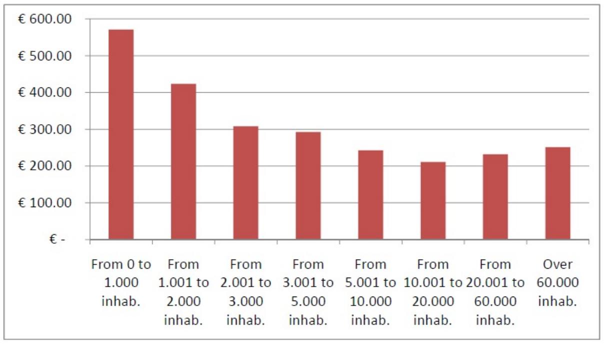
Per capita current expenditures
for “General administration” by dimensional class



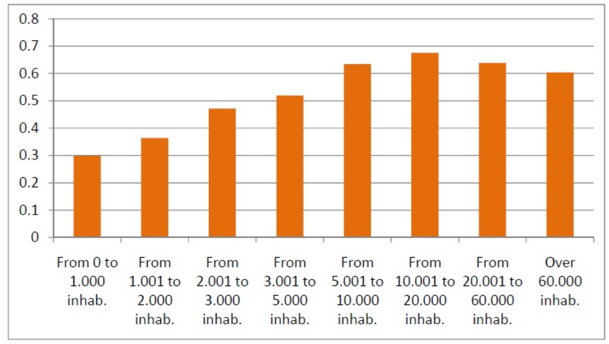
CRS DEA scores by dimensional classes
for “General administration”. 285 municipalities

[4] For a complete discussion on the DEA software choice, see the next section 3.2.

Figure 3.2: Comparison between per capita current expenditures and CRS DEA scores. 284 municipalities



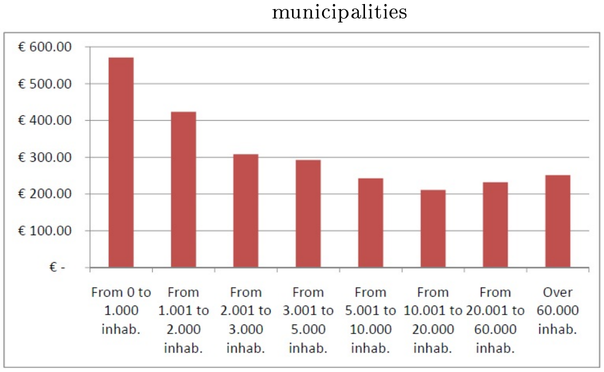
Per capita current expenditures
for "General administration" by dimensional class



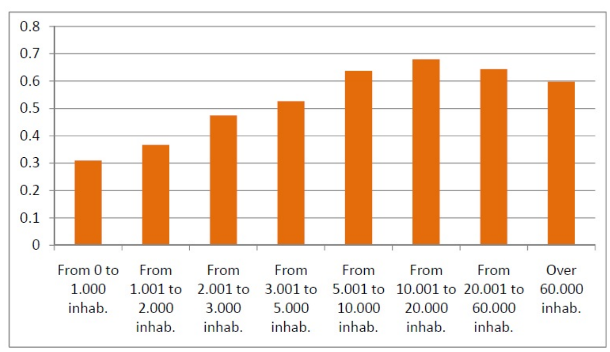
CRS DEA scores by dimensional classes
for "General administration". 284 municipalities

In order to detect other potential outliers, different reasonable alternatives have been considered. For example, in order to eliminate the extreme observations, the first and the last percentile have been excluded from the largest sample, so to have 279 municipalities (Figure 3.3); also all the provincial capitals have been dropped from the largest sample, so to have 275 municipalities (Figure 3.4); finally, also the second and the second last percentile have been excluded, so to have 273 municipalities 273. However, all these attempts show the same expected "U-shaped reverse form": so, in order to get consistent results, it's enough to drop Firenze from the biggest sample, that is DEA1, for the already presented reason.

Figure 3.3: Comparison between per capita current expenditures and CRS DEA scores. 279 municipalities

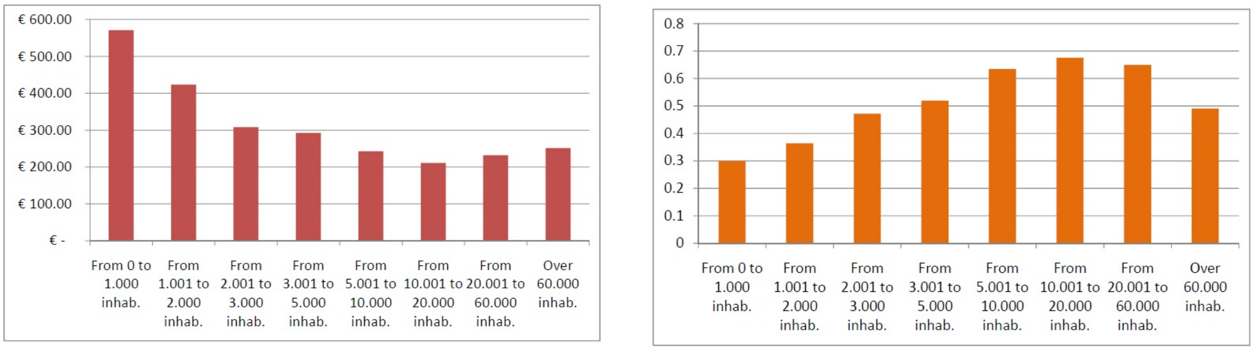


Per capita current expenditures
for "General administration" by dimensional class



CRS DEA scores by dimensional classes
for "General administration". 279 municipalities

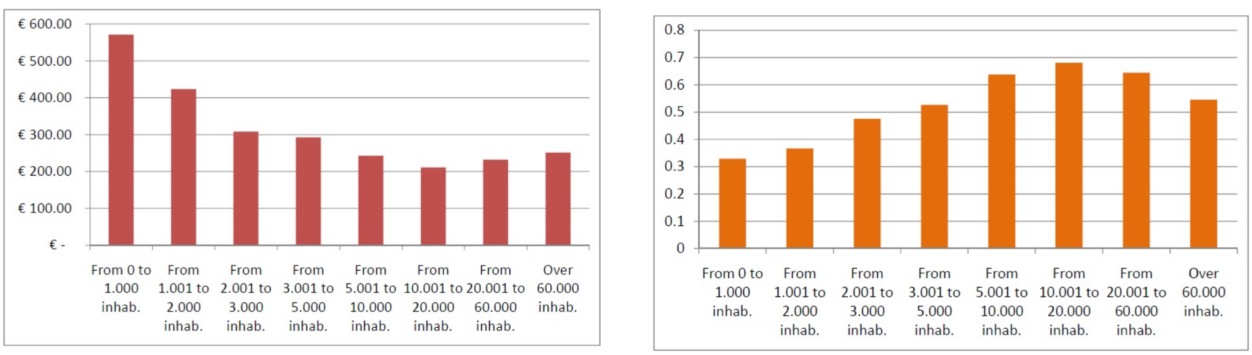
Figure 3.4: Comparison between per capita current expenditures and CRS DEA scores. 275 municipalities



Per capita current expenditures
for “General administration” by dimensional class

CRS DEA scores by dimensional classes
for “General administration”. 275 municipalities

Figure 3.5: Comparison between per capita current expenditures and CRS DEA scores. 273 municipalities

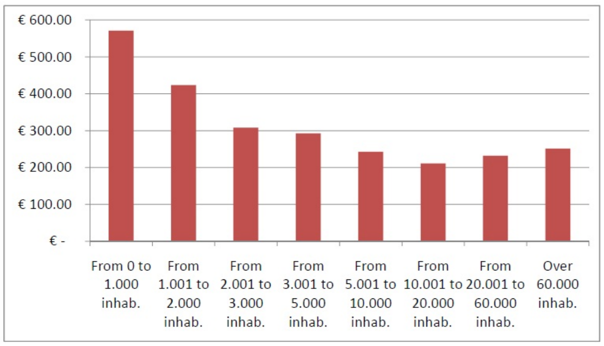


Per capita current expenditures
for “General administration” by dimensional class

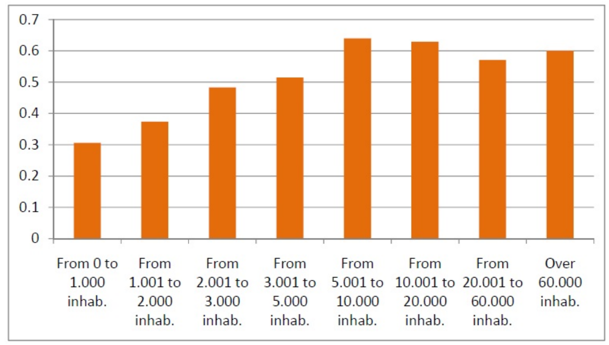
CRS DEA scores by dimensional classes
for “General administration”. 273 municipalities

Obviously, the same check applies also for the smallest sample, DEA2. As it’s possible to see from Figure 3.6, again the per capita expenditure for “General administration” function has the “U-shaped form” while the CRS DEA efficiency scores more or less the reverse: it’s worth noting that Firenze is already not included in this sample because it applies TIA.

Figure 3.6: Comparison between per capita current expenditures and CRS DEA scores. 192 municipalities



Per capita current expenditures
for "General administration" by dimensional class



CRS DEA scores by dimensional classes
for "General administration". 192 municipalities

Sources: personal elaborations

In conclusion, the data used in the empirical investigation are all referred to 2011. Two different dataset will be used in the efficiency analysis of the Tuscan municipalities expenditure:

1. DEA1: all the municipalities without Firenze, that is , 284 municipalities.
2. DEA2: all the municipalities that apply TARSU.

In addition, just to summarize, the chosen variables are:

- Expenditure for the "General administration" function $\Longrightarrow$Total resident population;
- Expenditure for the "Educational services" function$\Longrightarrow$Population from 3 to 13 years old;
- Expenditure for the "Social Services"$\Longrightarrow$Population from 0 to 5 years old + Population over 65 + Immigrants;
- Expenditure for the "Road maintenance and local mobility" function$\Longrightarrow$Resident population + Tourist presence and Length of roads;
- Expenditure for the "Local police" function$\Longrightarrow$Resident population + Tourist presence and Length of roads;
- Expenditure for the "Environmental management" function$\Longrightarrow$Municipal waste.

In the two tables below (Table 3.1 and Table 3.2) the descriptive statistics for the relevant input and output variables of the two datasets are presented: the sources details for each variable are presented in the Appendix B.

Table 3.1: Descriptive statistics for DEA1 dataset

INPUT (million euro)	Mean	Min	Max	Std. dev.
General administration	28.32	1.43	414.58	47.75
Local police	5.64	0.003	106.96	12.08
Educational services	11.70	0.10	185.81	21.41
Road maintenance and local mobility	8.54	0.16	187.52	19.31
Social services	16.58	0.05	354.14	37.22
OUTPUT	**Mean**	**Min**	**Max**	**Std. dev.**
popTot	11605.16	327.00	184885.00	20175.39
presTurist	346.15	0.10	5036.29	722.68
pop 0-5	612.36	11.00	11183.00	1087.58
pop over 65	2740.17	96.00	38702.00	4708.25
immigr	979.18	8.00	28405.00	2133.45
road	138846.12	0.00	1353082.12	156644.01

Table 3.2: Statistical description for DEA2 dataset

INPUT (million euro)	Mean	Min	Max	Std. dev.
General administration	18.38	1.43	270.07	29.83
Local police	3.30	0.003	67.05	7.03
Educational services	6.87	0.10	99.22	11.47
Road maintenance and local mobility	5.34	0.16	112.77	10.85
Social services	8.56	0.05	146.71	17.40
Environment	18.96	1.07	273.30	37.13
OUTPUT	**Mean**	**Min**	**Max**	**Std. dev.**
popTot	6732.44	327.00	85517.00	11493.49
presTurist	293.18	0.10	5036.29	733.99
pop 0-5	333.98	11.00	4110.00	565.69
pop over 65	1645.57	96.00	22323.00	2778.06
immigr	533.91	8.00	7945.00	895.01
road	101728.39	0.00	774280.86	93977.47
waste	4474.42	151.32	71938.02	8732.26

3.2 Choice of DEA model

In the determination of the DEA model that has to be used in the analysis, it's necessary to specify some elements: the orientation (i.e. input or output oriented), the returns to scale and the number of inputs and outputs considered together.

First of all, regarding the orientation, in compliance with the existing literature[5] an *input-oriented* approach is preferred: in fact, even in this context, the specification of the output makes the expenditures the only discretionary variables of the problem.

With regards to the returns to scale, the difference between Variable Return to Scale (VRS) and Constant Return to Scale (CRS) affects the municipal expenditure efficiency analysis. In fact, measuring the degree of inefficiency of a certain municipality, the VRS DEA model takes into account the possibility that each unit is characterized by technological returns of any nature; the CRS DEA model assumes, instead, that all units in the sample satisfy the property of constant returns, providing a mix of technical and scale inefficiency (i.e., overspending due to missing economies of scale or to the presence of diseconomies of scale). For these reasons, it seems to be more reasonable that the main analysis will use a VRS DEA model. However, it's worth mentioning that also a CRS DEA analysis will be run since it is possible to quantify the inefficiency of scale computing the ratio between the CRS and the VRS efficiency scores, so that to assess the impact of returns in the functioning of the municipalities (affected by the municipal size).

Finally, another critical issue to be solved regards the number of input and output put simultaneously in the DEA computation. However, before reasoning whether to use one-input/one-output model or a multi-input/multi output model or whatever, it's worth going into details with regards to the software used to compute DEA scores: in fact, in the literature different software packages are used. In this context, essentially two different software have been available to be used: the "Stata" program and a DOS program by Coelli. For the sake of simplicity, again just the CRS DEA scores for the "General administration" function has been computed to compare the two softwares, considering all the 285 municipalities.

As it's possible to see from the table below (Table 3.3), Stata and Coelli program give more or less the same ranking. However, differently from Coelli, Stata shows a numerical problem associated with a municipality (Firenze): in fact, as explained in the Appendix A, the efficiency score can at most be equal to one, instead in the Stata case Firenze gets 2.46 and it sounds very strange. In addition, adding more inputs and more outputs, the Stata program works very slowly, differently from the Coelli one. So, finally, Coelli program, that is "DEAP Version 2.1: A Data Envelopment Analysis (Computer Program)" is

[5] See section 2.2.

the chosen software to compute the DEA efficiency scores referred to Tuscan municipalities.

Table 3.3: Comparison between Stata and Coelli CRS DEA results

Municipality	CRS-Stata	Rank	Municipality	CRS-Coelli
Firenze	2.45707	1	Lamporecchio	1
Lamporecchio	1	2	Pieve a Nievole	0.975
Pieve a Nievole	0.975017	3	Vicopisano	0.973
Vicopisano	0.97342	4	Poggibonsi	0.963
Poggibonsi	0.962645	5	Ponte Buggianese	0.956
Ponte Buggianese	0.955688	6	Agliana	0.942
Agliana	0.942223	7	Carmignano	0.923
Empoli	0.937617	8	Empoli	0.896
Carmignano	0.922664	9	Montopoli in Val d'Arno	0.873
Quarrata	0.889837	10	Ponsacco	0.87
Scandicci	0.889507	11	Montecarlo	0.866
Colle di Val d'Elsa	0.887689	12	Quarrata	0.866
Grosseto	0.876516	13	Massa e Cozzile	0.865
Montopoli in Val d'Arno	0.87257	14	Colle di Val d'Elsa	0.864
*	*	*	*	*
Marciana	0.22492	272	Marciana	0.225
Vergemoli	0.224117	273	Vergemoli	0.224
Castiglione della Pescaia	0.213193	274	Castiglione della Pescaia	0.204
Montieri	0.19709	275	Montieri	0.197
Marciana Marina	0.195677	276	Marciana Marina	0.196
Capraia Isola	0.188332	277	Capraia Isola	0.188
Isola del Giglio	0.182186	278	Isola del Giglio	0.182
Villa Basilica	0.178438	279	Villa Basilica	0.178
Monteverdi Marittimo	0.176765	280	Monteverdi Marittimo	0.177
Fabbriche di Vallico	0.166629	281	Fabbriche di Vallico	0.167
Forte dei Marmi	0.162014	282	Forte dei Marmi	0.162
Rio nell'Elba	0.142388	283	Rio nell'Elba	0.142
Abetone	0.137617	284	Abetone	0.138
Radicondoli	0.10635	285	Radicondoli	0.106

Back to the above introduced problem, the practical application of DEA presents a procedural issue to be examined and solved that regards the number of used inputs and outputs, that is the pitfall to include variables indiscriminately, as presented by Dyson et al. (2001). As DEA allows flexibility in the choice of weights on the inputs and outputs, the greater the number of factors included the lower the level of discrimination between efficient and inefficient units: so, discrimination can be increased by being parsimonious in the number of the variables. In other words, by increasing the number of inputs and/or outputs, there is automatically, by construction, an increase of the efficient DMUs. This reasoning becomes very evident looking at the DEA results stemming from the municipal analysis: gradually adding in the VRS model a function, the number of efficient municipalities increases more and more. In fact, just considering the "General administration" function there are only 5 efficient municipalities. Considering also the function for "Educational services" the number of efficient municipalities increases at 16. Then, adding the function for "Social Services" 51 municipalities result to be efficient. Finally, the number of efficient municipalities becomes very big introducing the "Road maintenance and local mobility" function, i.e. 116 efficient municipalities, and then the "Local police" function, i.e. 109 efficient municipalities: obviously, it's quite unreasonable that so much municipalities are efficient.

In the literature, there is an open theoretical debate on this issue. From one hand, different suggested "rules of thumb" are proposed in order to achieve reasonable level of discrimination; for example, there are proposed rules in Bowlin (1998), i.e. there should be at least three DMUs for each input and output variable so to have sufficient degrees of freedom, or in Dyson et al. (ibidem), i.e. the number of units should be at least twice the product of the number of inputs and outputs. On the other hand, the definition of a stringent rule is considered not so necessary: in fact, this reasoning seems to be too rigid and useless in relation to the needs of research (see e.g. Cooper et al., 2011). However, from an application point of view, still other solutions have been proposed in the municipal expenditure efficiency analysis. For example, according to Bönisch et al. (2011), the bootstrap procedure is preferred in the general multi-input/multi-output framework, since it is the only means of inferring statistical properties essential for the interpretation of the estimated efficiency measures and the DEA-efficiency estimator is corrected for bias. In particular, taking into account bias, authors notice no efficient observations: in fact, by definition, the bias-corrected convex hull constructed by the DEA program is further away from the observed data than the initial DEA frontier. Another way to solve this problem is also proposed by Afonso et al. (2008): they use a Total Municipal Output Indicator (TMOI) to put together different outputs, following the reasoning of other studies, e.g. Afonso et al. (2005). They assume that TMOI depends on the $k \in \{1, 2, ..., l\}$ values of certain economic and social indicators. If there are $i \in \{1, 2, ..., n\}$ municipalities and $j \in \{1, 2, ..., m\}$ policy areas, the TMOI is defined as the sum of each total municipal total sub-indicators, TMSOI, that is:

$$TMOI_i = \sum_{j=1}^{m} TMOSI_{ij}.$$

So, previously all values of each sub-indicator must be computed: this indicator is calculated by centering each variable around the mean of all observations and then using an unweighted average of all variables for policy area.

$$TMOSI_{ij} = \frac{\sum_{k=1}^{l} \frac{x_{ijk}}{\bar{x}_{jk}}}{l}$$

where

$$\bar{x}_{jk} = \frac{\sum_{i=1}^{n} x_{ijk}}{n}.$$

The DEA analysis is then performed both with the composite TMOI and alternatively using the several sub-indicators directly as output: obviously, going from the "one input/one output" to the "one input/multi output" model, it's possible to observe the increase of the overall efficiency scores and the increase of the efficient DMUs.

In this thesis, a different way to solve this issue has been proposed: a composite indicator has been used, but not in the sense of the aforementioned TMOI. In fact, the use of the TMOI cannot identify the inputs in which there is the most waste, since it considers all the functions together; on the contrary, in this context it's possible to find the main waste areas. In fact, first of all, each function in considered separately: DEA scores are obtained for each function and it's possible to identify the level of overspending focusing on each area. Then, all these DEA scores have been put together through a weighted average, according to the weight of each function expenditure on the total (see Table 3.4 and Table 3.5 below). So, for DEA1 dataset, DEA efficiency scores have been computed five times and for DEA2 six times: each time for a different function proposed in this analysis; then these scores have been put together. There are three main advantages in this proposed approach:

1. there is a non-aggregate analysis for each function that makes possible to find the municipal inefficiencies separately, considering just a "one input-one output" model or at most "one input-two output" model, so to limit the number of efficient municipalities;

2. it's possible to compute an average level of inefficiency considering the weight that each function has in the total expenditure, so to have the average overspending for each municipality;

3. comparing the composite indicator obtained by the municipal weight with the indicator obtained by the Tuscan mean weight (see Table 3.4 and Table 3.5 below), there are possible suggestions as room for improvement for the inefficient municipalities: in some cases, just a change in the composition of the expenditure could bring to an increase of the efficiency composite indicator.

Table 3.4: Weights associated with the expenditure composition of DEA1 dataset

Municipality	%adm	%educ	%soc	%road	%pol
Abbadia San Salvatore	46%	17%	13%	16%	9%
Abetone	43%	8%	2%	38%	9%
Agliana	31%	19%	34%	9%	7%
Altopascio	50%	16%	19%	6%	9%
Anghiari	36%	12%	33%	13%	6%
Arcidosso	51%	20%	12%	10%	7%
Arezzo	39%	17%	23%	11%	10%
Asciano	45%	19%	18%	12%	6%
Aulla	45%	22%	12%	17%	5%
Badia Tedalda	27%	20%	39%	12%	2%
Bagni di Lucca	46%	18%	11%	18%	8%
Bagno a Ripoli	38%	22%	24%	9%	8%
Bagnone	64%	12%	7%	14%	4%
Barberino di Mugello	43%	19%	21%	10%	6%
Barberino Val d'Elsa	62%	12%	17%	6%	3%
Barga	44%	27%	9%	12%	8%
Bibbiena	41%	18%	25%	12%	5%
Bibbona	51%	20%	11%	11%	7%
Bientina	39%	20%	26%	8%	7%
Borgo a Mozzano	47%	16%	13%	18%	7%
Borgo San Lorenzo	34%	17%	30%	14%	6%
Bucine	28%	2%	60%	7%	4%
Buggiano	44%	24%	22%	5%	6%
Buonconvento	43%	14%	28%	7%	8%
Buti	42%	15%	21%	13%	9%
Calci	47%	15%	21%	10%	7%
Calcinaia	47%	15%	21%	9%	8%
Calenzano	40%	15%	28%	8%	9%
Camaiore	38%	14%	26%	12%	10%
Campagnatico	51%	13%	12%	17%	7%
Campi Bisenzio	52%	11%	22%	10%	6%
Campiglia Marittima	44%	13%	26%	7%	10%
Campo nell'Elba	60%	15%	4%	15%	6%
Camporgiano	33%	24%	7%	22%	13%
Cantagallo	57%	7%	15%	16%	5%
Capalbio	50%	19%	15%	8%	8%
Capannoli	47%	17%	23%	7%	6%
Capannori	52%	14%	24%	6%	4%
Capoliveri	51%	14%	9%	15%	11%
Capolona	39%	26%	16%	14%	6%
Capraia e Limite	46%	20%	20%	10%	4%
Capraia Isola	66%	21%	1%	4%	9%
Caprese Michelangelo	41%	23%	14%	18%	4%

Municipality	%adm	%educ	%soc	%road	%pol
Careggine	63%	11%	4%	20%	2%
Carmignano	34%	23%	27%	8%	8%
Carrara	39%	14%	19%	20%	8%
Casale Marittimo	52%	17%	20%	3%	8%
Casciana Terme	58%	15%	11%	10%	6%
Cascina	45%	21%	24%	4%	5%
Casola in Lunigiana	45%	18%	7%	24%	6%
Casole d'Elsa	44%	26%	18%	9%	4%
Castagneto Carducci	43%	15%	26%	6%	10%
Castel del Piano	54%	17%	11%	13%	5%
Castel Focognano	38%	22%	13%	22%	5%
Castel San Niccolò	31%	17%	31%	17%	4%
Castelfiorentino	38%	23%	25%	7%	7%
Castelfranco di Sopra	30%	15%	41%	11%	4%
Castelfranco di Sotto	50%	9%	26%	10%	6%
Castell'Azzara	56%	17%	11%	13%	3%
Castellina in Chianti	46%	20%	16%	8%	10%
Castellina Marittima	53%	19%	12%	11%	6%
Castelnuovo Berardenga	36%	18%	32%	9%	5%
Castelnuovo di Garfagnana	42%	17%	23%	9%	9%
Castelnuovo di Val di Cecina	49%	16%	21%	7%	8%
Castiglion Fibocchi	50%	14%	8%	21%	7%
Castiglione della Pescaia	52%	9%	11%	17%	11%
Castiglione di Garfagnana	42%	20%	8%	25%	5%
Castiglione d'Orcia	52%	16%	9%	13%	9%
Cavriglia	49%	17%	23%	7%	5%
Cecina	40%	13%	26%	12%	8%
Cerreto Guidi	34%	25%	27%	6%	8%
Certaldo	39%	21%	19%	14%	6%
Cetona	50%	16%	16%	10%	8%
Chianciano Terme	44%	20%	12%	14%	12%
Chianni	45%	24%	8%	15%	8%
Chiesina Uzzanese	43%	19%	12%	14%	12%
Chitignano	41%	18%	21%	13%	7%
Chiusdino	52%	23%	14%	10%	1%
Chiusi	43%	14%	18%	14%	10%
Chiusi della Verna	43%	30%	7%	16%	5%
Cinigiano	47%	24%	7%	15%	8%
Civitella in Val di Chiana	29%	16%	43%	10%	3%
Civitella Paganico	43%	15%	27%	9%	6%
Colle di Val d'Elsa	38%	17%	21%	15%	9%
Collesalvetti	44%	21%	18%	9%	7%
Comano	40%	22%	17%	18%	3%
Coreglia Antelminelli	48%	15%	19%	14%	4%
Cortona	35%	21%	25%	13%	6%
Crespina	45%	23%	13%	12%	7%

Municipality	%adm	%educ	%soc	%road	%pol
Cutigliano	50%	13%	3%	27%	7%
Dicomano	34%	25%	22%	15%	4%
Empoli	31%	20%	34%	7%	8%
Fabbriche di Vallico	62%	7%	9%	15%	7%
Fauglia	57%	21%	8%	9%	5%
Fiesole	54%	12%	15%	10%	9%
Figline Valdarno	35%	12%	28%	11%	14%
Filattiera	43%	19%	12%	19%	7%
Firenzuola	36%	23%	16%	19%	7%
Fivizzano	39%	23%	11%	16%	11%
Foiano della Chiana	33%	26%	29%	6%	6%
Follonica	56%	9%	17%	9%	9%
Forte dei Marmi	52%	16%	12%	8%	12%
Fosciandora	66%	10%	12%	11%	1%
Fosdinovo	52%	22%	6%	13%	6%
Fucecchio	37%	16%	28%	11%	7%
Gaiole in Chianti	48%	27%	13%	6%	6%
Gallicano	48%	17%	17%	13%	6%
Gambassi Terme	39%	27%	17%	10%	7%
Gavorrano	50%	19%	12%	13%	6%
Giuncugnano	46%	21%	6%	18%	9%
Greve in Chianti	36%	22%	26%	7%	9%
Grosseto	33%	23%	24%	10%	11%
Guardistallo	57%	15%	11%	10%	6%
Impruneta	47%	14%	21%	11%	7%
Incisa in Val d'Arno	36%	20%	26%	11%	7%
Isola del Giglio	74%	6%	3%	7%	11%
Lajatico	52%	14%	9%	16%	9%
Lamporecchio	34%	29%	17%	12%	7%
Larciano	44%	21%	17%	11%	8%
Lari	45%	23%	13%	10%	9%
Lastra a Signa	48%	17%	26%	4%	5%
Laterina	48%	21%	12%	12%	6%
Licciana Nardi	40%	24%	13%	15%	9%
Livorno	34%	15%	29%	15%	7%
Londa	47%	13%	14%	24%	3%
Lorenzana	49%	20%	8%	12%	11%
Loro Ciuffenna	35%	22%	22%	14%	7%
Lucca	27%	13%	35%	14%	10%
Lucignano	36%	13%	36%	9%	6%
Magliano in Toscana	59%	16%	10%	7%	9%
Manciano	53%	16%	9%	14%	7%
Marciana	51%	14%	11%	16%	9%
Marciana Marina	62%	11%	7%	12%	9%
Marciano della Chiana	41%	31%	9%	12%	7%
Marliana	50%	20%	14%	10%	7%

Municipality	%adm	%educ	%soc	%road	%pol
Marradi	42%	11%	22%	17%	8%
Massa	48%	13%	24%	9%	5%
Massa e Cozzile	39%	23%	19%	10%	9%
Massa Marittima	49%	10%	22%	10%	9%
Massarosa	45%	20%	24%	5%	6%
Minucciano	46%	17%	9%	25%	2%
Molazzana	48%	11%	14%	18%	9%
Monsummano Terme	40%	18%	26%	7%	9%
Montaione	19%	7%	70%	2%	3%
Montalcino	44%	9%	29%	11%	7%
Montale	37%	27%	22%	5%	9%
Monte Argentario	55%	9%	16%	6%	14%
Monte San Savino	41%	16%	19%	15%	9%
Montecarlo	38%	15%	21%	17%	8%
Montecatini Val di Cecina	52%	20%	8%	10%	9%
Montecatini-Terme	42%	11%	15%	15%	16%
Montelupo Fiorentino	35%	25%	19%	14%	7%
Montemignaio	38%	16%	19%	22%	4%
Montemurlo	46%	15%	21%	9%	8%
Montepulciano	43%	13%	23%	13%	7%
Monterchi	46%	20%	7%	19%	8%
Monteriggioni	38%	23%	22%	12%	6%
Monteroni d'Arbia	28%	21%	39%	5%	6%
Montescudaio	47%	11%	12%	8%	22%
Montespertoli	44%	21%	20%	7%	8%
Montevarchi	40%	19%	24%	10%	7%
Monteverdi Marittimo	71%	13%	9%	2%	5%
Monticiano	47%	22%	11%	13%	8%
Montieri	65%	15%	8%	8%	5%
Montignoso	40%	13%	16%	20%	11%
Montopoli in Val d'Arno	38%	20%	24%	9%	9%
Mulazzo	36%	11%	15%	30%	8%
Murlo	46%	21%	16%	14%	3%
Orbetello	43%	14%	26%	8%	10%
Orciano Pisano	39%	21%	16%	9%	14%
Ortignano Raggiolo	32%	18%	27%	17%	5%
Palaia	43%	19%	12%	16%	10%
Palazzuolo sul Senio	40%	6%	40%	10%	4%
Peccioli	39%	13%	34%	10%	4%
Pelago	40%	23%	20%	9%	8%
Pergine Valdarno	45%	19%	14%	14%	9%
Pescaglia	35%	20%	12%	25%	8%
Pescia	39%	18%	22%	13%	9%
Pian di Sco	43%	20%	17%	13%	7%
Piancastagnaio	41%	16%	19%	17%	7%

Municipality	%adm	%educ	%soc	%road	%pol
Piazza al Serchio	43%	22%	11%	19%	5%
Pienza	46%	22%	10%	14%	6%
Pietrasanta	45%	12%	21%	11%	10%
Pieve Fosciana	54%	19%	12%	10%	4%
Pieve Santo Stefano	30%	11%	46%	11%	2%
Piombino	39%	13%	22%	16%	10%
Pisa	40%	12%	22%	17%	10%
Pistoia	32%	20%	22%	17%	9%
Piteglio	53%	19%	8%	15%	6%
Pitigliano	57%	18%	5%	13%	7%
Podenzana	41%	24%	10%	14%	11%
Poggibonsi	31%	26%	23%	10%	10%
Poggio a Caiano	59%	17%	15%	4%	5%
Pomarance	61%	12%	13%	9%	5%
Ponsacco	40%	26%	17%	8%	7%
Pontassieve	36%	21%	30%	7%	6%
Ponte Buggianese	42%	29%	16%	7%	6%
Pontedera	39%	16%	22%	17%	7%
Pontremoli	49%	15%	16%	14%	6%
Poppi	26%	11%	46%	11%	6%
Porcari	40%	18%	28%	8%	6%
Porto Azzurro	58%	7%	12%	14%	9%
Portoferraio	45%	13%	20%	13%	8%
Prato	31%	16%	29%	14%	10%
Pratovecchio	30%	17%	29%	19%	5%
Quarrata	33%	23%	26%	12%	7%
Radda in Chianti	52%	14%	8%	17%	10%
Radicofani	54%	13%	8%	20%	6%
Radicondoli	71%	14%	8%	5%	2%
Rapolano Terme	50%	15%	18%	10%	7%
Reggello	38%	15%	25%	17%	5%
Rignano sull'Arno	35%	28%	24%	7%	7%
Rio Marina	58%	19%	5%	12%	7%
Rio nell'Elba	72%	8%	7%	9%	4%
Riparbella	65%	15%	11%	5%	4%
Roccalbegna	53%	21%	6%	16%	4%
Roccastrada	43%	26%	14%	10%	7%
Rosignano Marittimo	35%	18%	27%	14%	7%
Rufina	36%	18%	26%	7%	12%
Sambuca Pistoiese	54%	18%	3%	22%	3%
San Casciano dei Bagni	50%	22%	10%	12%	6%
San Casciano in Val di Pesa	35%	24%	19%	13%	8%
San Gimignano	35%	16%	16%	24%	9%
San Giovanni d'Asso	65%	5%	8%	17%	4%
San Giovanni Valdarno	38%	16%	28%	10%	7%
San Giuliano Terme	53%	10%	19%	9%	8%

Municipality	%adm	%educ	%soc	%road	%pol
San Godenzo	52%	11%	11%	25%	0%
San Marcello Pistoiese	41%	20%	14%	17%	8%
San Miniato	44%	14%	26%	8%	7%
San Piero a Sieve	40%	24%	19%	12%	5%
San Quirico d'Orcia	51%	19%	12%	11%	7%
San Romano in Garfagnana	45%	8%	21%	22%	4%
San Vincenzo	51%	9%	22%	11%	8%
Sansepolcro	40%	18%	20%	15%	7%
Santa Croce sull'Arno	35%	15%	35%	8%	6%
Santa Fiora	51%	16%	13%	12%	8%
Santa Luce	51%	24%	13%	9%	3%
Santa Maria a Monte	41%	19%	25%	9%	5%
Sarteano	31%	12%	47%	6%	4%
Sassetta	67%	16%	9%	6%	2%
Scandicci	31%	24%	25%	11%	8%
Scansano	54%	15%	12%	11%	8%
Scarlino	54%	13%	13%	11%	9%
Scarperia	46%	20%	17%	11%	6%
Seggiano	58%	16%	10%	13%	4%
Semproniano	48%	25%	12%	11%	4%
Seravezza	46%	18%	19%	9%	9%
Serravalle Pistoiese	39%	14%	29%	11%	8%
Sestino	37%	23%	17%	19%	4%
Sesto Fiorentino	34%	12%	34%	9%	11%
Siena	41%	17%	23%	11%	8%
Signa	41%	19%	25%	9%	6%
Sillano	45%	19%	7%	27%	2%
Sinalunga	46%	17%	19%	12%	6%
Sorano	53%	20%	10%	11%	6%
Sovicille	37%	28%	22%	9%	5%
Stazzema	38%	20%	15%	23%	4%
Stia	45%	19%	17%	16%	4%
Subbiano	39%	21%	16%	20%	4%
Suvereto	43%	19%	24%	7%	7%
Talla	42%	20%	15%	18%	5%
Tavarnelle Val di Pesa	42%	13%	19%	22%	5%
Terranuova Bracciolini	49%	14%	21%	8%	7%
Terricciola	43%	17%	14%	18%	8%
Torrita di Siena	48%	21%	10%	16%	6%
Trequanda	54%	20%	11%	12%	3%
Tresana	56%	18%	12%	11%	4%
Uzzano	45%	22%	19%	7%	6%
Vagli Sotto	64%	13%	4%	18%	1%
Vaglia	41%	17%	25%	11%	7%
Vaiano	41%	25%	19%	8%	7%
Vecchiano	44%	16%	19%	10%	12%

Municipality	%adm	%educ	%soc	%road	%pol
Vergemoli	43%	2%	15%	40%	0%
Vernio	45%	19%	22%	9%	5%
Viareggio	44%	11%	24%	11%	10%
Vicchio	40%	20%	24%	10%	7%
Vicopisano	36%	18%	20%	16%	10%
Villa Basilica	66%	13%	8%	8%	4%
Villa Collemandina	40%	23%	9%	24%	4%
Villafranca in Lunigiana	41%	16%	17%	14%	12%
Vinci	38%	14%	29%	13%	6%
Volterra	43%	19%	20%	12%	6%
Zeri	42%	21%	7%	27%	4%
TUSCANY	40%	17%	23%	12%	8%

Source: elaborations of municipal balance sheets

Table 3.5: Weights associated with the expenditure composition of DEA2 dataset

Municipality	%adm	%educ	%soc	%road	%pol	%envir
Abetone	32%	7%	6%	28%	1%	26%
Altopascio	33%	6%	10%	4%	12%	35%
Anghiari	29%	5%	10%	11%	27%	18%
Arcidosso	36%	5%	14%	7%	9%	29%
Aulla	21%	2%	10%	8%	6%	53%
Badia Tedalda	24%	2%	18%	11%	35%	12%
Bagni di Lucca	33%	6%	13%	13%	8%	28%
Bagno a Ripoli	27%	5%	15%	6%	17%	29%
Bagnone	51%	3%	9%	12%	5%	19%
Barberino di Mugello	29%	4%	13%	7%	14%	33%
Barberino Val d'Elsa	48%	3%	9%	4%	13%	22%
Barga	32%	6%	19%	9%	7%	28%
Bibbiena	29%	4%	13%	9%	18%	28%
Bibbona	32%	5%	13%	7%	7%	36%
Bucine	23%	3%	2%	6%	50%	17%
Buggiano	33%	4%	18%	4%	17%	24%
Buonconvento	34%	6%	11%	6%	22%	22%
Buti	31%	7%	11%	10%	15%	25%
Camaiore	25%	6%	9%	8%	17%	35%
Campagnatico	35%	5%	9%	12%	8%	31%
Campo nell'Elba	36%	4%	9%	9%	3%	40%
Camporgiano	21%	8%	16%	14%	5%	36%
Cantagallo	45%	4%	5%	12%	12%	22%
Capalbio	36%	5%	14%	6%	11%	28%
Capannoli	35%	5%	12%	5%	17%	26%
Capoliveri	28%	6%	8%	8%	5%	45%
Capolona	28%	4%	19%	10%	11%	28%
Capraia Isola	44%	6%	14%	2%	1%	33%
Caprese Michelangelo	35%	3%	19%	15%	12%	15%
Careggine	45%	2%	8%	14%	3%	27%
Carrara	25%	5%	9%	13%	12%	37%
Casale Marittimo	36%	6%	11%	2%	14%	31%
Casciana Terme	40%	4%	10%	7%	7%	31%
Casola in Lunigiana	36%	4%	15%	19%	6%	21%
Casole d'Elsa	34%	3%	20%	7%	14%	23%
Castel del Piano	38%	4%	13%	9%	8%	28%
Castel Focognano	28%	4%	16%	16%	9%	27%
Castel San Niccolò	23%	3%	13%	13%	23%	25%
Castelfranco di Sopra	23%	3%	11%	8%	32%	22%
Castelfranco di Sotto	37%	4%	6%	7%	19%	27%
Castell'Azzara	43%	2%	13%	10%	8%	24%
Castellina in Chianti	32%	7%	14%	6%	12%	29%
Castellina Marittima	37%	4%	14%	8%	8%	30%

Municipality	%adm	%educ	%soc	%road	%pol	%envir
Castelnuovo di Garfagnana	25%	5%	10%	6%	14%	40%
Castelnuovo di Val di Cecina	39%	6%	13%	6%	16%	21%
Castiglion Fibocchi	35%	5%	10%	15%	6%	29%
Castiglione della Pescaia	32%	7%	5%	10%	7%	39%
Castiglione di Garfagnana	30%	3%	14%	18%	6%	28%
Castiglione d'Orcia	37%	7%	12%	10%	6%	28%
Cavriglia	38%	4%	14%	5%	18%	22%
Cetona	38%	6%	12%	8%	12%	24%
Chianni	39%	7%	21%	13%	7%	13%
Chiesina Uzzanese	31%	9%	14%	10%	9%	27%
Chitignano	30%	5%	13%	9%	15%	27%
Chiusdino	36%	1%	16%	7%	10%	31%
Chiusi	28%	7%	10%	9%	12%	34%
Chiusi della Verna	30%	3%	21%	11%	5%	29%
Cinigiano	35%	6%	18%	11%	5%	26%
Civitella in Val di Chiana	21%	3%	12%	7%	32%	25%
Civitella Paganico	17%	2%	6%	4%	11%	61%
Comano	28%	2%	15%	12%	12%	31%
Coreglia Antelminelli	35%	3%	11%	10%	14%	26%
Cortona	27%	4%	16%	10%	19%	24%
Cutigliano	41%	6%	11%	22%	2%	19%
Dicomano	23%	3%	18%	10%	15%	30%
Fabbriche di Vallico	54%	6%	6%	13%	8%	14%
Fauglia	41%	4%	15%	6%	6%	29%
Filattiera	33%	6%	15%	14%	9%	23%
Fivizzano	27%	8%	16%	11%	8%	30%
Follonica	37%	6%	6%	6%	11%	33%
Forte dei Marmi	33%	8%	10%	5%	8%	37%
Fosciandora	52%	1%	8%	9%	9%	21%
Fosdinovo	37%	4%	16%	10%	4%	29%
Gaiole in Chianti	33%	4%	19%	4%	9%	30%
Gallicano	33%	4%	11%	9%	12%	31%
Gavorrano	33%	4%	13%	8%	8%	34%
Giuncugnano	33%	6%	15%	13%	5%	28%
Grosseto	20%	7%	14%	6%	15%	38%
Guardistallo	45%	5%	12%	8%	8%	22%
Impruneta	32%	5%	10%	8%	14%	32%
Isola del Giglio	45%	7%	4%	4%	2%	38%
Lajatico	44%	8%	12%	13%	8%	16%
Lari	32%	7%	17%	7%	9%	28%
Laterina	35%	4%	15%	9%	9%	27%
Licciana Nardi	29%	6%	17%	11%	9%	29%
Londa	36%	3%	10%	18%	10%	23%
Lorenzana	34%	8%	14%	8%	6%	30%
Loro Ciuffenna	27%	5%	17%	11%	17%	24%
Lucignano	28%	5%	10%	7%	28%	22%

Municipality	%adm	%educ	%soc	%road	%pol	%envir
Magliano in Toscana	40%	6%	11%	4%	7%	31%
Manciano	39%	5%	12%	10%	7%	27%
Marciana	31%	5%	8%	9%	7%	40%
Marciana Marina	39%	6%	7%	7%	4%	37%
Marciano della Chiana	29%	5%	22%	9%	6%	28%
Marliana	37%	5%	15%	7%	10%	25%
Massa	31%	3%	9%	6%	16%	35%
Massa Marittima	32%	6%	7%	7%	14%	34%
Massarosa	31%	4%	14%	4%	17%	30%
Minucciano	32%	2%	12%	17%	6%	31%
Molazzana	36%	6%	9%	14%	11%	24%
Monte Argentario	36%	9%	6%	4%	10%	34%
Monte San Savino	28%	6%	11%	11%	13%	30%
Montecatini Val di Cecina	38%	7%	14%	7%	6%	27%
Montecatini-Terme	29%	11%	8%	10%	11%	32%
Montemignaio	29%	3%	12%	17%	15%	24%
Monterchi	34%	6%	15%	14%	5%	25%
Montescudaio	34%	16%	8%	6%	9%	28%
Montevarchi	28%	5%	13%	7%	17%	29%
Monteverdi Marittimo	59%	4%	11%	2%	7%	17%
Monticiano	37%	6%	17%	10%	8%	22%
Montieri	25%	2%	6%	3%	3%	61%
Montignoso	28%	8%	9%	14%	11%	30%
Montopoli in Val d'Arno	27%	6%	14%	7%	17%	30%
Mulazzo	25%	6%	8%	21%	10%	29%
Murlo	31%	2%	14%	9%	11%	33%
Orbetello	31%	7%	10%	6%	19%	27%
Orciano Pisano	29%	10%	16%	7%	12%	26%
Ortignano Raggiolo	26%	4%	14%	14%	22%	20%
Palaia	33%	8%	15%	12%	9%	22%
Palazzuolo sul Senio	34%	4%	6%	8%	34%	15%
Peccioli	27%	3%	9%	7%	24%	29%
Pergine Valdarno	32%	6%	13%	10%	10%	29%
Pescaglia	28%	7%	15%	19%	10%	21%
Pescia	25%	6%	11%	8%	14%	36%
Pian di Sco	32%	5%	15%	10%	13%	26%
Piancastagnaio	26%	4%	10%	11%	12%	36%
Piazza al Serchio	28%	3%	15%	13%	7%	34%
Pienza	33%	4%	16%	10%	7%	30%
Pietrasanta	28%	7%	8%	7%	13%	37%
Pieve a Nievole	24%	8%	18%	6%	19%	26%
Pieve Fosciana	32%	3%	12%	6%	7%	40%
Pieve Santo Stefano	25%	1%	9%	9%	38%	17%
Pisa	28%	7%	8%	12%	15%	29%
Piteglio	44%	5%	16%	12%	6%	18%
Pitigliano	42%	5%	14%	10%	4%	25%

Municipality	%adm	%educ	%soc	%road	%pol	%envir
Podenzana	31%	8%	18%	10%	7%	25%
Pomarance	47%	4%	10%	7%	10%	22%
Poppi	20%	5%	9%	8%	36%	22%
Porto Azzurro	36%	5%	5%	9%	7%	38%
Pratovecchio	23%	4%	13%	14%	22%	24%
Radda in Chianti	40%	7%	10%	13%	6%	24%
Radicofani	39%	4%	10%	14%	6%	27%
Radicondoli	58%	2%	11%	4%	7%	18%
Rapolano Terme	38%	6%	11%	8%	13%	24%
Rio Marina	31%	4%	10%	6%	3%	47%
Rio nell'Elba	55%	3%	6%	7%	5%	23%
Riparbella	38%	2%	9%	3%	6%	42%
Roccalbegna	42%	3%	17%	12%	5%	20%
Roccastrada	28%	5%	17%	7%	9%	34%
Rosignano Marittimo	28%	6%	14%	11%	22%	19%
Sambuca Pistoiese	44%	2%	15%	18%	2%	17%
San Casciano dei Bagni	36%	4%	16%	8%	7%	29%
San Giovanni d'Asso	51%	3%	4%	14%	6%	22%
San Giovanni Valdarno	29%	5%	12%	8%	21%	25%
San Godenzo	40%	0%	8%	19%	8%	24%
San Marcello Pistoiese	31%	6%	15%	13%	11%	25%
San Piero a Sieve	27%	4%	17%	8%	13%	32%
San Quirico d'Orcia	35%	5%	13%	7%	8%	32%
San Romano in Garfagnana	33%	3%	6%	16%	15%	27%
Sansepolcro	28%	5%	13%	10%	14%	31%
Santa Croce sull'Arno	27%	5%	12%	6%	27%	23%
Santa Fiora	36%	6%	11%	9%	9%	29%
Santa Luce	36%	2%	17%	6%	9%	31%
Sarteano	25%	4%	9%	5%	38%	19%
Sassetta	39%	1%	9%	3%	5%	42%
Scansano	41%	6%	12%	9%	9%	24%
Scarlino	34%	6%	8%	7%	8%	36%
Seggiano	46%	3%	12%	10%	8%	21%
Semproniano	39%	3%	20%	9%	10%	19%
Seravezza	29%	5%	11%	6%	12%	38%
Sestino	28%	3%	18%	15%	13%	23%
Sillano	35%	1%	15%	20%	5%	23%
Sorano	40%	4%	15%	8%	8%	25%
Stazzema	29%	3%	15%	17%	11%	24%
Stia	33%	3%	14%	12%	12%	27%
Subbiano	29%	3%	16%	15%	11%	26%
Talla	31%	4%	15%	14%	11%	25%
Tavarnelle Val di Pesa	30%	3%	9%	16%	14%	29%
Terricciola	35%	6%	14%	15%	11%	19%
Trequanda	43%	3%	16%	10%	9%	20%
Tresana	43%	3%	13%	8%	9%	24%

Municipality	%adm	%educ	%soc	%road	%pol	%envir
Uzzano	34%	5%	17%	5%	15%	24%
Vagli Sotto	47%	1%	9%	13%	3%	27%
Vaglia	31%	6%	13%	8%	19%	24%
Vergemoli	34%	0%	2%	33%	12%	19%
Vernio	35%	4%	15%	7%	17%	22%
Vicchio	29%	5%	15%	7%	17%	27%
Villa Basilica	37%	2%	7%	4%	5%	45%
Villa Collemandina	28%	3%	16%	17%	6%	30%
Villafranca in Lunigiana	28%	8%	11%	9%	12%	32%
Volterra	33%	5%	15%	9%	15%	23%
Zeri	30%	3%	15%	20%	5%	29%
TUSCANY	30%	5%	11%	9%	14%	31%

Source: elaborations of municipal balance sheets

In conclusion, in this thesis an input-oriented VRS DEA model will be implemented: a "one input-one output" model or at most "one input-two output" model will be used for each municipal function and then these efficiency scores will be put together as an efficiency composite indicator.

3.3 Choice of the determinants for the Tobit regression

In compliance with the existing literature, in this thesis also a second stage analysis have been applied: in fact, the explanation of the efficiency results considering some municipal features can be useful to understand the sources of potential inefficiency in a municipality. In particular, a Tobit regression will be employed[6] and implemented by "Stata".

Certainly, in order to choose the explanatory variables in the municipal context, the literature has been taken into account[7]. So, in this context some financial, socio-economic, geographical and political variables have been considered in order to consider some of the main environmental factors that can influence the local government efficiency.

First of all, economic variables are considered, in particular those variables that focus on the accountability degree of local governments with respect to the citizens and soft budget constraint[8]. The first aspect is reached by the continuous variable "FISCAL AUTONOMY", that is the ratio between local taxes over the total expenditures in the functions involved in the analysis: so, for DEA2 there are all the six fundamental functions ("AUTONOMY1"), while for DEA1 the expenditure for the "Environmental management" function is dropped ("AUTONOMY2"); local taxes data are taken from the municipal

[6]For more details, see Appendix A.
[7]See section 2.3.
[8]See e.g. in Kornai et al. (2003) and Boetti et al. (2010).

balance sheets referred to 2011. According to the literature, this variable should have a positive effect on the level of the efficiency: the higher is the revenues stemming from the citizens contribution, the higher is the responsibility of the local government, that will spend in a more efficient way these resources. The other aspect is reached by the continuous variable “REVENUES”: it is the ratio of total revenues over total resident population, so it's a normalized variable: total revenues data are taken from the municipal balance sheets referred to 2011 and total resident population data are taken, as the same, from DEMO ISTAT and are referred to 2011. Actually, as already presented, the expected effect of this variable is uncertain.

Regarding to the socio-economic factors, there is the attempt to understand how the level of tourism and the municipal size affect the efficiency of the municipalities. As presented in the first chapter, the per capita expenditure according to the tourism classes increases as the level of tourism increases, even taken into account the tourism presence in addition to the population: so, at first glance, the tourism presence seems to negatively affects the municipal performance, in the sense that it implies more per capita costs. For the continuous variable “TOURISM”, the annual tourist presence data of 2011 contained in a survey of Tuscany Region are used and then divided by 365 days, in order to have the average annual presence. Going to the other element, the effect of the municipal size is a long debated issue in the literature and also in the normative context, as explained in the section 1.2. In this case, the variable “DIMENSION” is a categorical variable, that takes on a finite number of values, each denoting membership in one of the subclasses listed as follows:

1. from 0 to 5.000 inhabitants;
2. from 5.000 to 10.000 inhabitants;
3. from 10.000 to 20.000 inhabitants;
4. from 20.000 to 60.000 inhabitants;
5. over 60.000 inhabitants.

The information contained in the 5-valued categorical variable can be, and it is, well represented by 5 dummy variables (that is a special type of two-valued categorical variable containing values 0, denoting false, and 1, denoting true): these dummies denote the truth or falseness of “the municipality has from 0 to 5.000 inhabitants”, “the municipality has from 5.000 to 10.000 inhabitants” and so on. For a practical reason, these dummies are named Dim1, Dim2, Dim3, Dim4 and Dim5. It's worth mentioning that the difference between Dim4 and Dim3 is significant as the difference between Dim5 and Dim4: this has been checked by Wald tests performed by “Stata”. These dimensional classes are obtained grouping the non-significant different classes presented in section 1.1.

Since also the geographical factors affect the level of municipal efficiency, also the dummy variable “SEA” and the dummy “MOUNTAIN” are considered. Certainly, the sea places can be subject to seasonality and this could suggest a negative impact on the municipal efficiency. In addition, it's worth mentioning that, as a limit of the dataset, there are not into account the vacation properties: this could reduce the potential output as services provided by sea municipalities. For the "SEA" variable, data are taken from the ISTAT classification regarding the capacity of accommodation establishments; the dummy is equal to one when the municipality is a sea place. In addition, the interaction of the sea municipalities with the variable "tourism" is also considered and the variable is "SEA*TOURISM": so it's possible to distinguish the effect of turisticity when the municipality is a sea place or not. With respects to the mountain feature, the distinction between mountain and non-mountain municipalities is taken from the legislation, as already presented in the chapter 1: the dummy is equal to one when the municipality is a mountain place. Obviously, the negative effect of the mountain feature on the municipal efficiency is expected: the more impervious is the municipal territory, the more high costs this municipality has to pay, affecting the efficiency. Moreover, also the continuous variable "DENSITY" is considered: it is the ratio of total resident population over the municipal surface: total resident population data are taken from DEMO ISTAT and referred to 2011 and the municipal surface data are taken from ISTAT and referred to 2011. In this case, a positive effect of the degree of density is expected: the more densely populated is a municipality, the less dispersion of resources is present.

Finally, as a political variable the dummy variable "SECOND MANDATE" is considered: the dummy is equal to one when a municipality has its major at the second mandate. For "SECOND MANDATE", data are taken from the election timetable data provided by ANCI TOSCANA. Certainly, the effect of this variable on the municipal efficiency is not so obvious and different explanation could be given: on one hand, it can positively affect the efficiency because at the second mandate the major and its staff has become more competent on the local issues; on the other hand, however, there is no room to be re-elected after the second mandate, so the local government can decide to spend in a less prudent manner. In addition, the interaction of the municipalities at the second mandate with the variable "revenues" is also considered and the variable is "SECOND*REVENUES": so it's possible to go into details in the effect of the revenues when the municipality is at the second mandate of its major or not.

Chapter 4

The empirical application II: Results

In this chapter the efficiency analysis results are presented: in the first two sections DEA results are described and in the last section the explanation of the expenditure efficiency through the comparison of the Tobit regression results are commented.

As a preliminary consideration, it's worth explaining that DEA results are mainly presented in inefficiency terms: in this way, it's immediately possible to get the municipalities that behave worse. The assessment of expenditure performance expressed in terms of DEA scores is represented by values between 0 and 1, where the municipalities with a score equal to one are those that are fully efficient: computing the complement to one of that scores, there is the assessment in terms of inefficiency. Moreover, from a theoretical point of view, these inefficiency scores denote the percentage of expenditure in excess in comparison with the level that would allow municipalities to operate on the efficiency frontier. However, since DEA is a non-parametric technique, in this context it's preferable to focus more on the ordering, among municipalities and different classes of municipalities, that DEA analysis provides and to understand which are the municipalities that behave better and worse: the task of waste resources computation is delegated to the slack variables associated to the DEA model.

Before to go into the result details, it's necessary to point out an important aspect: the concept of obtained technical efficiency results. In fact, when a DMU is on the theoretical production possibility frontier, it is completely efficient. However, when a DMU is far from the frontier (i.e. it is technically inefficient), this may happen for two reasons that can coexist: the first is related to the fact that the management are not using the resources in the best way (pure technical efficiency); the second reason is related to the fact that, even if inputs are used in an efficient manner, the scale production is "wrong", i.e. it's possible to increase/decrease proportionally all the inputs to produce in a better way (scale efficiency). The first source of inefficiency can be detected by the VRS DEA efficiency scores, while the second by the scale efficiency scores (i.e. the ratio between the CRS over the VRS DEA scores): in fact, the overall inefficiency can be found by the CRS DEA scores[1] . Certainly, it's fundamental to distinguish the inefficiency responsibilities, but in the municipal efficiency analysis this could be very controversial. In fact, the municipal management of the services provision can be in general internal or outsourced: this element introduces a high variability in the management outcome and it makes not very reliable the results about the optimal productive scale. The function that avoids this kind of problem is mainly the function for the general administration. In fact, differently from the other functions, in this function the services management is almost completely internalized and it is quite evident from the municipal balance sheets: as already presented in section 1.1, this function has the highest prevalence of staff expenditure. So, for the general administration function both the CRS and the VRS DEA scores are presented, so to understand how the decisions of the local governments and the production scale affect the municipal efficiency. In particular, since it has as output the population, this inefficiency decomposition could be useful to face the issue of the municipal size. In addition, it's worth pointing out that the function for the general administration covers the main part of the municipal expenditure. Furthermore, since for the function for the environmental management the DEA2 dataset already takes into account just the municipalities that apply TARSU, even in this case is reasonable to ask whether the level of efficiency is affected by mismanagement and by the presence of economies/diseconomies of scale (obviously with the already mentioned prudence). In conclusion, for the general administration and environmental functions, both CRS and VRS DEA scores are presented, while for the other functions just the VRS DEA scores are described, so to understand the level of resources waste due to a mismanagement, since reasoning about a "wrong" productive scale is not meaningful due to the different kinds of management organization.

4.1 DEA 1

In this section, the main results of the first dataset are presented: DEA1 regards all the six fundamental functions except the function for the environmental management and considers 284 municipalities.

In the following, firstly there are the results of the non-aggregate analysis that makes possible to find the municipal inefficiencies function by function separately. Secondly, the average level of inefficiency is described considering the weight that each function has in the total expenditure, so to have the average overspending for each municipality. Finally, the comparison between the composite indicator obtained by the municipal weight with the indicator obtained by the Tuscan mean weight is considered so to have possible suggestions as room

[1]For further theoretical explanation, see for example Banker et al., 2011.

for improvement for the inefficient municipalities. For more details about DEA 1 results, see Appendix C.

General Administration

First of all, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for general administration provides services regarding the institutional bodies, the administrative office, the management of tax revenue, the technical office, military services, civil registration and electoral services, vital records and statistics, according to the municipal balance sheet items of expenditure. As presented in the introduction of this chapter, for this function the CRS efficiency results together with the VRS and scale efficiency results are presented, so to understand how the mismanagement and the presence of economies/diseconomies of scale affect the overall technical efficiency.

Table 4.1 presents the overall technical inefficiency scores of the CRS analysis. The mean of the inefficiency scores is equal to 0.45 and implies that theoretically the 45 % of the expenditure spent for this function could be reduced. In addition, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are the same. However, as already said, this level of inefficiency could be affected by the constant return to scale assumption: for this reason, municipal inefficiency is estimated just taking into account the mismanagement component, so in other words just considering the variable returns to scale.

So, Table 4.2 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.40, so it's a lower value than in the CRS case: certainly this implies that among some municipalities there is the presence of economies/diseconomies of scale. In addition, also in this case, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are very similar. However, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.1: DEA1. Descriptive statistics of CRS inefficiency scores in general administration. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.45	0.19	0.00	0.89	0.21	0.32	0.45	0.60	0.70

Table 4.2: DEA1. Descriptive statistics of VRS inefficiency scores in general administration. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.40	0.19	0.00	0.85	0.16	0.27	0.42	0.54	0.63

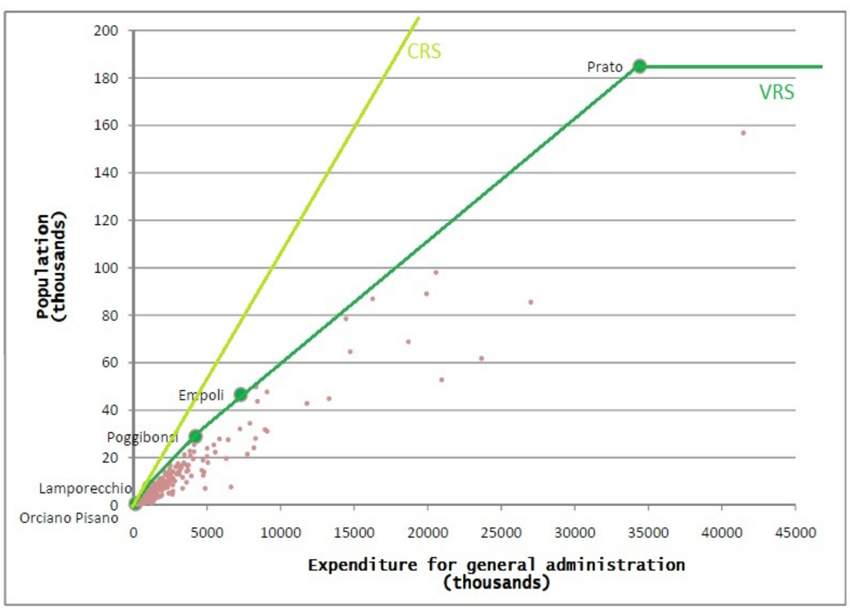
By construction, in the CRS analysis, just a municipality is completely efficient: Lamporecchio. Table 4.3 instead describes the municipalities that results to be efficient according to the VRS analysis. It becomes immediately evident that the non-mountain feature represents a common element of these municipalities. In addition, three out of five municipalities belong to the highest dimensional classes and four out of five have a low level of tourism. It's worth noting the number of times each efficient municipality is a peer for the others [2]: the two smallest efficient municipalities are the peer for the greatest part of the municipalities and this is a relevant information. In fact, the presence of the biggest municipalities (except Firenze) could be criticized to represent potential outliers; however, in the detection of the potential outliers, some authors consider precisely the high number of times each unit is a peer for other units under analysis (see e.g. in Tran et al., 2010) and this reasoning could exclude potential critique. Moreover, Figure 4.1 presents the theoretical production possibility frontier associated with the aforementioned sets of efficient municipalities: also from a graphical point of view it's possible to observe how the two smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case. The horizontal distance from the CRS frontier of municipality indicates whether it is globally inefficient, while the horizontal distance from the VRS frontier shows whether it is inefficient because it uses the available input in a bad manner. It follows that the horizontal distance between the two frontier indicates the efficiency score of scale: a value less than unity indicates inefficiency.

[2]Information provided directly by Coelli software.

Table 4.3: DEA1. Details of efficient municipalities in general administration. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Orciano Pisano	From 0 to 1.000 inhab.	Non-mountain	Very low tourism	166	30%
Lamporecchio	From 5.001 to 10.000 inhab.	Non-mountain	High tourism	252	46%
Empoli	From 20.001 to 60.000 inhab.	Non-mountain	Very low tourism	19	3%
Poggibonsi	From 20.001 to 60.000 inhab.	Non-mountain	Low tourism	101	18%
Prato	Over 60.000 inhab.	Non-mountain	Low tourism	12	2%
				550	100%

Figure 4.1: DEA1. Theoretical production possibility frontier for general administration. 2011



In order to disentangle the causes that affect the overall technical inefficiency, the level of inefficiency depending on the dimensional classes is observed. Table 4.4 and Table 4.5 present the descriptive statistics of the inefficiency scores respectively for the CRS and the VRS case and the related graph (Figure 4.2) gives a graphical intuition of the two inefficiency distributions. From the comparison between CRS and VRS inefficiency scores, it's possible to observe that in the extreme classes the gap between CRS and VRS scores is higher than in the central classes: the differences between CRS and VRS is to be attributed to the scale inefficiency. For the same reason, the scale inefficiency scores presented graphically (Figure 4.3) also denotes higher scores at the extreme demographical classes. In addition, as described in Table 4.6, the scale inefficiencies for the smallest dimensional classes are related to missing economies of scale, in fact there are observed increasing return to scale; while for the biggest municipalities the scale inefficiency are due to the presence of diseconomies of scale, as the prevalent presence of decreasing returns to scale shows. However, there is a very relevant aspect to underline: even taken into account the presence of scale inefficiencies, the smallest municipalities result to be the most technically inefficient ones. In others words, this implies that these small dimensional classes show technical inefficiency even taking into account that they can produce under variable returns to scale and this inefficiency can be attributed entirely to a bad municipal management. This does not hold for the biggest municipalities. In fact, these municipalities result to be technically inefficient under the global point of view. However, if they are evaluated under variable returns to scale, they result to be the most efficient class: so the main inefficiency problem in their case is related with their too big dimension and actually not to their municipal management. These considerations suggest that at least under 5.000 thousands of inhabitants an aggregation among the smallest municipalities should be promoted in order to reach the missing economies of scale and so to improve the level of efficiency at least under this aspect. So, at least in relation to the general administration function, it is clear that it is not entirely correct to impute all the inefficiency to the municipal management, certainly not responsible for a wrong municipal size. Especially with regard to the small municipalities, the cause of the inefficiency results from the presence of too much small fragmented municipalities: this evidence is therefore in line with the legislative measures already undertaken by the Tuscany Region in order to overcome this problematic aspect, see section 1.2.

Table 4.4: DEA1. Descriptive statistics of CRS inefficiency scores in general administration by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.70	0.15	0.38	0.89
From 1.001 to 2.000 inhab.	0.64	0.11	0.37	0.86
From 2.001 to 3.000 inhab.	0.53	0.12	0.21	0.78
From 3.001 to 5.000 inhab.	0.48	0.15	0.13	0.76
From 5.001 to 10.000 inhab.	0.37	0.18	0.00	0.84
From 10.001 to 20.000 inhab.	0.32	0.13	0.06	0.63
From 20.001 to 60.000 inhab.	0.36	0.17	0.04	0.65
Over 60.000 inhab.	0.40	0.14	0.24	0.63

Table 4.5: DEA1. Descriptive statistics of VRS inefficiency scores in general administration by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.49	0.23	0.00	0.85
From 1.001 to 2.000 inhab.	0.55	0.14	0.21	0.82
From 2.001 to 3.000 inhab.	0.47	0.13	0.11	0.75
From 3.001 to 5.000 inhab.	0.45	0.16	0.10	0.75
From 5.001 to 10.000 inhab.	0.36	0.18	0.00	0.84
From 10.001 to 20.000 inhab.	0.31	0.14	0.03	0.62
From 20.001 to 60.000 inhab.	0.32	0.18	0.00	0.60
Over 60.000 inhab.	0.25	0.18	0.00	0.57

Figure 4.2: DEA1. Inefficiency scores in general administration by dimensional classes. 2011

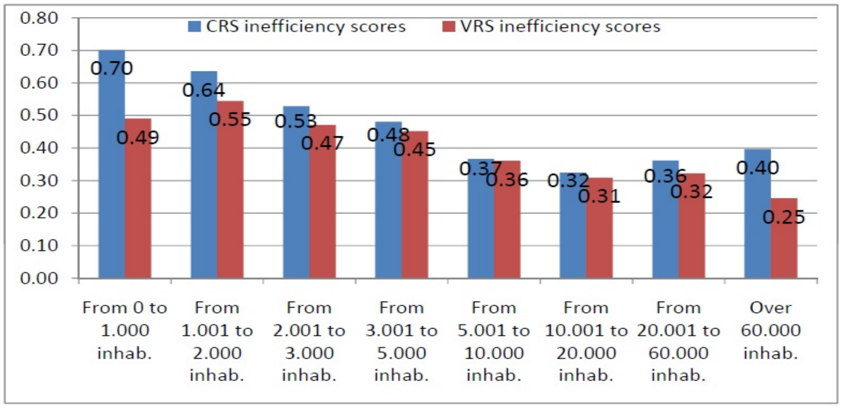
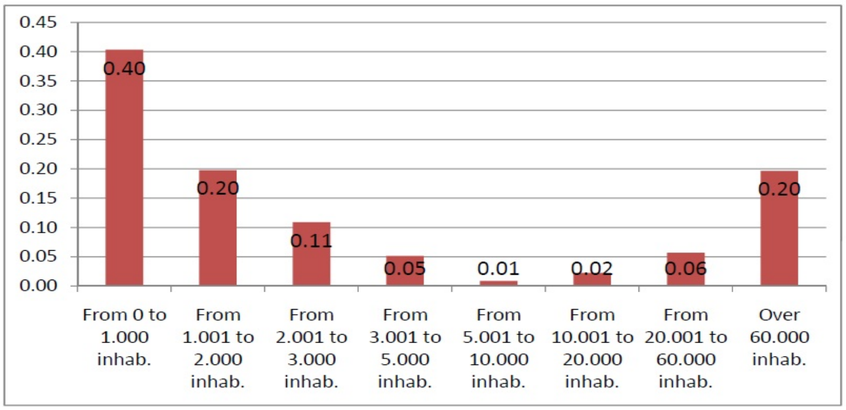


Table 4.6: DEA1. Descriptive statistics of scale inefficiency scores in general administration by dimensional classes. 2011

Dimensional class	Mean	Std. dev.	Prevalent RTS
From 0 to 1.000 inhab.	0.40	0.12	irts
From 1.001 to 2.000 inhab.	0.20	0.04	irts
From 2.001 to 3.000 inhab.	0.11	0.02	irts
From 3.001 to 5.000 inhab.	0.05	0.02	irts
From 5.001 to 10.000 inhab.	0.01	0.01	mixed
From 10.001 to 20.000 inhab.	0.02	0.01	drts
From 20.001 to 60.000 inhab.	0.06	0.03	drts
Over 60.000 inhab.	0.20	0.03	drts

Figure 4.3: DEA1. Scale inefficiency scores in general administration by dimensional classes. 2011



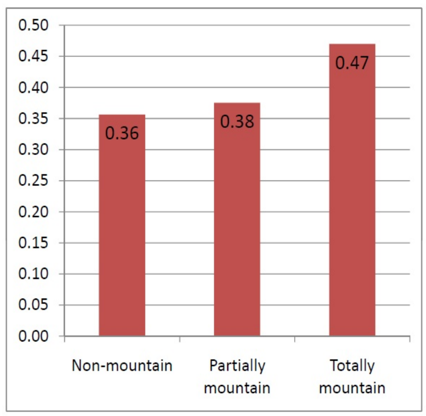
Furthermore, it can be said that the municipal inefficiency is strongly influenced by the characteristics of the municipalities themselves, as already seen in the main features of the found efficient municipalities. For this reason, a more detailed analysis of the inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by mountain, tourism and local labour system classes), and in particular just the VRS inefficiency scores are considered for the already explained reasons: so, the level of municipal mismanagement is under attention.

Table 4.7 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.4) gives a graphical intuition of the inefficiency distribution considering the municipal classification by mountain classes. The highest level of inefficiency is present in the totally mountain classes, while the opposite holds for the non-mountain classes. Moreover, it's worth noting that the partially mountain class has the lowest maximum value of inefficiency, while the totally mountain class has the highest level of maximum inefficiency. The minimum level of inefficiency is equal to zero just in the non-mountain class, as already found in the general features of the completely efficient municipalities: however it's worth noting that in the non-mountain there is the highest value of standard deviation, meaning high level of variability within this class. To conclude, it's possible to observe that going from non-mountain to totally mountain municipalities the level of inefficiency increases: certainly, the local governments of the totally mountain places have to face more difficulties to accomplish their services for all the citizens and can be influenced in their municipal management.

Table 4.7: DEA1. Descriptive statistics of inefficiency scores in general administration by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.36	0.20	0.00	0.84
Partially mountain	0.38	0.16	0.06	0.69
Totally mountain	0.47	0.16	0.11	0.85

Figure 4.4: DEA1. Inefficiency scores in general administration by mountain classes. 2011

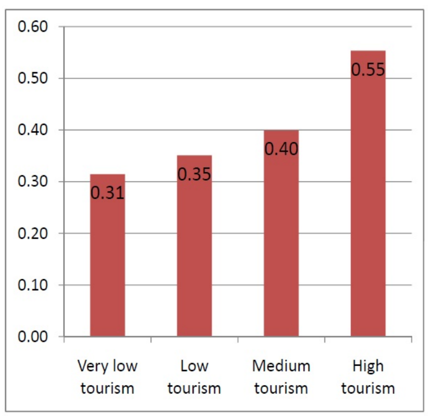


Regarding the municipal classification by tourism classes, Table 4.8 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.5) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. Moreover, it's worth noting that the municipalities with high level of tourism have the highest level of maximum inefficiency. The minimum level of inefficiency is not equal to zero just in the municipalities with medium level of tourism: in fact, it's the only feature that has not been mentioned among the completely efficient municipalities. To conclude, it's possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. Certainly, a clarification is necessary: probably, this high score of inefficiency for the municipalities subject to high tourism level should be lower if the average annual tourism presence and also vacancy properties (and its resident) would be taken into account. In fact, the general administration services are addressed to all these users, that are the resident population, but also the tourists and the owners of vacancy properties: probably, this level of inefficiency would be mitigated.

Table 4.8: DEA1. Descriptive statistics of inefficiency scores in general administration by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.31	0.16	0.00	0.79
Low tourism	0.35	0.17	0.00	0.73
Medium tourism	0.40	0.15	0.06	0.74
High tourism	0.55	0.16	0.00	0.85

Figure 4.5: DEA1. Inefficiency scores in general administration by tourism classes. 2011

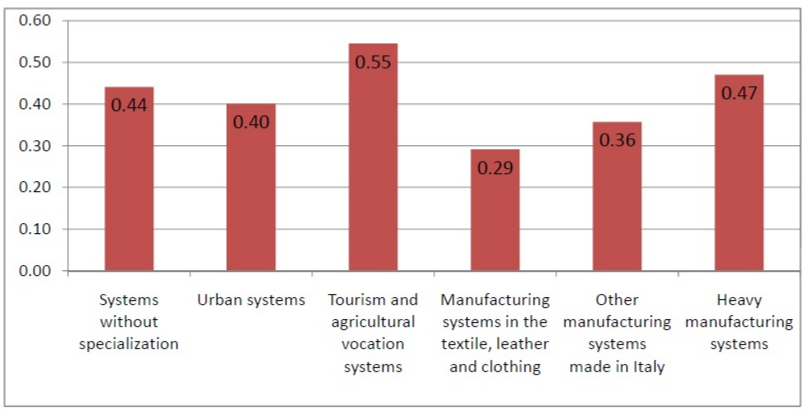


Finally, Table 4.9 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.6) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present, consistently with what said earlier, in the tourism and agricultural vocation systems, while the opposite holds for the manufacturing systems in the textile, leather and clothing. Moreover, it's worth noting that in general all the manufacturing systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities), even if they also have the highest value of maximum inefficiency: it is not surprising that for these classes there is the highest value of standard deviation, meaning high level of variability within each class.

Table 4.9: DEA1. Descriptive statistics of inefficiency scores in general administration by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.44	0.15	0.11	0.74
Urban systems	0.40	0.16	0.05	0.80
Tourism and agricultural vocation systems	0.55	0.14	0.19	0.82
Manufacturing systems in the textile, leather and clothing	0.29	0.16	0.00	0.79
Other manufacturing systems made in Italy	0.36	0.19	0.00	0.85
Heavy manufacturing systems	0.47	0.18	0.00	0.84

Figure 4.6: DEA1. Inefficiency scores in general administration by local labour system classes. 2011



Education

First of all, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for educational services provides services regarding the nursery schools, the primary and secondary education, the school assistance, school transport and school meals, according with the municipal balance sheet items of expenditure. In addition, it's worth remembering that the production scale problems are not taken into account in the considered function.

Table 4.10 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.76, so it's a higher value than in the general administration case. In addition, in this case, the distribution of the estimated level of inefficiency is not symmetric: in fact, the mean and the median are totally different. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.10: DEA1. Descriptive statistics of inefficiency scores in educational services. 2011

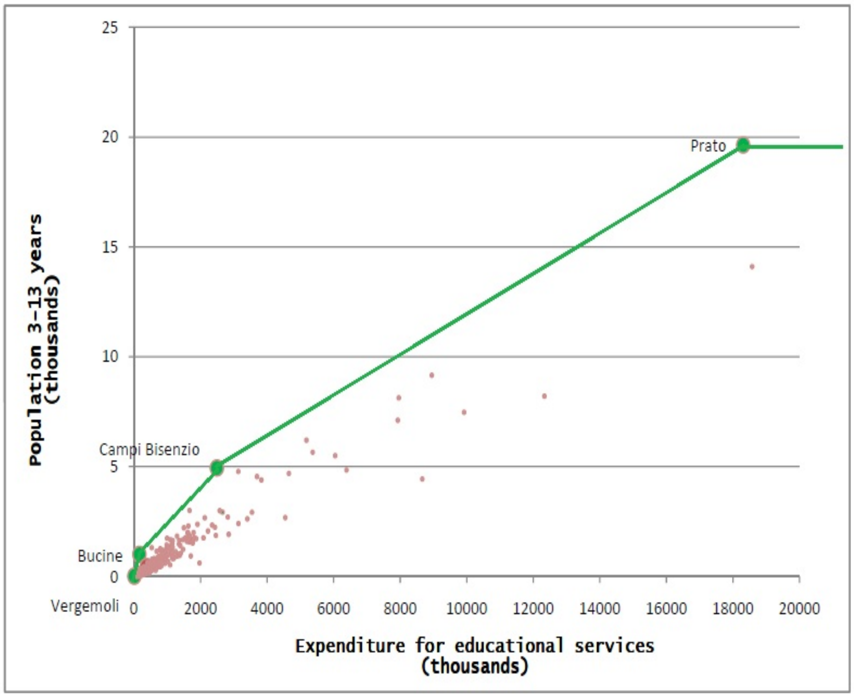
Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.76	0.17	0.00	0.95	0.53	0.72	0.83	0.87	0.90

Table 4.11 describes the municipalities that results to be efficient according to the VRS analysis. Two out of four municipalities belong to the highest dimensional classes and three out of four have a low level of tourism. Again, it's worth noting the number of times each efficient municipality is a peer for the others: the two smallest efficient municipalities are the peer for the greatest part of the municipalities. Moreover, Figure 4.7 presents the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities: also from a graphical point of view it's possible to observe how the two smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case.

Table 4.11: DEA1. Details of efficient municipalities in educational services. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Vergemoli	From 0 to 1.000 inhab.	Totally mountain	Very low tourism	199	36%
Bucine	From 10.001 to 20.000 inhab.	Non-mountain	Medium tourism	270	48%
Campi Bisenzio	From 20.001 to 60.000 inhab.	Non-mountain	Low tourism	80	14%
Prato	Over 60.000 inhab.	Non-mountain	Low tourism	9	2%
				558	100%

Figure 4.7: DEA1. Theoretical production possibility frontier for educational services. 2011



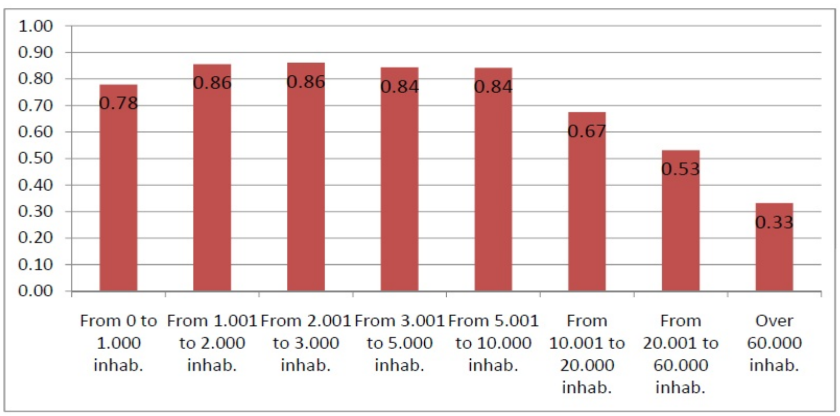
In the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.12 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.8) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a reverse "U-shaped form" and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is very low for the central classes: this could suggest that in average there is the same behavior among these classes. In order to explain these outcomes, it's useful to take into account that the school age population increases as the total resident population increases. The inefficiency results suggest that in the provision of the educational services a municipality works better with a larger catchment area than a smaller. A clear example of this could be the school transportation: certainly, it's more expensive the school transportation for few children than for many.

Table 4.12: DEA1. Descriptive statistics of inefficiency scores in educational services by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.78	0.21	0.00	0.92
From 1.001 to 2.000 inhab.	0.86	0.05	0.73	0.93
From 2.001 to 3.000 inhab.	0.86	0.05	0.76	0.93
From 3.001 to 5.000 inhab.	0.84	0.06	0.62	0.92
From 5.001 to 10.000 inhab.	0.84	0.04	0.74	0.95
From 10.001 to 20.000 inhab.	0.67	0.15	0.00	0.91
From 20.001 to 60.000 inhab.	0.53	0.18	0.00	0.75
Over 60.000 inhab.	0.33	0.16	0.00	0.51

Figure 4.8: DEA1. Inefficiency scores in educational services by dimensional classes. 2011

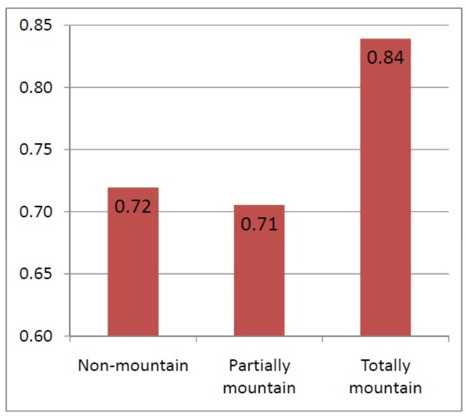


Obviously, the same reasoning applies also considering the municipal classification by mountain features. In fact, both Table 4.13 that presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.9), that gives a graphical intuition of the inefficiency distribution, show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory and the smallest presence of school age people make more inefficient the provision of the educational services.

Table 4.13: DEA1. Descriptive statistics of inefficiency scores in educational services by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.72	0.19	0.00	0.95
Partially mountain	0.71	0.21	0.22	0.91
Totally mountain	0.84	0.10	0.00	0.93

Figure 4.9: DEA1. Inefficiency scores in educational services by mountain classes. 2011

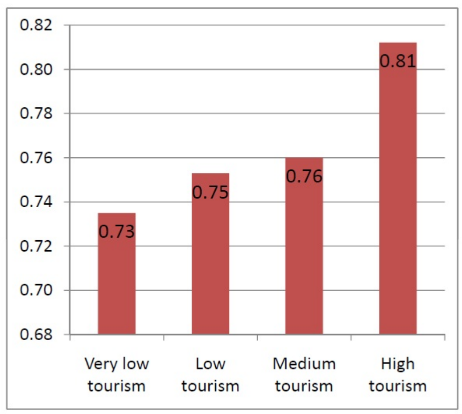


Regarding the municipal classification by tourism classes, Table 4.14 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.10) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. The minimum level of inefficiency is not equal to zero just in the municipalities with high level of tourism: in fact, it's the only feature that has not been mentioned among the completely efficient municipalities. To conclude, it's possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. Certainly, a clarification is necessary. In fact, obviously, the municipalities with the highest level of tourism present the lowest average presence of school-age population and so the already presented reasoning still applies.

Table 4.14: DEA1. Descriptive statistics of inefficiency scores in educational services by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.73	0.18	0.00	0.92
Low tourism	0.75	0.18	0.00	0.92
Medium tourism	0.76	0.19	0.00	0.93
High tourism	0.81	0.12	0.39	0.95

Figure 4.10: DEA1. Inefficiency scores in educational services by tourism classes. 2011

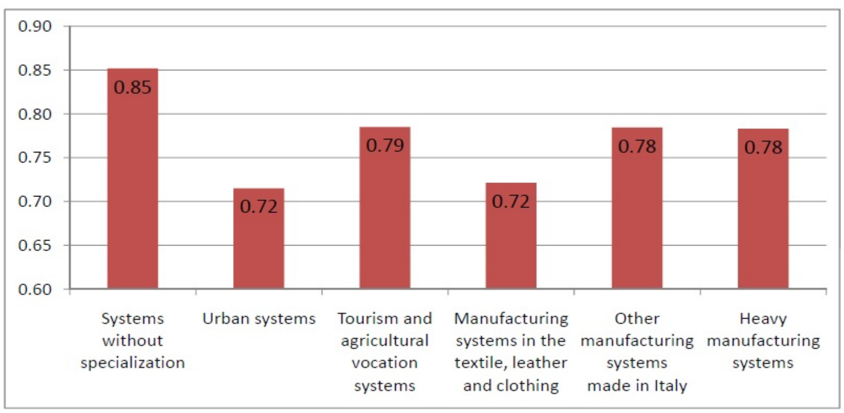


Finally, Table 4.15 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.11) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present in the systems without specialization, while the opposite holds for the urban systems and for the manufacturing systems in the textile, leather and clothing. Moreover, it's worth noting that these two typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, for these classes there is the highest value of standard deviation, meaning high level of variability within both classes.

Table 4.15: DEA1. Descriptive statistics of inefficiency scores in educational services by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.85	0.05	0.73	0.92
Urban systems	0.72	0.21	0.00	0.91
Tourism and agricultural vocation systems	0.79	0.17	0.20	0.92
Manufacturing systems in the textile, leather and clothing	0.72	0.19	0.00	0.93
Other manufacturing systems made in Italy	0.78	0.14	0.22	0.93
Heavy manufacturing systems	0.78	0.16	0.00	0.95

Figure 4.11: DEA1. Inefficiency scores in educational services by local labour system classes. 2011



Social services

First of all, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for social services provides services regarding childcare, kindergarten, services to minors, facilities and care for the elderly and leisure structures, according to the municipal balance sheet items of expenditure. In addition, it's worth remembering that the production scale problems are not taken into account in the considered function.

Table 4.16 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.55, so it's a lower value than in the educational services case and implies that theoretically the 55 % of the expenditure spent for this function could be reduced. In addition, in this case, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.16: DEA1. Descriptive statistics of inefficiency scores in social services. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.55	0.24	0.00	0.98	0.17	0.43	0.60	0.73	0.82

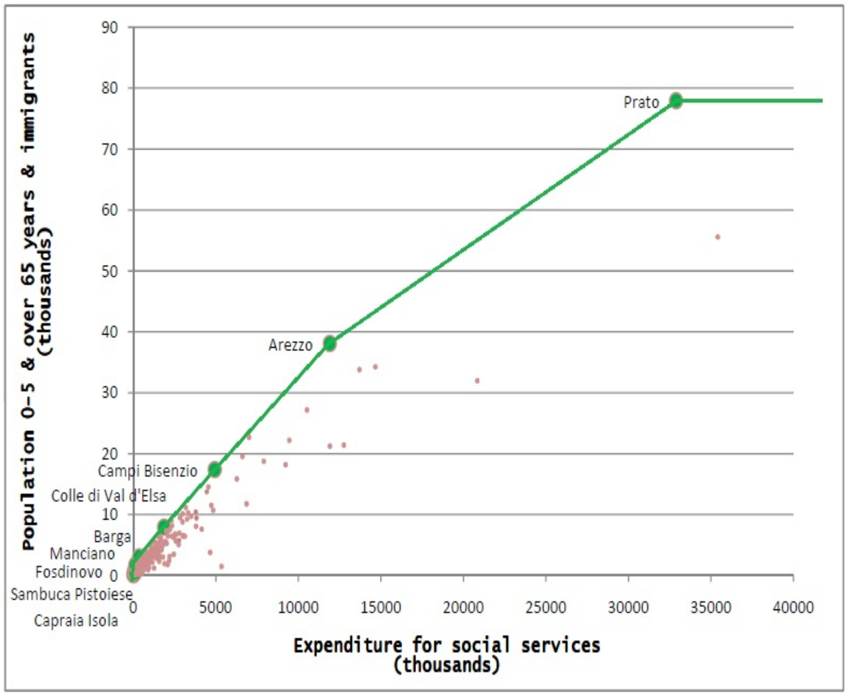
Table 4.17 describes the municipalities that results to be efficient according to the VRS analysis. Four out of nine municipalities belong to the highest dimensional classes and six out of nine have a low level of tourism. Differently from the previous functions, five out of nine efficient municipalities belong to the mountain classification. Again, it's worth noting the number of times each efficient municipality is a peer for the others: the 69 % of times the peer for the greatest part of municipalities are the four efficient municipalities under ten thousands of inhabitants.

Moreover, Figure 4.12 presents the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities: also from a graphical point of view it's possible to observe how the smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case.

Table 4.17: DEA1. Details of efficient municipalities in social services. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Capraia Isola	From 0 to 1.000 inhab.	Totally mountain	High tourism	47	9%
Sambuca Pistoiese	From 1.001 to 2.000 inhab.	Totally mountain	Low tourism	123	22%
Fosdinovo	From 3.001 to 5.000 inhab.	Totally mountain	Very low tourism	130	24%
Manciano	From 5.001 to 10.000 inhab.	Totally mountain	High tourism	78	14%
Barga	From 10.001 to 20.000 inhab.	Totally mountain	Medium tourism	68	12%
Campi Bisenzio	From 20.001 to 60.000 inhab.	Non-mountain	Low tourism	29	5%
Colle di Val d'Elsa	From 20.001 to 60.000 inhab.	Non-mountain	Low tourism	61	11%
Arezzo	Over 60.000 inhab.	Partially mountain	Low tourism	12	2%
Prato	Over 60.000 inhab.	Non-mountain	Low tourism	1	0%
				549	100%

Figure 4.12: DEA1. Theorical production possibility frontier for social services. 2011



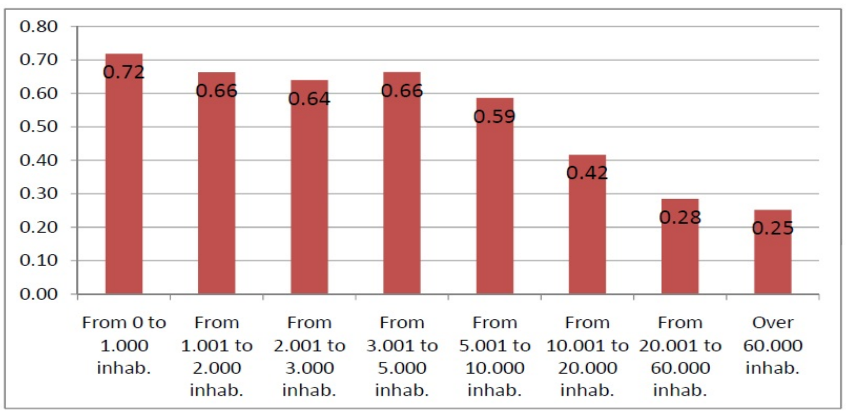
In the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.18 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.13) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a quite decreasing form and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is quite high for all the classes: this could suggest that in average there is a great variability of inefficiencies in each classes. In order to explain these outcomes, it's useful to take into account that the target population increases as the total resident population increases. The inefficiency results suggest that in the provision of the social services a municipality works better with a larger catchment area than a smaller.

Table 4.18: DEA1. Descriptive statistics of inefficiency scores in social services by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.72	0.22	0.00	0.93
From 1.001 to 2.000 inhab.	0.66	0.19	0.00	0.96
From 2.001 to 3.000 inhab.	0.64	0.14	0.24	0.89
From 3.001 to 5.000 inhab.	0.66	0.21	0.00	0.98
From 5.001 to 10.000 inhab.	0.59	0.22	0.00	0.89
From 10.001 to 20.000 inhab.	0.42	0.19	0.00	0.88
From 20.001 to 60.000 inhab.	0.28	0.17	0.00	0.58
Over 60.000 inhab.	0.25	0.19	0.00	0.53

Figure 4.13: DEA1. Inefficiency scores in social services by dimensional classes. 2011

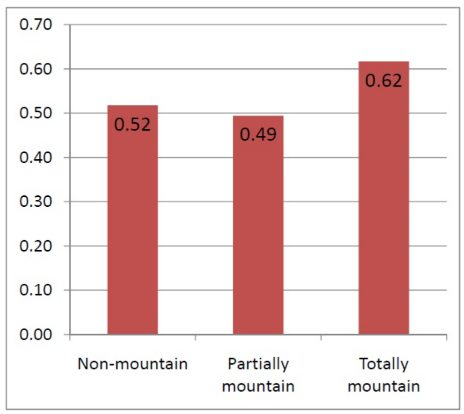


Obviously, the same reasoning applies also considering the municipal classification by mountain features. In fact, both Table 4.19 that presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.14), that gives a graphical intuition of the inefficiency distribution, show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory and the smallest presence of the involved catchment area make more inefficient the provision of the social services. Of course, it's worth recalling that however five out of nine efficient municipalities belong to the mountain classification.

Table 4.19: DEA1. Descriptive statistics of inefficiency scores in social services by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.52	0.24	0.00	0.98
Partially mountain	0.49	0.23	0.00	0.93
Totally mountain	0.62	0.23	0.00	0.96

Figure 4.14: DEA1. Inefficiency scores in social services by mountain classes. 2011

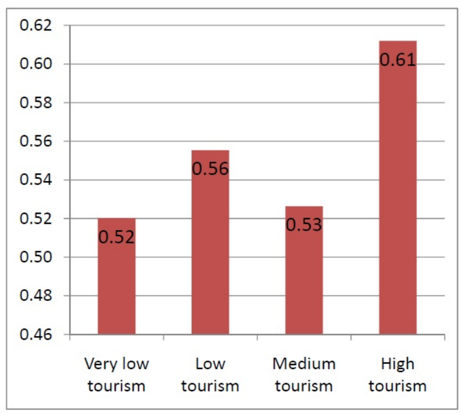


Regarding the municipal classification by tourism classes, Table 4.20 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.15) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. In this case, differently from the previous functions, it's not possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. However, it's useful to make notice that also the target population has the same reverse distribution among the different tourism classes: that is, the lower the target population, the higher the level of inefficiency.

Table 4.20: DEA1. Descriptive statistics of inefficiency scores in social services by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.52	0.23	0.00	0.93
Low tourism	0.56	0.28	0.00	0.95
Medium tourism	0.53	0.21	0.00	0.93
High tourism	0.61	0.22	0.00	0.98

Figure 4.15: DEA1. Inefficiency scores in social services by tourism classes. 2011

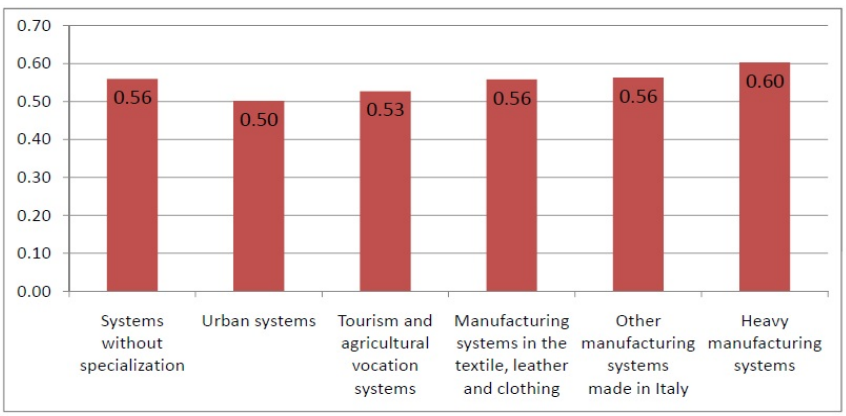


Finally, Table 4.21 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.16) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present in the heavy manufacturing systems, while the opposite holds for the urban systems. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class.

Table 4.21: DEA1. Descriptive statistics of inefficiency scores in social services by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.56	0.19	0.05	0.90
Urban systems	0.50	0.22	0.00	0.86
Tourism and agricultural vocation systems	0.53	0.25	0.00	0.91
Manufacturing systems in the textile, leather and clothing	0.56	0.25	0.00	0.98
Other manufacturing systems made in Italy	0.56	0.27	0.00	0.96
Heavy manufacturing systems	0.60	0.23	0.00	0.93

Figure 4.16: DEA1. Inefficiency scores in social services by local labour system classes. 2011



Road maintenance and local mobility

Also in this case, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for road maintenance and local mobility provides services regarding viability, traffic circulation, public lighting and public transport, according to the municipal balance sheet items of expenditure. In addition, it's worth remembering that the production scale problems are not taken into account in the considered function.

Table 4.22 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.65, so it's a higher value than in the social services case (but still lower than the function for the educational services) and implies that theoretically the 65 % of the expenditure spent for this function could be reduced. In addition, in this case, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.22: DEA1. Descriptive statistics of inefficiency scores in road maintenance and local mobility. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.65	0.20	0.00	0.97	0.39	0.57	0.70	0.80	0.86

Table 4.23 describes the municipalities that results to be efficient according to the VRS analysis. Five out of nine municipalities belong to the highest dimensional classes and just four out of nine have a low level of tourism. Differently from the previous functions, four out of nine efficient municipalities belong to the non-mountain classification and three out of nine belong to the partially mountain classification. In this case, it's worth noting the number of times each efficient municipality is a peer for the others, because a different situation applies: from one hand the 56 % of times the peer for the municipalities are the four efficient municipalities under two thousands of inhabitants, on the other hand the 36 % of times the peer for the other municipalities is basically Cascina, that belongs to the dimensional class between twenty and sixty thousands of inhabitants.

Since in this case the results are obtained through a “one input-two output” DEA model, the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities is not presented.

Table 4.23: DEA1. Details of efficient municipalities in road maintenance and local mobility. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Capraia Isola	From 0 to 1.000 inhab.	Totally mountain	High tourism	26	4%
Monteverdi Marittimo	From 0 to 1.000 inhab.	Totally mountain	High tourism	96	14%
Casale Marittimo	From 1.001 to 2.000 inhab.	Non-mountain	High tourism	209	31%
Riparbella	From 1.001 to 2.000 inhab.	Non-mountain	High tourism	47	7%
Greve in Chianti	From 10.001 to 20.000 inhab.	Partially mountain	Medium tourism	34	5%
Capannori	From 20.001 to 60.000 inhab.	Partially mountain	Very low tourism	1	0%
Cascina	From 20.001 to 60.000 inhab.	Non-mountain	Very low tourism	242	36%
Arezzo	Over 60.000 inhab.	Partially mountain	Low tourism	12	2%
Prato	Over 60.000 inhab.	Non-mountain	Low tourism	1	0%
				668	100%

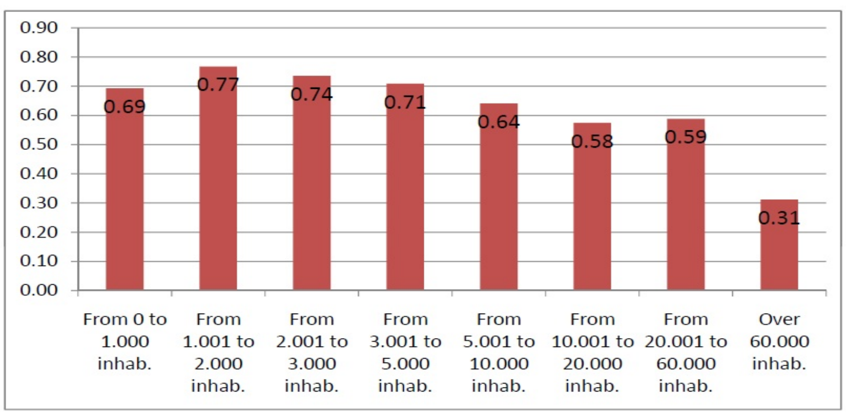
In the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.24 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.17) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a quite reversed "U-shaped form" and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is quite high for all the classes except the dimensional class ranging from three and five thousands of inhabitants: this could suggest that in average there is a great variability of inefficiencies in each classes.

Table 4.24: DEA1. Descriptive statistics of inefficiency scores in road maintenance and local mobility by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.69	0.29	0.00	0.97
From 1.001 to 2.000 inhab.	0.77	0.23	0.00	0.92
From 2.001 to 3.000 inhab.	0.74	0.14	0.29	0.90
From 3.001 to 5.000 inhab.	0.71	0.11	0.39	0.89
From 5.001 to 10.000 inhab.	0.64	0.16	0.26	0.90
From 10.001 to 20.000 inhab.	0.58	0.18	0.00	0.84
From 20.001 to 60.000 inhab.	0.59	0.21	0.00	0.85
Over 60.000 inhab.	0.31	0.26	0.00	0.64

Figure 4.17: DEA1. Inefficiency scores in road maintenance and local mobility by dimensional classes. 2011

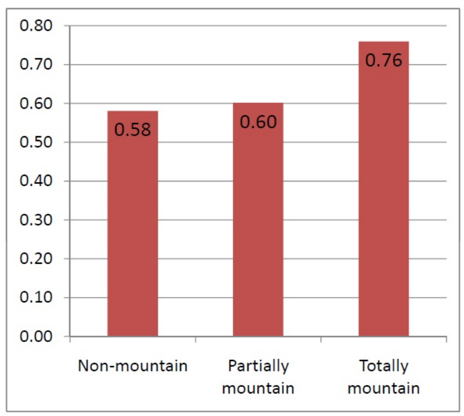


Regarding the mountain features, Table 4.25 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.18) gives a graphical intuition of the inefficiency distribution. They both show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory makes more inefficient the provision of services by the road maintenance and local mobility function. In particular, going from a non-mountain to a totally mountain place the level of inefficiency increase: the more difficult the territory, the higher is the municipal mismanagement. In addition, also the maximum value of inefficiency is present in the mountain class. Of course, it's worth recalling that however two out of nine efficient municipalities belong to the mountain classification.

Table 4.25: DEA1. Descriptive statistics of inefficiency scores in road maintenance and local mobility by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.58	0.19	0.00	0.90
Partially mountain	0.60	0.22	0.00	0.86
Totally mountain	0.76	0.16	0.00	0.97

Figure 4.18: DEA1. Inefficiency scores in road maintenance and local mobility by mountain classes. 2011

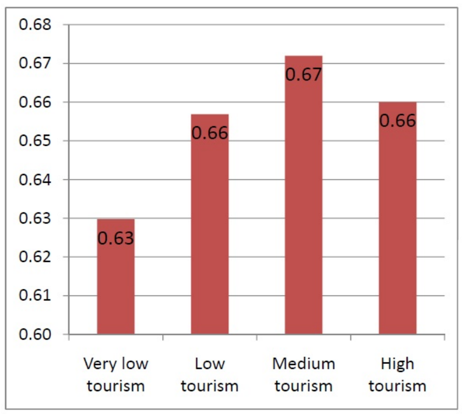


Regarding the municipal classification by tourism classes, Table 4.26 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.19) gives a graphical intuition of the inefficiency distribution. Differently from the other functions the highest level of inefficiency is present in the municipalities with medium level of tourism, while at the same the opposite holds for those municipalities with very low level of tourism. However, it's worth noting that the differences in the inefficiency scores among different classes is not so relevant. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. In this case, as in the previous functions, it's not possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases.

Table 4.26: DEA1. Descriptive statistics of inefficiency scores in road maintenance and local mobility by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.63	0.21	0.00	0.92
Low tourism	0.66	0.20	0.00	0.90
Medium tourism	0.67	0.19	0.00	0.91
High tourism	0.66	0.22	0.00	0.97

Figure 4.19: DEA1. Inefficiency scores in road maintenance and local mobility by tourism classes. 2011

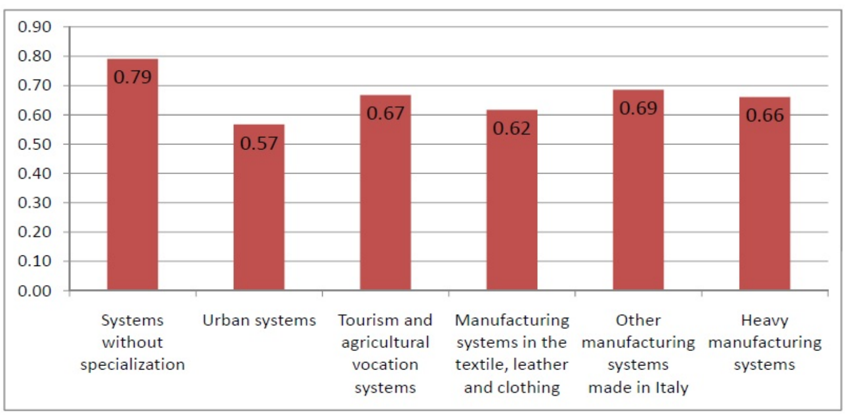


Finally, Table 4.27 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.20) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present in the systems without specialization, while the opposite holds for the urban systems, as in the function for the social services. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class, except within the municipalities belonging to the systems without specialization.

Table 4.27: DEA1. Descriptive statistics of inefficiency scores in road maintenance and local mobility by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.79	0.09	0.58	0.92
Urban systems	0.57	0.23	0.00	0.89
Tourism and agricultural vocation systems	0.67	0.20	0.00	0.97
Manufacturing systems in the textile, leather and clothing	0.62	0.21	0.00	0.89
Other manufacturing systems made in Italy	0.69	0.16	0.00	0.91
Heavy manufacturing systems	0.66	0.22	0.00	0.92

Figure 4.20: DEA1. Inefficiency scores in road maintenance and local mobility by local labour system classes. 2011



Local police

Even in this case, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for local police provides services regarding the municipal police, the commercial police and the administrative police , according to the municipal balance sheet items of expenditure. In addition, it's worth remembering that the production scale problems are not taken into account in the considered function.

Table 4.28 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.57, so it's a higher value than in the road maintenance and local mobility case and implies that theoretically the 57 % of the expenditure spent for this function could be reduced. In addition, in this case, the distribution of the estimated level of inefficiency is very symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.28: DEA1. Descriptive statistics of inefficiency scores in local police. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.57	0.24	0.00	0.99	0.24	0.44	0.58	0.74	0.88

Table 4.29 describes the municipalities that results to be efficient according to the VRS analysis. Just five out of twelve municipalities belong to the highest dimensional classes and seven out of twelve have a low level of tourism. Regarding the function for road maintenance and local mobility, four out of twelve efficient municipalities belong to the non-mountain classification and five out of twelve belong to the partially mountain classification. It's interesting to note that four of the efficient municipalities in this function are the same considered as efficient in the previous function. In addition, even in this case, it's worth noting the number of times each efficient municipality is a peer for the others, because a particular situation applies: from one hand for the 46 % of times the five efficient municipalities under three thousands of inhabitants are the peer for the smallest municipalities, on the other hand the 23 % of times the peer for the other municipalities is basically Capannori, that belongs to the dimensional class between twenty and sixty thousands of inhabitants.

Since in this case the results are obtained through a "one input-two output" DEA model, the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities is not presented.

Table 4.29: DEA1. Details of efficient municipalities in local police. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Fosciandora	From 0 to 1.000 inhab.	Totally mountain	Low tourism	38	5%
Vergemoli	From 0 to 1.000 inhab.	Totally mountain	Very low tourism	20	3%
San Godenzo	From 1.001 to 2.000 inhab.	Totally mountain	Medium tourism	35	5%
Chiusdino	From 2.001 to 3.000 inhab.	Partially mountain	High tourism	172	24%
Murlo	From 2.001 to 3.000 inhab.	Non-mountain	High tourism	65	9%
Capraia e Limite	From 5.001 to 10.000 inhab.	Non-mountain	Low tourism	127	18%
Civitella in Val di Chiana	From 5.001 to 10.000 inhab.	Non-mountain	Low tourism	73	10%
Greve in Chianti	From 10.001 to 20.000 inhab.	Partially mountain	Medium tourism	4	1%
Capannori	From 20.001 to 60.000 inhab.	Partially mountain	Very low tourism	161	23%
Massa	Over 60.000 inhab.	Partially mountain	Medium tourism	10	1%
Arezzo	Over 60.000 inhab.	Partially mountain	Low tourism	4	1%
Prato	Over 60.000 inhab.	Non-mountain	Low tourism	4	1%
				713	100%

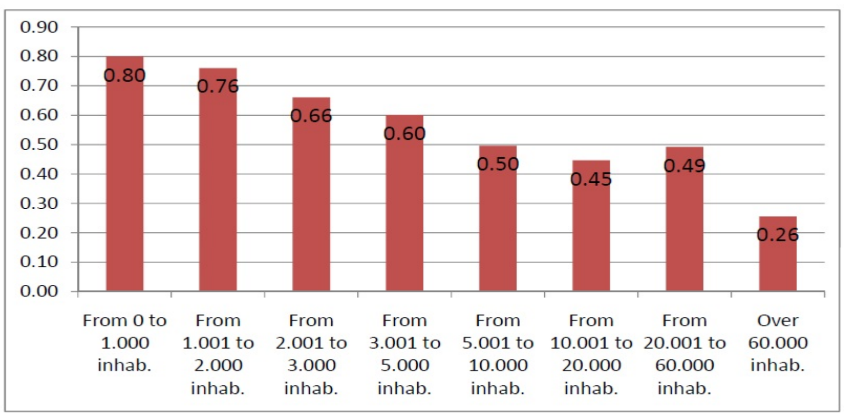
As the same, in the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.30 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.21) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a quite decreasing form and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is quite high for all the classes except the dimensional class ranging from three and five thousands of inhabitants: this could suggest that in average there is a great variability of inefficiencies in each classes.

Table 4.30: DEA1. Descriptive statistics of inefficiency scores in local police by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.80	0.31	0.00	0.99
From 1.001 to 2.000 inhab.	0.76	0.22	0.00	0.96
From 2.001 to 3.000 inhab.	0.66	0.23	0.00	0.94
From 3.001 to 5.000 inhab.	0.60	0.13	0.16	0.80
From 5.001 to 10.000 inhab.	0.50	0.19	0.00	0.90
From 10.001 to 20.000 inhab.	0.45	0.17	0.00	0.80
From 20.001 to 60.000 inhab.	0.49	0.18	0.00	0.79
Over 60.000 inhab.	0.26	0.24	0.00	0.68

Figure 4.21: DEA1. Inefficiency scores in local police by dimensional classes. 2011

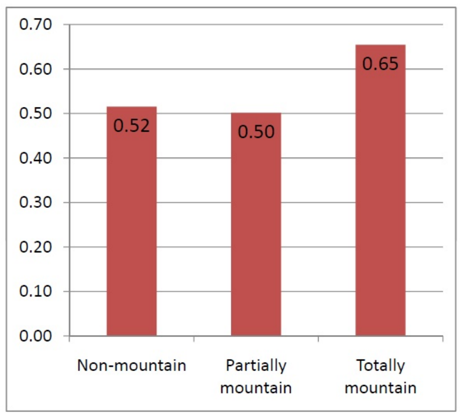


Regarding the mountain features, Table 4.31 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.22) gives a graphical intuition of the inefficiency distribution. They both show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficulties related to the territory makes more inefficient the provision of the services related to the local police function. Of course, it's worth recalling that however three out of twelve efficient municipalities belong to the mountain classification.

Table 4.31: DEA1. Descriptive statistics of inefficiency scores in local police by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.52	0.22	0.00	0.98
Partially mountain	0.50	0.25	0.00	0.88
Totally mountain	0.65	0.23	0.00	0.99

Figure 4.22: DEA1. Inefficiency scores in local police by mountain classes. 2011

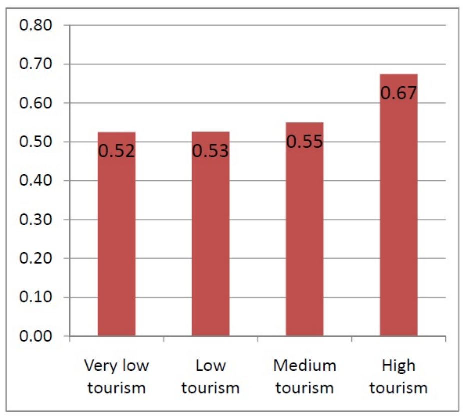


Regarding the municipal classification by tourism classes, Table 4.32 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.23) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. To conclude, it's possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases.

Table 4.32: DEA1. Descriptive statistics of inefficiency scores in local police by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.52	0.24	0.00	0.98
Low tourism	0.53	0.24	0.00	0.98
Medium tourism	0.55	0.22	0.00	0.96
High tourism	0.67	0.22	0.00	0.99

Figure 4.23: DEA1. Inefficiency scores in local police by tourist classes. 2011

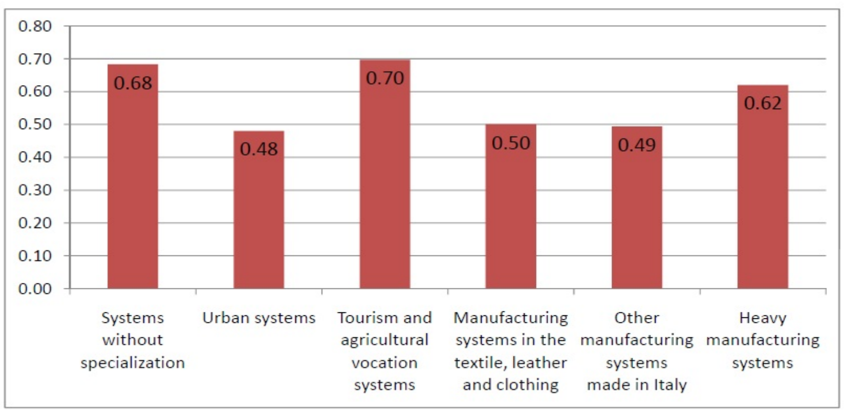


Finally, Table 4.33 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.24) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present in the tourism and agricultural vocation systems, while the opposite holds for the urban systems. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class.

Table 4.33: DEA1. Descriptive statistics of inefficiency scores in local police by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.68	0.22	0.00	0.98
Urban systems	0.48	0.23	0.00	0.81
Tourism and agricultural vocation systems	0.70	0.21	0.05	0.99
Manufacturing systems in the textile, leather and clothing	0.50	0.21	0.00	0.95
Other manufacturing systems made in Italy	0.49	0.25	0.00	0.95
Heavy manufacturing systems	0.62	0.21	0.00	0.98

Figure 4.24: DEA1. Inefficiency scores in local police by local labour system classes. 2011



Average inefficiency among functions

In this part, the average inefficiency results among Tuscan municipalities is described, considering the average municipal behaviour among the different functions. Just to recall it, these average inefficiency scores are obtained as the weighted average among each function efficiency scores according to the different weight they cover in the total expenditure (see section 3.2).

Obviously, the VRS DEA scores are used to compute the average inefficiency: so, in this context, the average waste of resources per function due to municipal mismanagement is evaluated.

Table 4.34 presents the statistics of the average inefficiency scores of the VRS analysis. The mean of the average inefficiency scores is equal to 0.57. This implies that considering the weight of each function expenditure, in average a Tuscan municipalities could not waste the 57% of the resources. In this case, the distribution of the level of inefficiencies is symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the min and max values and especially to the percentiles, it's possible to see that the inefficiency scores are more concentrated than in the singular case. This could be explained by the fact that taking into consideration all the function together the difference among municipalities efficiency becomes smaller rather than function by function.

Table 4.34: DEA1. Descriptive statistics of average inefficiency scores among functions. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.57	0.14	0.00	0.89	0.39	0.47	0.58	0.66	0.73

Since, as already seen, the municipal inefficiency is strongly influenced by the characteristics of the municipalities themselves, a more detailed analysis of the inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

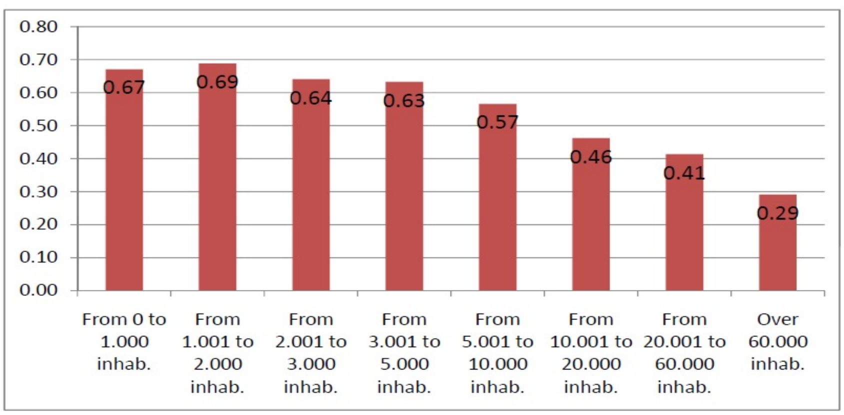
Table 4.35 presents the descriptive statistics of the average inefficiency scores by dimensional classes and the related graph (Figure 4.25) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional class. In this average analysis, it's possible to observe a reverse "U-shaped form" of the inefficiency scores distribution. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. More important, just in the biggest dimensional class there is zero as a minimum value of inefficiency: just in this class there is a complete efficient municipality, according to this analysis and it is Prato.

As already explained, it's useful to take into account that the resident population increases as the total resident population increases. The inefficiency results suggest that in the provision of the services a municipality works better with a larger catchment area than a smaller.

Table 4.35: DEA1. Descriptive statistics of average inefficiency scores among functions by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.67	0.10	0.49	0.88
From 1.001 to 2.000 inhab.	0.69	0.07	0.57	0.82
From 2.001 to 3.000 inhab.	0.64	0.06	0.49	0.80
From 3.001 to 5.000 inhab.	0.63	0.09	0.46	0.89
From 5.001 to 10.000 inhab.	0.57	0.10	0.33	0.86
From 10.001 to 20.000 inhab.	0.46	0.09	0.29	0.68
From 20.001 to 60.000 inhab.	0.41	0.12	0.21	0.61
Over 60.000 inhab.	0.29	0.16	0.00	0.55

Figure 4.25: DEA1. Average inefficiency scores among functions by dimensional classes. 2011

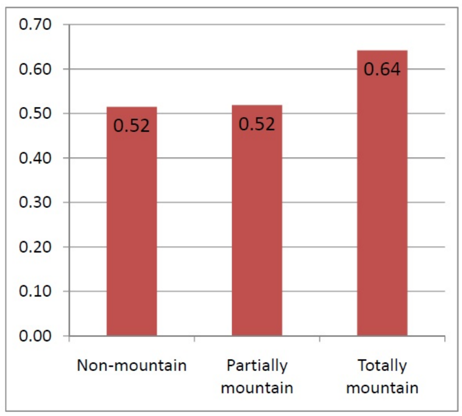


Considering also the municipal classification by mountain features, Table 4.36 presents the descriptive statistics of the average inefficiency scores and the related graph (Figure 4.26) gives a graphical intuition of the inefficiency distribution: they both show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory and the smallest presence of resident population make more inefficient the provision of the services.

Table 4.36: DEA1. Descriptive statistics of average inefficiency scores among functions by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.52	0.15	0.00	0.89
Partially mountain	0.52	0.14	0.10	0.78
Totally mountain	0.64	0.09	0.39	0.88

Figure 4.26: DEA1. Average inefficiency scores among functions by mountain classes. 2011

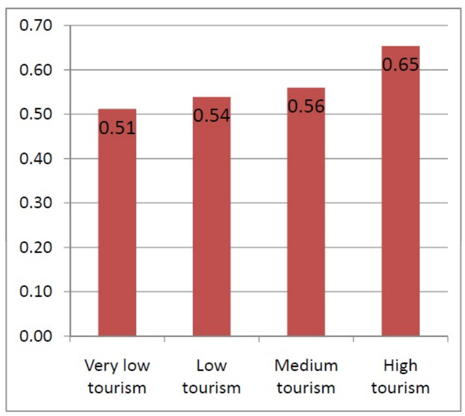


Regarding the municipal classification by tourism classes, Table 4.37 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.27) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. In general, it's possible to observe that considering an increasing level of tourism, the average level of inefficiency systematically increases. Certainly, a clarification must be recalled. Considering the tourism presence there is no account of the vacancy properties owners, that certainly represent a non-negligible part of the catchment area of the municipal services in general that surely would lower the inefficiency scores. Anyhow, especially the tourist municipalities subject to strong seasonality certainly face higher costs than others (e.g. this is the case of the sea places).

Table 4.37: DEA1. Descriptive statistics of average inefficiency scores among functions by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.51	0.13	0.21	0.81
Low tourism	0.54	0.15	0.00	0.80
Medium tourism	0.56	0.12	0.23	0.78
High tourism	0.65	0.11	0.39	0.89

Figure 4.27: DEA1. Average inefficiency scores among functions by tourism classes. 2011



Finally, Table 4.38 presents the descriptive statistics of the average inefficiency scores and the related graph (Figure 4.28) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. Consistently with what already said, the highest level of inefficiency is present in the tourism and agricultural vocation systems, while the opposite holds for the manufacturing systems in the textile, leather and clothing. In relation to this last mentioned class, it's worth noting that the obtained most efficient municipality, Prato, belongs precisely to it. Moreover, almost all the other capital provinces result to be the most efficient municipalities: this can be seen also graphically from Figure 4.29 [3]. This evidence makes stronger the reasoning about the municipal size: the bigger is the municipal catchment area, the lower the average cost in the provision of municipal services; moreover, it's worth pointing out that this lower cost makes possible to provide more differentiated and complex services. In addition, graphically it's possible to see also

[3]Figure 4.29 is obtained by "Stata" program.

that the main municipal efficient areas correspond to those areas already put in evidence in section 1.1 in Figure 1.4, that are the areas with the lowest per capita expenditure (and the opposite holds for the areas with the highest per capita expenditure): so, for example, the color corresponding to the Firenze plain in the per capita expenditure figure shows exactly the same behavior of the efficiency level picture (respectively white and red). So, without loss of generalization, from the obtained evidences, it can be said that the average efficiency behavior of a municipality can be inferred in a preliminary way by the total per capita expenditure trend.

Table 4.38: DEA1. Descriptive statistics of average inefficiency scores among functions by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.62	0.07	0.49	0.77
Urban systems	0.53	0.13	0.23	0.81
Tourism and agricultural vocation systems	0.63	0.14	0.21	0.88
Manufacturing systems in the textile, leather and clothing	0.51	0.15	0.00	0.89
Other manufacturing systems made in Italy	0.55	0.15	0.10	0.86
Heavy manufacturing systems	0.60	0.12	0.29	0.86

Figure 4.28: DEA1. Average inefficiency scores among functions by local labour system classes. 2011

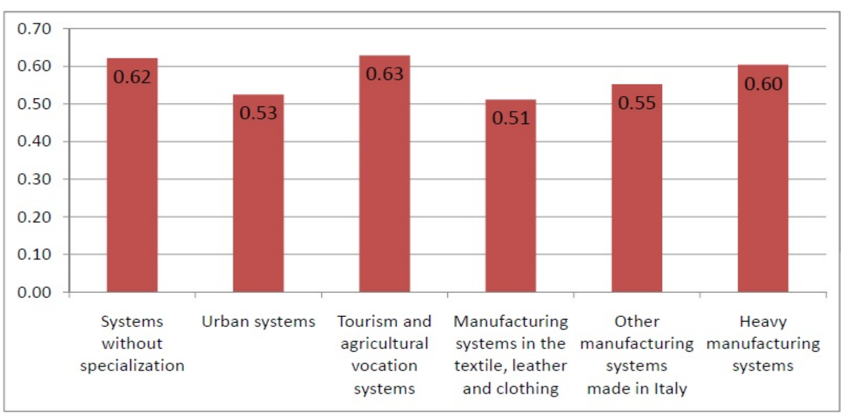
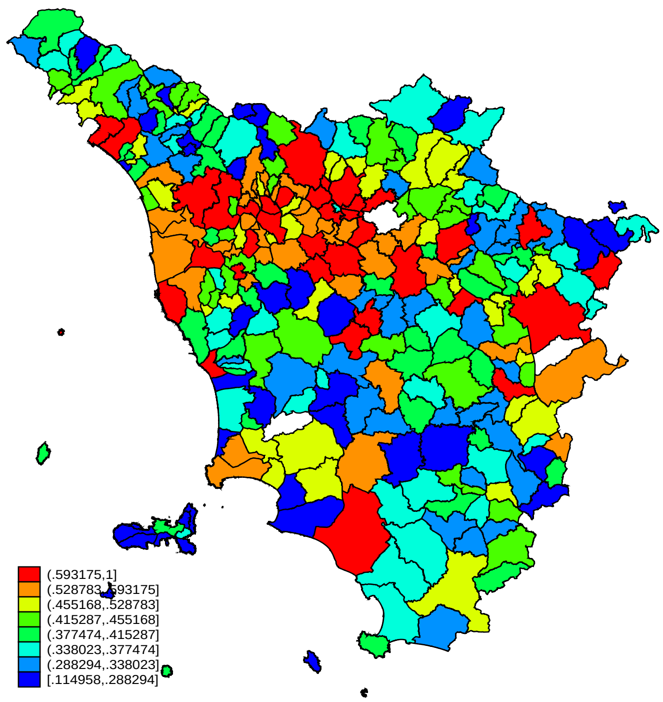


Figure 4.29: DEA1. Geographical distribution of the average efficiency scores. 2011



In order to conclude this section, it's interesting to go into details about a last aspect: the comparison between the average inefficiency scores computed for each municipality considering its own expenditure composition and the average inefficiency scores computed considering the average Tuscan expenditure composition. From this comparisons, it could be possible to make some considerations about the effect on the average inefficiency of the municipal expenditure allocation among the different functions.

So, firstly the descriptive statistics of these new average inefficiency scores are presented in Table 4.39. As evident, the average inefficiency computed through these different weights is higher than in the previous case: this should suggest that in average, if the expenditure composition was different and in line with the Tuscan average, the level of average efficiency would be higher. Of course, also the percentiles denotes these lower scores.

Table 4.39: DEA1. Descriptive statistics of average inefficiency scores among functions (Tuscan weights). 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.54	0.14	0.00	0.86	0.36	0.45	0.56	0.64	0.70

Finally, in order to go deeply in the differences among municipal performances, municipalities have been divided according with two features. The first regards the relative level of efficiency: the difference between each average inefficiency score (computed considering its own expenditure composition) and its median (that, as already said, quite coincides to the mean) is computed, so to have the relative efficiency of each municipality in comparison to all the others. The second feature regards the expenditure composition: the difference between each average inefficiency score computed considering its own expenditure composition and that one computed considering the Tuscan expenditure composition is calculated. If this difference is positive, this means that the municipality has chosen a composition that allows it to achieve a better level of average efficiency rather than in the other composition; in the other case (i.e. if the difference is negative), this means that the municipality has chosen a composition that brings it to achieve a worse level of efficiency.

These two features are put in relationship in a graphical and intuitive way (Figure 4.30), so to distinguish four groups of municipalities: on the vertical axis there is the relative efficiency, while on the horizontal axis the expenditure composition aspect is considered. So, municipalities are laid out into four quadrants. In the North-East quadrant, there are the municipalities that result more efficient than the median and that have an expenditure composition that allows them to achieve a better level of average efficiency (in the following, this quadrant will be named Efficient-Better quadrant or shortly E-B quadrant). In the North-West quadrant, there are municipalities that result more efficient than the median, but have an expenditure composition that brings them to achieve a worse level of efficiency (in the following, this quadrant will be named Efficient-Worse quadrant or shortly E-W quadrant). In the South-East quadrant, there are the municipalities that result less efficient than the median but that have an expenditure composition that allows them to achieve a better level of average efficiency (in the following, this quadrant will be named Inefficient-Better quadrant or shortly I-B quadrant). In the South-West quadrant, there are municipalities that result less efficient than the median and also have an expenditure composition that brings them to achieve a worse level of efficiency (in the following, this quadrant will be named Efficient-Worse quadrant or shortly E-W quadrant).

So shortly it can be said that the municipalities in the Efficient-Worse and Inefficient-Worse quadrant have possible room of improvement in the efficiency level just changing a little the composition of the expenditure. Certainly, this suggestion should be handle carefully, especially for two reasons: the change in the expenditure brings to a change in the DEA model input, so to modify endogenously the level of the efficiency; secondly, especially for the smallest municipalities there are some binding thresholds of expenditure that cannot be avoided.

Furthermore, the municipalities in the Inefficient-Worse and Inefficient-Better quadrant certainly could improve their level of efficiency at least solving the present mismanagement problems and their causes. So, in conclusion, the Efficient- Better quadrant seems to collect the municipalities that behave better, according to this analysis.

In a synthetic way, Table 4.40 shows the main features of each quadrant according to the dimensional, mountain, tourism and local labour system classes and referring the number of present municipalities (shortly, DMUs).

In the Efficient-Better quadrant, there is the prevalence of municipalities belonging to the class ranging from twenty thousands to sixty thousands of inhabitants; these municipalities are non-mountain places and subject to very low level of tourism. Moreover, the manufacturing systems in the textile, leather and clothing system represents the main class of these municipalities. As evident, these features recall those already presented in the description of the average inefficiency results; so, results are again confirmed.

In the Efficient-Worse quadrant municipalities ranging from five thousands to twenty thousands are prevalent and again the non-mountain feature represents the main characteristic of these municipalities. Moreover, they also belong to the very low tourism class and to the manufacturing systems in the textile, leather and clothing system.

In the Inefficient-Better quadrant, there is the prevalence of a lower dimensional class, that is that one from one to two thousands of inhabitants. Furthermore, these municipalities are totally-mountain places and are subject to a high level of tourism; related to this, there is the prevalence of municipalities that belong to the tourism and agricultural vocation system.

In the end, in the Inefficient-Worse quadrant there are municipalities that belong to the dimensional class ranging from three thousands to five thousands; they are totally mountain places, with high level of tourism and are prevalently heavy manufacturing systems.

Figure 4.30: DEA1. Municipalities representation by relative efficiency and expenditure composition. 2011

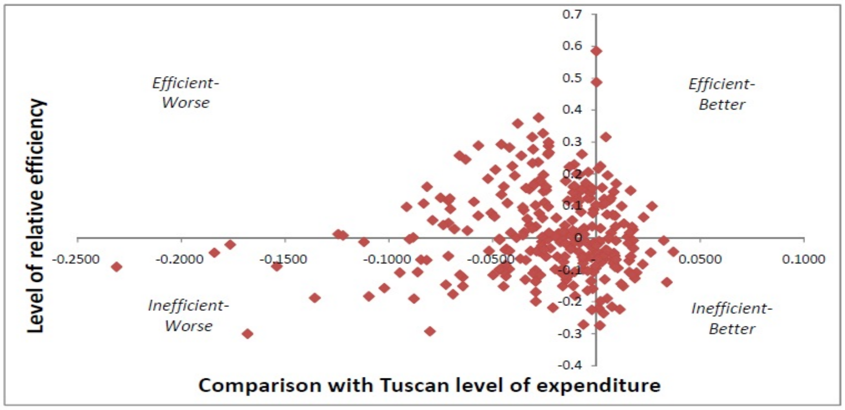


Table 4.40: DEA1. Descriptive statistics of each quadrant. 2011

	Efficient-Better quadrant		Efficient-Worse quadrant		Inefficient-Better quadrant		Inefficient-Worse quadrant		
Dimensional class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
From 0 to 1.000 inhab.	2	7%	1	1%	5	11%	10	10%	18
From 1.001 to 2.000 inhab.	1	3%	3	3%	14	32%	22	22%	40
From 2.001 to 3.000 inhab.	2	7%	3	3%	6	14%	17	17%	28
From 3.001 to 5.000 inhab.	5	17%	10	9%	9	20%	24	24%	48
From 5.001 to 10.000 inhab.	4	14%	34	30%	6	14%	19	19%	63
From 10.001 to 20.000 inhab.	9	31%	34	30%	3	7%	4	4%	50
From 20.001 to 60.000 inhab .	4	14%	20	18%	1	2%	2	2%	27
Over 60.000 inhab.	2	7%	8	7%	0	0%	0	0%	10
TOTAL	29	100%	113	100%	44	100%	98	100%	284
Mountain class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Non-mountain	16	55%	67	59%	15	34%	31	32%	129
Partially mountain	5	17%	23	20%	4	9%	10	10%	42
Totally mountain	8	28%	23	20%	25	57%	57	58%	113
TOTAL	29	100%	113	100%	44	100%	98	100%	284
Tourism class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Very low tourism	14	48%	36	32%	4	9%	17	17%	71
Low tourism	6	21%	33	29%	12	27%	20	20%	71
Medium tourism	7	24%	31	27%	7	16%	26	27%	71
High tourism	2	7%	13	12%	21	48%	35	36%	71
TOTAL	29	100%	113	100%	44	100%	98	100%	284
Local labour system class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Systems without specialization	4	14%	9	8%	4	9%	16	16%	33
Urban systems	2	7%	25	22%	4	9%	12	12%	43
Tourism and agricultural vocation systems	3	10%	8	7%	15	34%	17	17%	43
Manufacturing systems in the textile, leather and clothing	9	31%	41	36%	5	11%	20	20%	75
Other manufacturing systems made in Italy	4	14%	19	17%	5	11%	12	12%	40
Heavy manufacturing systems	7	24%	11	10%	11	25%	21	21%	50
TOTAL	29	100%	113	100%	44	100%	98	100%	284

4.2 DEA 2

In this section, the main results of the second dataset are presented: DEA2 regards all the six fundamental functions but considers the 192 municipalities which still apply TARSU.

As in the previous section, in the following, firstly there are the results of the non-aggregate analysis that makes possible to find the municipal inefficiencies function by function separately. Secondly, the average level of inefficiency is described considering the weight that each function has in the total expenditure, so to have the average overspending for each municipality. Finally, the comparison between the composite indicator obtained by the municipal weight with the indicator obtained by the Tuscan mean weight is considered so to have possible suggestions as room for improvement for the inefficient municipalities.

Certainly, in the description of these different results, there is the attempt to focus on some peculiarities in comparison with the first model results. For more details about DEA 2 results, see Appendix C.

General Administration

As presented in the introduction of this chapter, also in this case for the general administration function, the CRS efficiency results together with the VRS and scale efficiency results are presented, so to understand how the mismanagement and the presence of economies/diseconomies of scale affect the overall technical efficiency.

Table 4.41 presents the overall technical inefficiency scores of the CRS analysis. The mean of the inefficiency scores is equal to 0.50 and implies that theoretically the 50 % of the expenditure spent for this function could be reduced. In addition, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are the same. However, as already said, this level of inefficiency could be affected by the constant return to scale assumption: for this reason, municipal inefficiency is estimated just taking into account the mismanagement component, so in other words just considering the variable returns to scale.

So, Table 4.2 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.43, so it's a lower value than in the CRS case: certainly this implies that among some municipalities there is the presence of economies/diseconomies of scale. In addition, also in this case, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are very similar. However, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.41: DEA2. Descriptive statistics of CRS inefficiency scores in general administration. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.50	0.18	0.00	0.89	0.26	0.37	0.51	0.63	0.74

Table 4.42: DEA2. Descriptive statistics of VRS inefficiency scores in general administration. 2011

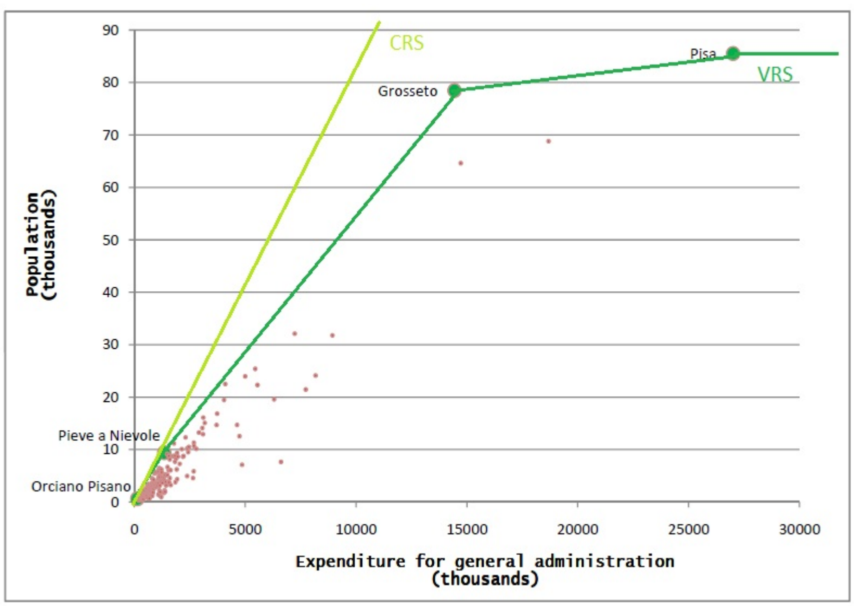
Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.43	0.18	0.00	0.85	0.19	0.30	0.44	0.55	0.66

By construction, in the CRS analysis, just a municipality is completely efficient: Pieve a Nievole. Table 4.43 instead describes the municipalities that results to be efficient according to the VRS analysis. It becomes immediately evident that the non-mountain feature represents a common element of these municipalities. This result is consistent with the evidence obtained from the first model. In addition, half efficient municipalities belong to the highest dimensional classes. It's worth noting the number of times each efficient municipality is a peer for the others: the two smallest efficient municipalities are the peer for the greatest part of the municipalities and this is a relevant information. In fact, the presence still in this dataset of some biggest municipalities could be criticized to represent potential outliers; however, as explained before, it's possible to exclude potential critique. Moreover, Figure 4.31 presents the theoretical production possibility frontier associated with the aforementioned sets of efficient municipalities: also from a graphical point of view it's possible to observe how the two smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case. Also under this aspect, the results stemming from the two analysis are coherent.

Table 4.43: DEA2. Details of inefficient municipalities in general administration. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Orciano Pisano	From 0 to 1.000 inhab.	Non-mountain	Very low tourism	158	43%
Pieve a Nievole	From 5.001 to 10.000 inhab.	Non-mountain	Low tourism	180	49%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	0	0%
Grosseto	Over 60.000 inhab.	Non-mountain	Medium tourism	30	8%
				368	100%

Figure 4.31: DEA2. Theoretical production possibility frontier for general administration. 2011



Even in this case, in order to disentangle the causes that affect the overall technical inefficiency, the level of inefficiency depending on the dimensional classes is observed. Table 4.44 and Table 4.45 present the descriptive statistics of the inefficiency scores respectively for the CRS and the VRS case and the related graph (Figure 4.32) gives a graphical intuition of the two inefficiency distributions. From the comparison between CRS and VRS inefficiency scores, it's possible to observe that in the extreme classes the gap between CRS and VRS scores is higher than in the central classes: the differences between CRS and VRS is to be attributed to the scale inefficiency. For the same reason, the scale inefficiency scores presented graphically (Figure 4.33) also denotes higher scores at the extreme demographical classes. In addition, as described in Table 4.46, the scale inefficiencies for the smallest dimensional classes are related to missing economies of scale, in fact there are observed increasing return to scale; while for the biggest municipalities the scale inefficiency are due to the presence of diseconomies of scale, as the prevalent presence of decreasing returns to scale shows. However, there is a very relevant aspect to underline: even taken into account the presence of scale inefficiencies, the smallest municipalities result to be the most technically inefficient ones. In others words, this implies that these small dimensional classes show technical inefficiency even taking into account that they can produce under variable returns to scale and this inefficiency can be attributed entirely to a bad municipal management. This does not hold for the biggest municipalities. In fact, these municipalities result to be technically inefficient under the global point of view. However, if they are evaluated under variable returns to scale, they result to be the most efficient class: so the main inefficiency problem in their case is related with their too big dimension and actually not to their municipal management. These considerations suggest that at least under 5.000 thousands of inhabitants an aggregation among the smallest municipalities should be promoted in order to reach the missing economies of scale and so to improve the level of efficiency at least under this aspect. So, at least in relation to the general administration function, it is clear that it is not entirely correct to impute all the inefficiency to the municipal management, certainly not responsible for a wrong municipal size. Especially with regard to the small municipalities, the cause of the inefficiency results from the presence of too much small fragmented municipalities. As evident, exactly the same reasoning could be applied on both the set of results. This is an important element to be underlined: in fact, even if in DEA2 there are 92 less municipalities, until now more or less the same reasoning about the ranking among the municipal efficiency level applies.

Table 4.44: DEA2. Descriptive statistics of CRS inefficiency scores in general administration by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.69	0.15	0.36	0.89
From 1.001 to 2.000 inhab.	0.63	0.11	0.35	0.85
From 2.001 to 3.000 inhab.	0.52	0.12	0.19	0.77
From 3.001 to 5.000 inhab.	0.49	0.15	0.19	0.75
From 5.001 to 10.000 inhab.	0.36	0.18	0.00	0.83
From 10.001 to 20.000 inhab.	0.37	0.12	0.11	0.62
From 20.001 to 60.000 inhab.	0.43	0.14	0.21	0.60
Over 60.000 inhab.	0.40	0.14	0.22	0.54

Table 4.45: DEA2. Descriptive statistics of VRS inefficiency scores in general administration by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.49	0.23	0.00	0.85
From 1.001 to 2.000 inhab.	0.54	0.14	0.19	0.81
From 2.001 to 3.000 inhab.	0.46	0.14	0.08	0.74
From 3.001 to 5.000 inhab.	0.45	0.16	0.16	0.74
From 5.001 to 10.000 inhab.	0.35	0.19	0.00	0.83
From 10.001 to 20.000 inhab.	0.32	0.13	0.06	0.59
From 20.001 to 60.000 inhab.	0.32	0.16	0.07	0.53
Over 60.000 inhab.	0.13	0.16	0.00	0.33

Figure 4.32: DEA2. Inefficiency scores in general administration by dimensional classes. 2011

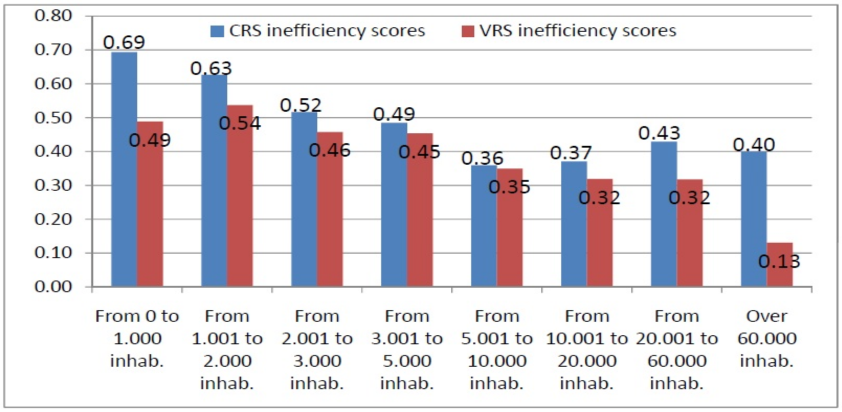
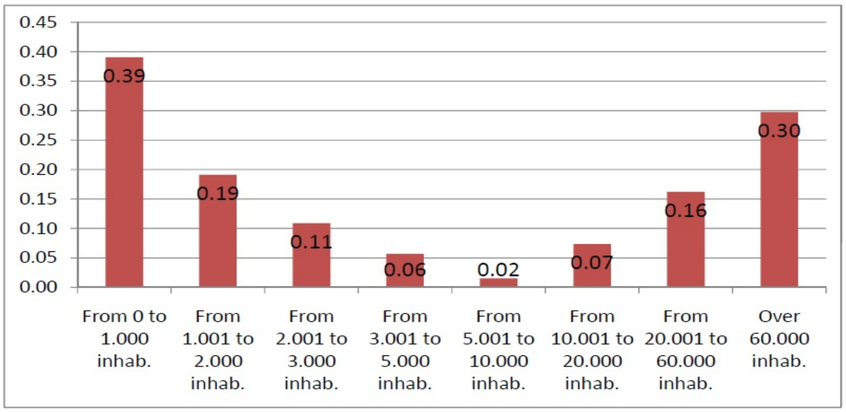


Table 4.46: DEA2. Descriptive statistics of scale inefficiency scores in general administration by dimensional classes. 2011

Dimensional class	Mean	Std. dev.	Prevalent RTS
From 0 to 1.000 inhab.	0.39	0.12	irts
From 1.001 to 2.000 inhab.	0.19	0.04	irts
From 2.001 to 3.000 inhab.	0.11	0.02	irts
From 3.001 to 5.000 inhab.	0.06	0.01	irts
From 5.001 to 10.000 inhab.	0.02	0.01	mixed
From 10.001 to 20.000 inhab.	0.07	0.04	drts
From 20.001 to 60.000 inhab.	0.16	0.01	drts
Over 60.000 inhab.	0.30	0.16	drts

Figure 4.33: DEA2. Scale inefficiency scores in general administration by dimensional classes. 2011



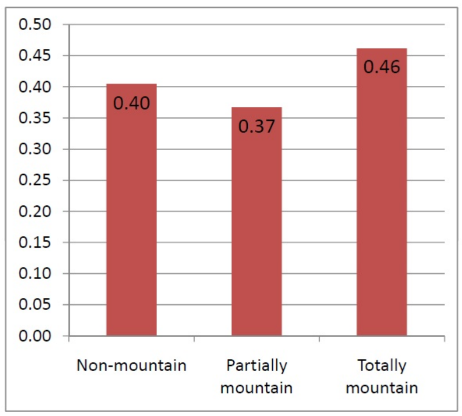
Since, as already seen, the municipal inefficiency is strongly influenced by the characteristics of the municipalities themselves, a more detailed analysis of the inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by mountain, tourism and local labour system classes), and in particular just the VRS inefficiency scores are considered for the already explained reasons: so, the level of municipal mismanagement is under attention.

Table 4.47 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.34) gives a graphical intuition of the inefficiency distribution considering the municipal classification by mountain classes. The highest level of inefficiency is present in the totally mountain classes, while the opposite holds for the partially mountain classes (differently from DEA1 results). Moreover, it's worth noting that, as in DEA1 results, the partially mountain class has the lowest maximum value of inefficiency, while the totally mountain class has the highest value of maximum inefficiency. The minimum level of inefficiency is equal to zero just in the non-mountain class, as already found in the general features of the completely efficient municipalities: however it's worth noting that in the non-mountain there is the highest value of standard deviation, meaning high level of variability within this class. As already justified, certainly the local governments of the totally mountain places have to face more difficulties to accomplish their services for all the citizens and can be influenced in their municipal management.

Table 4.47: DEA2. Descriptive statistics of inefficiency scores in general administration by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.40	0.20	0.00	0.83
Partially mountain	0.37	0.17	0.07	0.66
Totally mountain	0.46	0.17	0.08	0.85

Figure 4.34: DEA2. Inefficiency scores in general administration by mountain classes. 2011

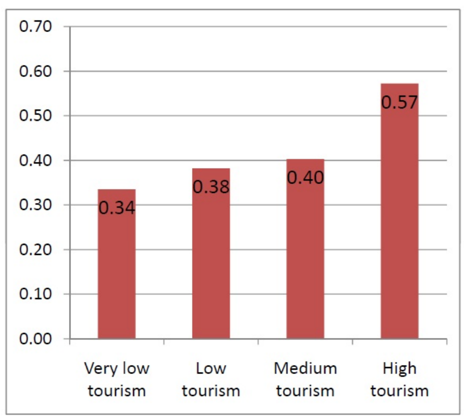


Regarding the municipal classification by tourism classes, Table 4.48 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.35) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. Moreover, it's worth noting that the municipalities with high level of tourism have the highest level of maximum inefficiency. Differently from DEA1 results, the minimum level of inefficiency is equal to zero in all the classes. To conclude, as in DEA1 results, it's possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. So, the higher is the level of tourism for a municipality, the higher is the level of mismanagement. As explained in the previous section, also in this case probably this high score of inefficiency for the municipalities subject to high tourism level should be lower if the average annual tourism presence and also vacancy properties (and its resident) would be taken into account. In fact, the general administration services are addressed to all these users, that are the resident population, but also the tourists and the owners of vacancy properties: probably, this level of inefficiency would be mitigated.

Table 4.48: DEA2. Descriptive statistics of inefficiency scores in general administration by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.34	0.15	0.00	0.78
Low tourism	0.38	0.18	0.00	0.73
Medium tourism	0.40	0.16	0.00	0.74
High tourism	0.57	0.15	0.00	0.85

Figure 4.35: DEA2. Inefficiency scores in general administration by tourism classes. 2011

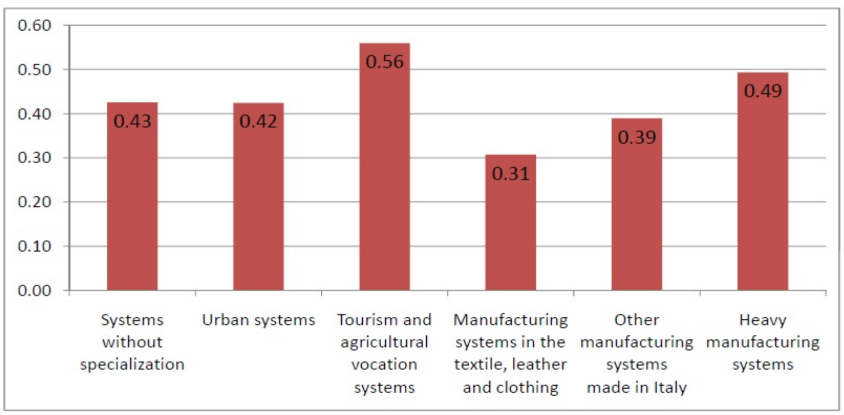


Finally, Table 4.49 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.36) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present, consistently with what said earlier, in the tourism and agricultural vocation systems, while the opposite holds for the manufacturing systems in the textile, leather and clothing: even in this case these results are consistent with DEA1 results. However, in this case there is no the evidence that all the manufacturing systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): the efficient municipalities belong to the urban systems, to the manufacturing systems in the textile, leather and clothing to heavy manufacturing systems and also to tourism and agricultural vocation systems.

Table 4.49: DEA2. Descriptive statistics of inefficiency scores in general administration by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.43	0.15	0.08	0.74
Urban systems	0.42	0.17	0.00	0.79
Tourism and agricultural vocation systems	0.56	0.16	0.00	0.81
Manufacturing systems in the textile, leather and clothing	0.31	0.15	0.00	0.78
Other manufacturing systems made in Italy	0.39	0.20	0.11	0.85
Heavy manufacturing systems	0.49	0.16	0.00	0.83

Figure 4.36: DEA2. Inefficiency scores in general administration by local labour system classes. 2011



Education

In this section, the function for the educational services is under analysis. It's worth remembering that the production scale problems are not taken into account in the considered function: so, there is the focus just on the mismanagement of the local municipalities in order to explain the degree of inefficiency.

Table 4.50 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.78, so it's quite higher than in the DEA1 model results. Also in this case, the distribution of the estimated level of inefficiency is not symmetric: in fact, the mean and the median are totally different. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.50: DEA2. Descriptive statistics of inefficiency scores in educational services. 2011

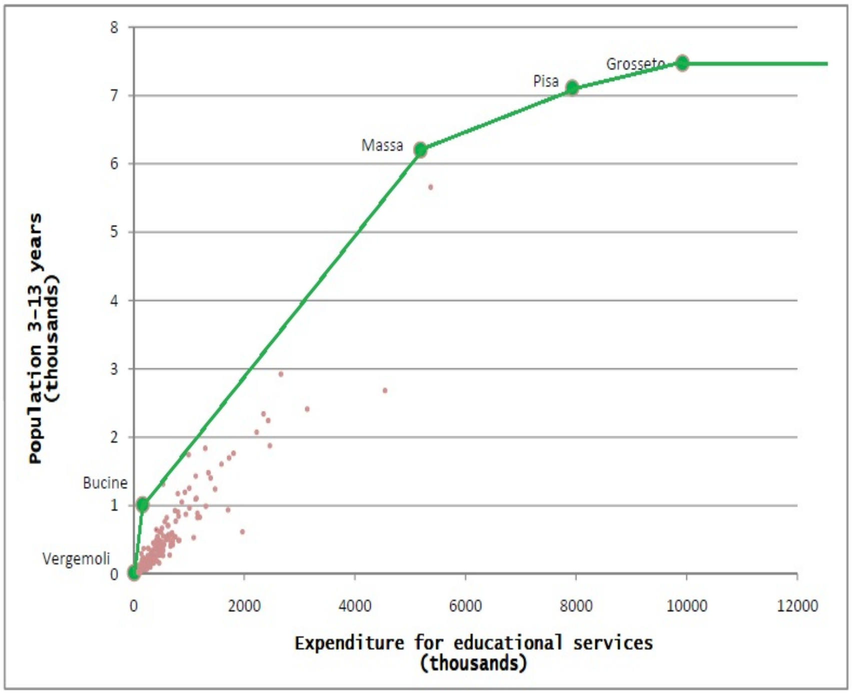
Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.78	0.19	0.00	0.95	0.58	0.79	0.85	0.88	0.90

Table 4.51 describes the municipalities that results to be efficient according to the VRS analysis. Three out of five municipalities belong to the highest dimensional classes. Differently from the DEA1 results, just one out of five has a very low level of tourism. Again, it's worth noting the number of times each efficient municipality is a peer for the others: : the two smallest efficient municipalities are the peer for the greatest part of the municipalities and in particular they are exactly the same municipalities as in DEA1 results. In addition, it's worth pointing out that the biggest efficient municipalities have zero as the absolute and percentage number of times they are referred as a peer: this implies that these two municipalities are on the frontier and there are not other municipalities to be compared with them. Graphically, Figure 4.37 presents the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities: it's possible to observe both how the two smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case and that there are no other municipalities to be compared with the two biggest efficient municipalities.

Table 4.51: DEA2. Details of inefficient municipalities in educational services. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Vergemoli	From 0 to 1.000 inhab.	Totally mountain	Very low tourism	163	44%
Bucine	From 10.001 to 20.000 inhab.	Non-mountain	Medium tourism	186	50%
Massa	Over 60.000 inhab.	Partially mountain	Medium tourism	24	6%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	0	0%
Grosseto	Over 60.000 inhab.	Non-mountain	Medium tourism	0	0%
				373	100%

Figure 4.37: DEA2. Theoretical production possibility frontier for educational services. 2011



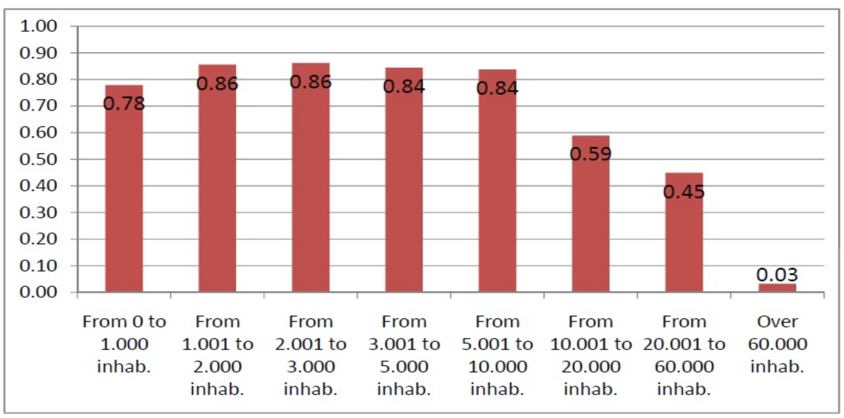
As the same, in the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.52 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.38) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a reverse "U-shaped form" and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that, as for DEA1 results, the standard deviation is very low for the central classes, but also for the last class: this could suggest that in average there is the same behavior among these classes. In order to explain these outcomes, it's useful to take into account that the school age population increases as the total resident population increases. As before, the inefficiency results suggest that in the provision of the educational services a municipality works better with a larger catchment area than a smaller: the lower the municipal size, the higher the mismanagement in the provision of educational services.

Table 4.52: DEA2. Descriptive statistics of inefficiency scores in educational services by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.78	0.21	0.00	0.92
From 1.001 to 2.000 inhab.	0.86	0.05	0.73	0.93
From 2.001 to 3.000 inhab.	0.86	0.05	0.76	0.93
From 3.001 to 5.000 inhab.	0.84	0.06	0.62	0.92
From 5.001 to 10.000 inhab.	0.84	0.05	0.74	0.95
From 10.001 to 20.000 inhab.	0.59	0.27	0.00	0.91
From 20.001 to 60.000 inhab.	0.45	0.13	0.25	0.61
Over 60.000 inhab.	0.03	0.07	0.00	0.13

Figure 4.38: DEA2. Inefficiency scores in educational services by dimensional classes. 2011

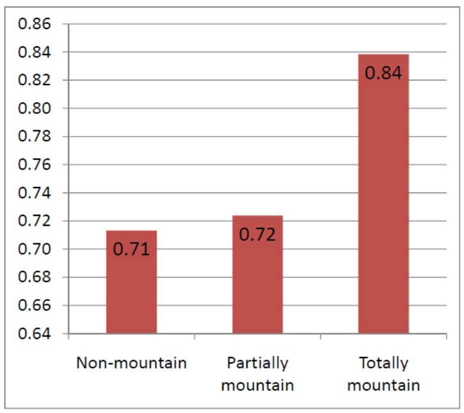


Obviously, the same reasoning applies also considering the municipal classification by mountain features. In fact, both Table 4.53 that presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.39), that gives a graphical intuition of the inefficiency distribution, show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory and the smallest presence of school age people make more inefficient the provision of the educational services.

Table 4.53: DEA2. Descriptive statistics of inefficiency scores in educational services by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.71	0.24	0.00	0.95
Partially mountain	0.72	0.26	0.00	0.91
Totally mountain	0.84	0.11	0.00	0.93

Figure 4.39: DEA2. Inefficiency scores in educational services by mountain classes. 2011

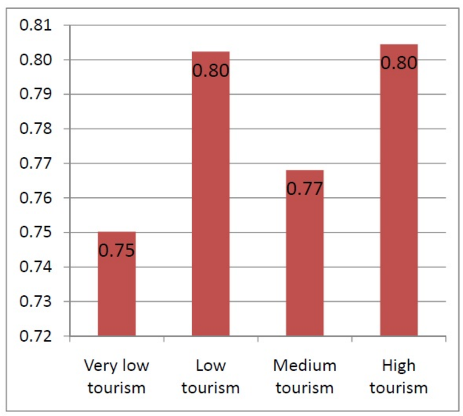


Regarding the municipal classification by tourism classes, Table 4.54 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.40) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities both with low (differently from DEA1 results) and with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. The minimum level of inefficiency is not equal to zero just in the municipalities with low level of tourism. To conclude, differently from DEA1 results, it's possible to observe that considering an increasing level of tourism, there is no a systematical level of increasing inefficiency. Certainly, a clarification is necessary. In fact, in this case both the municipalities with low level and high level of tourism present the lowest average presence of school-age population and so the already presented reasoning still applies: the greater the catchment area, the lowest is the mismanagement.

Table 4.54: DEA2. Descriptive statistics of inefficiency scores in educational services by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.75	0.22	0.00	0.92
Low tourism	0.80	0.14	0.13	0.92
Medium tourism	0.77	0.22	0.00	0.93
High tourism	0.80	0.17	0.00	0.95

Figure 4.40: DEA2. Inefficiency scores in educational services by tourism classes. 2011

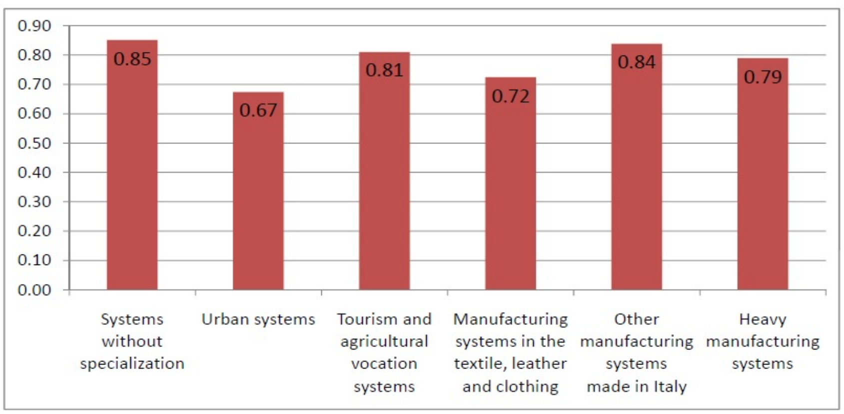


Finally, Table 4.55 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.41) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. As for DEA1, the highest level of inefficiency is present in the systems without specialization, while the opposite holds for the urban systems. Furthermore, it's worth noting that just two typologies of systems have a very low value of standard deviation: however, all the other classes have higher value of standard deviation, meaning high level of variability.

Table 4.55: DEA2. Descriptive statistics of inefficiency scores in educational services by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.85	0.05	0.73	0.92
Urban systems	0.67	0.31	0.00	0.91
Tourism and agricultural vocation systems	0.81	0.17	0.00	0.92
Manufacturing systems in the textile, leather and clothing	0.72	0.23	0.00	0.93
Other manufacturing systems made in Italy	0.84	0.04	0.77	0.93
Heavy manufacturing systems	0.79	0.18	0.00	0.95

Figure 4.41: DEA2. Inefficiency scores in educational services by local labour system classes. 2011



Social services

In this part, the obtained efficiency results for the social services function are presented. As in the previous function, it's worth recalling that the production scale problems are not taken into account in the considered function: so, the inefficiency scores denote the level of municipal mismanagement regarding this function.

Table 4.56 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.59, so it's a lower value than in the educational services case and implies that theoretically the 59 % of the expenditure spent for this function could be reduced. As evident, this mean is higher than the DEA1 mean result. In addition, in this case, the distribution of the estimated level of inefficiency is not so symmetric, differently from DEA1 results: in fact, the mean and the median are not similar. As the same instead, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.56: DEA2. Descriptive statistics of inefficiency scores in social services. 2011

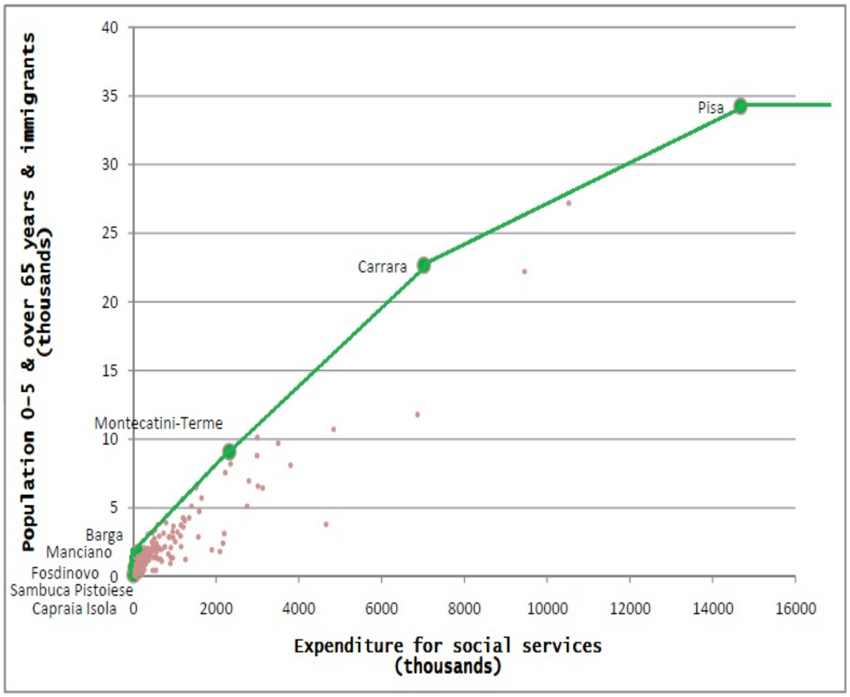
Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.59	0.24	0.00	0.96	0.19	0.49	0.64	0.76	0.84

Table 4.57 describes the municipalities that results to be efficient according to the VRS analysis. It's worth pointing out that for the lowest dimensional classes, the efficient municipalities are the same found in DEA1 results. Moreover, it's worth noting that the biggest efficient municipality has zero as the percentage number of times it is referred as a peer: this implies that Pisa is on the frontier and there are not other municipalities to be compared with it, as already seen in the previous function. This can be seen also from the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities presented in Figure 4.42: in addition, from a graphical point of view it's possible to observe how the smallest efficient municipalities are the peer for the greatest part of the municipalities in the VRS case. In fact, the 69 % of times the peer for the greatest part of municipalities are the four efficient municipalities under ten thousands of inhabitants. Moreover, three out of eight municipalities belong to the highest dimensional classes and just three out of eight have a low level of tourism (differently from DEA1 results). As in DEA1 results, five out of eight efficient municipalities belong to the mountain class.

Table 4.57: DEA2. Details of inefficient municipalities in social services. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Capraia Isola	From 0 to 1.000 inhab.	Totally mountain	High tourism	47	13%
Sambuca Pistoiese	From 1.001 to 2.000 inhab.	Totally mountain	Low tourism	117	32%
Fosdinovo	From 3.001 to 5.000 inhab.	Totally mountain	Very low tourism	102	28%
Manciano	From 5.001 to 10.000 inhab.	Totally mountain	High tourism	42	11%
Barga	From 10.001 to 20.000 inhab.	Totally mountain	Medium tourism	29	8%
Montecatini-Terme	From 20.001 to 60.000 inhab.	Non-mountain	High tourism	23	6%
Carrara	Over 60.000 inhab.	Partially mountain	Very low tourism	6	2%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	1	0%
				367	100%

Figure 4.42: DEA2. Theorical production possibility frontier for social services. 2011



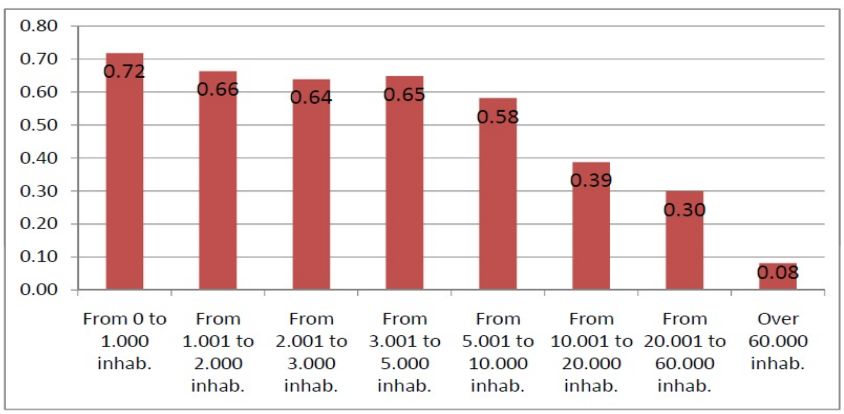
As usual, in the following a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.58 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.43) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a decreasing form and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. As before, in order to explain these outcomes, it's useful to take into account that the target population increases as the total resident population increases. The inefficiency results suggest that in the provision of the social services a municipality works better with a larger catchment area than a smaller.

Table 4.58: DEA2. Descriptive statistics of inefficiency scores in social services by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.72	0.22	0.00	0.93
From 1.001 to 2.000 inhab.	0.66	0.19	0.00	0.96
From 2.001 to 3.000 inhab.	0.64	0.14	0.24	0.89
From 3.001 to 5.000 inhab.	0.65	0.22	0.00	0.93
From 5.001 to 10.000 inhab.	0.58	0.23	0.00	0.89
From 10.001 to 20.000 inhab.	0.39	0.24	0.00	0.88
From 20.001 to 60.000 inhab.	0.30	0.19	0.00	0.53
Over 60.000 inhab.	0.08	0.13	0.00	0.28

Figure 4.43: DEA2. Inefficiency scores in social services by dimensional classes. 2011

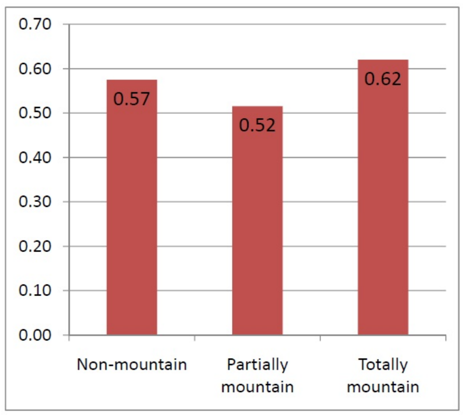


The same reasoning applies also considering the municipal classification by mountain features. In fact, both Table 4.59 that presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.44), that gives a graphical intuition of the inefficiency distribution, show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory and the smallest presence of the involved catchment area make more inefficient the provision of the social services. Of course, it's worth recalling that however five out of eight efficient municipalities belong to the mountain classification.

Table 4.59: DEA2. Descriptive statistics of inefficiency scores in social services by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.57	0.24	0.00	0.93
Partially mountain	0.52	0.27	0.00	0.93
Totally mountain	0.62	0.23	0.00	0.96

Figure 4.44: DEA2. Inefficiency scores in social services by mountain classes. 2011

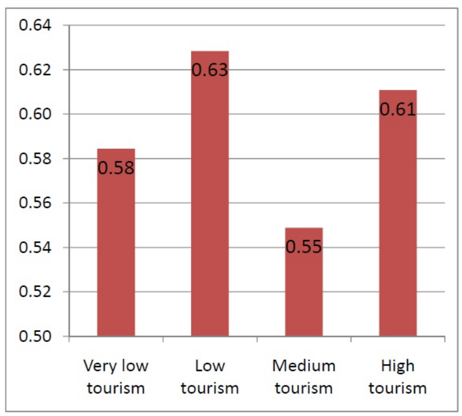


Regarding the municipal classification by tourism classes, Table 4.60 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.45) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with low and high level of tourism, while the opposite holds for those municipalities with medium level of tourism: this result is quite different from DEA1 results. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. In this case, as in the case of DEA1 results, it's not possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. However, it's useful to make notice that also the target population has the same reverse distribution among the different tourism classes: that is, the lower the target population, the higher the level of inefficiency.

Table 4.60: DEA2. Descriptive statistics of inefficiency scores in social services by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.58	0.24	0.00	0.93
Low tourism	0.63	0.26	0.00	0.95
Medium tourism	0.55	0.23	0.00	0.93
High tourism	0.61	0.24	0.00	0.96

Figure 4.45: DEA2. Inefficiency scores in social services by tourism classes. 2011

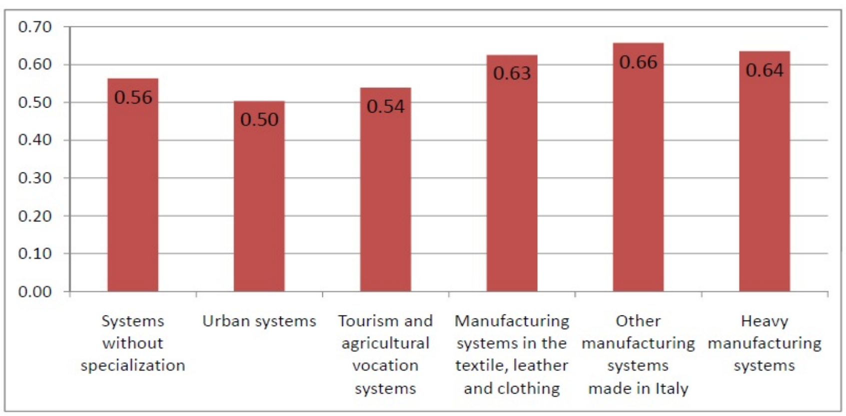


Finally, Table 4.61 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.46) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes. The highest level of inefficiency is present in the manufacturing systems, while the opposite holds for the urban systems. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class.

Table 4.61: DEA2. Descriptive statistics of inefficiency scores in social services by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.56	0.20	0.05	0.90
Urban systems	0.50	0.25	0.00	0.86
Tourism and agricultural vocation systems	0.54	0.26	0.00	0.91
Manufacturing systems in the textile, leather and clothing	0.63	0.27	0.00	0.95
Other manufacturing systems made in Italy	0.66	0.20	0.00	0.96
Heavy manufacturing systems	0.64	0.22	0.00	0.93

Figure 4.46: DEA2. Inefficiency scores in social services by local labour system classes. 2011



Road maintenance and local mobility

In this part, the obtained efficiency results for the road maintenance and local mobility function are presented. As in the previous functions, it's worth recalling that the production scale problems are not taken into account in the considered function: so, the inefficiency scores denote the level of municipal mismanagement regarding this function.

Table 4.62 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.64, so it's a quite similar to the mean of DEA1 results and implies that theoretically the 64 % of the expenditure spent for this function could be reduced. In addition, in this case, the distribution of the estimated level of inefficiency is not properly symmetric: in fact, the mean and the median are just quite similar. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.62: DEA2. Descriptive statistics of inefficiency scores in road maintenance and local mobility. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.64	0.23	0.00	0.97	0.33	0.55	0.68	0.80	0.86

Table 4.63 describes the municipalities that results to be efficient according to the VRS analysis. It's worth pointing out that for the lowest dimensional classes, the efficient municipalities are the same found in DEA1 results (except Montecatini Val di Cecina). Moreover, it's worth noting that the biggest efficient municipalities have zero as the absolute and percentage number of times they are referred as a peer: this implies that they are on the frontier and there are not other municipalities to be compared with them, as already seen in the previous functions. However, since in this case the results are obtained through a "one input-two output" DEA model, the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities is not presented. Moreover, it's worth noting the number of times each efficient municipality is a peer for the others also for another reason, because a particular situation applies: from one hand the 60 % of times the peer for the municipalities are the four efficient municipalities under two thousands of inhabitants, on the other hand the 35 % of times the peer for the other municipalities is basically Altopascio, that belongs to the dimensional class between ten and twenty thousands of inhabitants. Five out of ten municipalities belong to the highest dimensional classes and just two out of ten have a low level of tourism. Differently from the DEA1 results, six out of ten efficient municipalities belong to the non-mountain classification and just one belong to the partially mountain classification.

Table 4.63: DEA2. Details of inefficient municipalities in road maintenance and local mobility. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Capraia Isola	From 0 to 1.000 inhab.	Totally mountain	High tourism	26	6%
Monteverdi Marittimo	From 0 to 1.000 inhab.	Totally mountain	High tourism	21	5%
Casale Marittimo	From 1.001 to 2.000 inhab.	Non-mountain	High tourism	154	36%
Montecatini Val di Cecina	From 1.001 to 2.000 inhab.	Totally mountain	High tourism	8	2%
Riparbella	From 1.001 to 2.000 inhab.	Non-mountain	High tourism	47	11%
Altopascio	From 10.001 to 20.000 inhab.	Non-mountain	Low tourism	147	35%
Massarosa	From 20.001 to 60.000 inhab.	Non-mountain	Very low tourism	11	3%
Massa	Over 60.000 inhab.	Partially mountain	Medium tourism	10	2%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	0	0%
Grosseto	Over 60.000 inhab.	Non-mountain	Medium tourism	0	0%
				424	100%

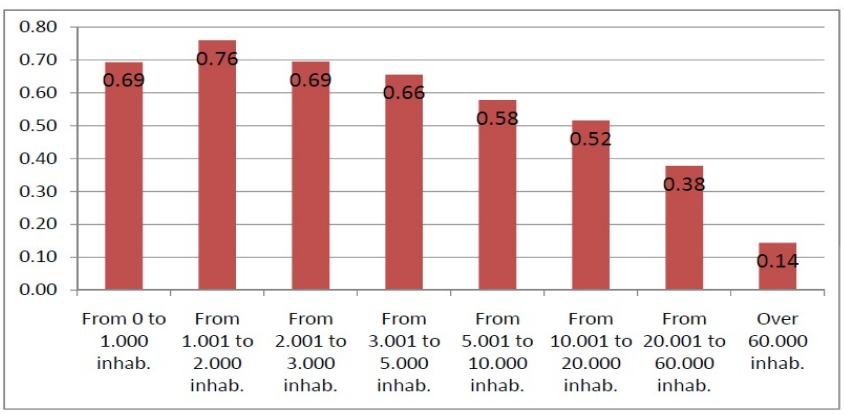
In the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.64 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.47) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a quite reversed "U-shaped form" and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is quite high for all the classes except the dimensional class ranging from three and five thousands of inhabitants: this could suggest that in average there is a great variability of inefficiencies in each classes.

Table 4.64: DEA2. Descriptive statistics of inefficiency scores in road maintenance and local mobility by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.69	0.29	0.00	0.97
From 1.001 to 2.000 inhab.	0.76	0.23	0.00	0.92
From 2.001 to 3.000 inhab.	0.69	0.16	0.20	0.88
From 3.001 to 5.000 inhab.	0.66	0.12	0.35	0.87
From 5.001 to 10.000 inhab.	0.58	0.19	0.02	0.83
From 10.001 to 20.000 inhab.	0.52	0.17	0.00	0.79
From 20.001 to 60.000 inhab.	0.38	0.20	0.00	0.64
Over 60.000 inhab.	0.14	0.29	0.00	0.57

Figure 4.47: DEA2. Inefficiency scores in road maintenance and local mobility by dimensional classes. 2011

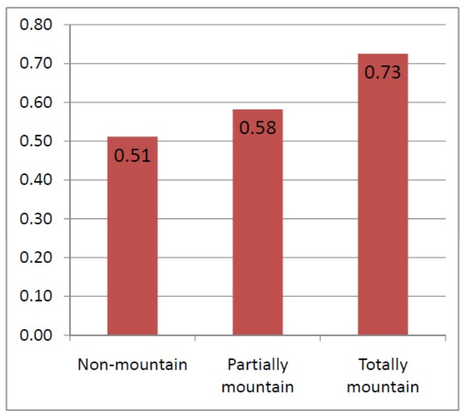


Regarding the mountain features, Table 4.65 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.48) gives a graphical intuition of the inefficiency distribution. They both show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficult territory makes more inefficient the provision of services by the road maintenance and local mobility function. In particular, going from a non-mountain to a totally mountain place the level of inefficiency increase: the more difficult the territory, the higher is the municipal mismanagement. In addition, also the maximum value of inefficiency is present in the mountain class. Of course, it's worth recalling that however three out of ten efficient municipalities belong to the mountain classification.

Table 4.65: DEA2. Descriptive statistics of inefficiency scores in road maintenance and local mobility by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.51	0.24	0.00	0.86
Partially mountain	0.58	0.19	0.00	0.84
Totally mountain	0.73	0.18	0.00	0.97

Figure 4.48: DEA2. Inefficiency scores in road maintenance and local mobility by mountain classes. 2011

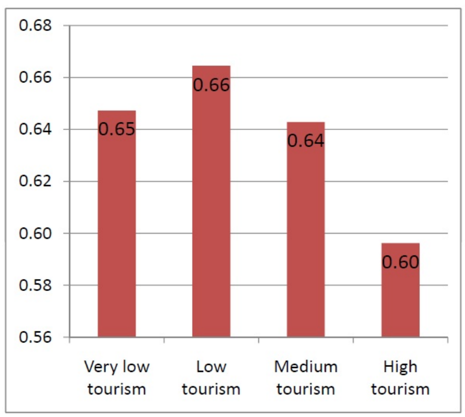


Regarding the municipal classification by tourism classes, Table 4.66 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.49) gives a graphical intuition of the inefficiency distribution. In this case, there is a total different result with respect to DEA1 results: the highest level of inefficiency is present in the municipalities with low level of tourism, while at the same the opposite holds for those municipalities with very high of tourism. However, it's worth noting that the differences in the inefficiency scores among different classes is not so relevant. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. In this case, as in the previous functions, it's not possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases: however, a reversed "U-shaped form" can be observed.

Table 4.66: DEA2. Descriptive statistics of inefficiency scores in road maintenance and local mobility by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.65	0.23	0.00	0.92
Low tourism	0.66	0.21	0.00	0.89
Medium tourism	0.64	0.19	0.00	0.91
High tourism	0.60	0.26	0.00	0.97

Figure 4.49: DEA2. Inefficiency scores in road maintenance and local mobility by tourism classes. 2011

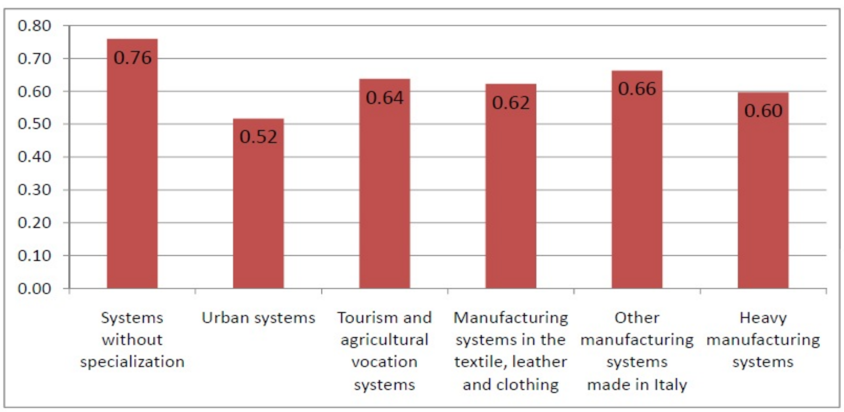


Finally, Table 4.67 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.50) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes. The highest level of inefficiency is present in the systems without specialization, while the opposite holds for the urban systems, as for DEA1 results. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class, except within the municipalities belonging to the systems without specialization.

Table 4.67: DEA2. Descriptive statistics of inefficiency scores in road maintenance and local mobility by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.76	0.12	0.51	0.92
Urban systems	0.52	0.29	0.00	0.88
Tourism and agricultural vocation systems	0.64	0.23	0.00	0.97
Manufacturing systems in the textile, leather and clothing	0.62	0.23	0.00	0.89
Other manufacturing systems made in Italy	0.66	0.14	0.35	0.91
Heavy manufacturing systems	0.60	0.25	0.00	0.92

Figure 4.50: DEA2. Inefficiency scores in road maintenance and local mobility by local labour system classes. 2011



Local police

In this part, the obtained efficiency results for the local police function are presented. As in the previous functions, it's worth recalling that the production scale problems are not taken into account in the considered function: so, the inefficiency scores denote the level of municipal mismanagement regarding this function.

Table 4.68 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.60, so it's a higher value than in the road maintenance and local mobility case and implies that theoretically the 60 % of the expenditure spent for this function could be reduced. In addition, in this case, the distribution of the estimated level of inefficiency is symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.68: DEA2. Descriptive statistics of inefficiency scores in local police. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.60	0.26	0.00	0.99	0.20	0.44	0.62	0.79	0.92

Table 4.69 describes the municipalities that results to be efficient according to the VRS analysis. First of all, it's worth pointing out that under ten thousands of inhabitants, the efficient municipalities are the same present in DEA1 results; however, there are less efficient municipalities than in DEA1 results. Just two out of eight municipalities belong to the highest dimensional classes and three out of eight have a low level of tourism. It's interesting to note that two of the efficient municipalities in this function are the same considered as efficient in the previous function. In addition, even in this case, it's worth noting the number of times each efficient municipality is a peer for the others, because a particular situation applies: from one hand for the 65% of times the five efficient municipalities under three thousands of inhabitants are the peer for the smallest municipalities, on the other hand the 28% of times the peer for the other municipalities is basically Civitella in Val di Chiana, that belongs to the dimensional class between five and ten thousands of inhabitants.

Also in this case, since the results are obtained through a "one input-two output" DEA model, the theoretical production possibility frontier associated with the aforementioned set of efficient municipalities is not presented.

Table 4.69: DEA2. Details of efficient municipalities in local police. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Fosciandora	From 0 to 1.000 inhab.	Totally mountain	Low tourism	38	9%
Vergemoli	From 0 to 1.000 inhab.	Totally mountain	Very low tourism	20	5%
San Godenzo	From 1.001 to 2.000 inhab.	Totally mountain	Medium tourism	35	8%
Chiusdino	From 2.001 to 3.000 inhab.	Partially mountain	High tourism	128	29%
Murlo	From 2.001 to 3.000 inhab.	Non-mountain	High tourism	61	14%
Civitella in Val di Chiana	From 5.001 to 10.000 inhab.	Non-mountain	Low tourism	122	28%
Massa	Over 60.000 inhab.	Partially mountain	Medium tourism	36	8%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	1	0%
				441	100%

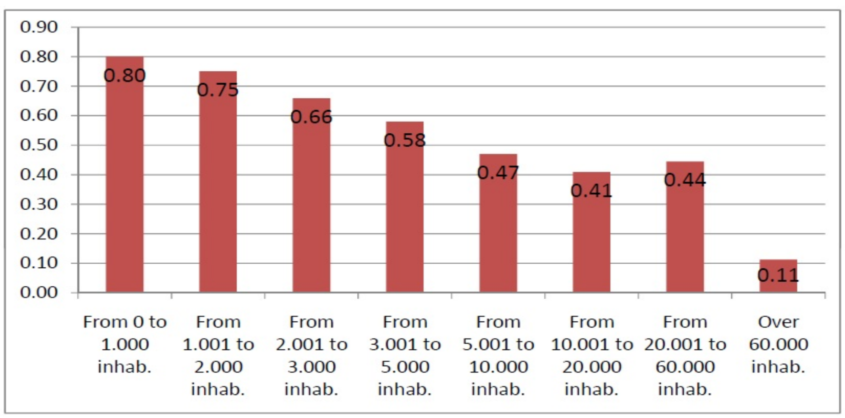
In the following, a more detailed analysis of the VRS inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.70 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.51) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional classes. In particular, the distribution of the inefficiency scores has a quite decreasing form and the biggest dimensional class has the lowest inefficient score. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. It's interesting to notice that the standard deviation is quite high for all the classes except the dimensional class ranging from three and five thousands of inhabitants: this could suggest that in average there is a great variability of inefficiencies in each classes.

Table 4.70: DEA2. Descriptive statistics of inefficiency scores in local police by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.80	0.31	0.00	0.99
From 1.001 to 2.000 inhab.	0.75	0.24	0.00	0.96
From 2.001 to 3.000 inhab.	0.66	0.23	0.00	0.94
From 3.001 to 5.000 inhab.	0.58	0.16	0.07	0.80
From 5.001 to 10.000 inhab.	0.47	0.21	0.00	0.89
From 10.001 to 20.000 inhab.	0.41	0.18	0.06	0.77
From 20.001 to 60.000 inhab.	0.44	0.17	0.16	0.75
Over 60.000 inhab.	0.11	0.19	0.00	0.39

Figure 4.51: DEA2. Inefficiency scores in local police by dimensional classes. 2011

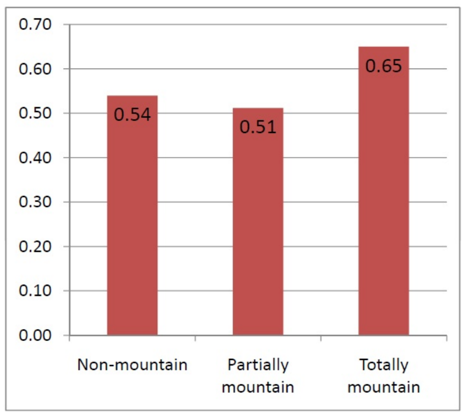


Regarding the mountain features, Table 4.71 presents the descriptive statistics of the VRS inefficiency scores and the related graph (Figure 4.52) gives a graphical intuition of the inefficiency distribution. As for DEA1 results, they both show that the highest inefficiencies are present in the mountain municipalities: certainly, the difficulties related to the territory makes more inefficient the provision of the services related to the local police function. Of course, it's worth recalling that however three out of eight efficient municipalities belong to the mountain classification.

Table 4.71: DEA2. Descriptive statistics of inefficiency scores in local police by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.54	0.26	0.00	0.98
Partially mountain	0.51	0.25	0.00	0.88
Totally mountain	0.65	0.25	0.00	0.99

Figure 4.52: DEA2. Inefficiency scores in local police by mountain classes. 2011

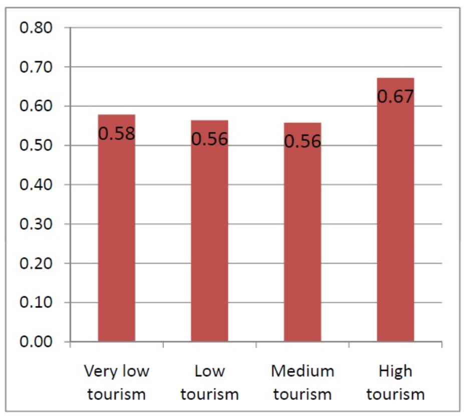


Regarding the municipal classification by tourism classes, Table 4.72 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.53) gives a graphical intuition of the inefficiency distribution. As for DEA1 results, the highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with low and medium level of tourism. The minimum level of inefficiency is equal to zero for all the classes: in fact, all the classes among the completely efficient municipalities are mentioned. To conclude, differently from DEA1 results, it's possible to observe that considering an increasing level of tourism the level of inefficiency assumes a "U-shaped form".

Table 4.72: DEA2. Descriptive statistics of inefficiency scores in local police by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.58	0.26	0.00	0.98
Low tourism	0.56	0.27	0.00	0.98
Medium tourism	0.56	0.23	0.00	0.96
High tourism	0.67	0.27	0.00	0.99

Figure 4.53: DEA2. Inefficiency scores in local police by tourism classes. 2011

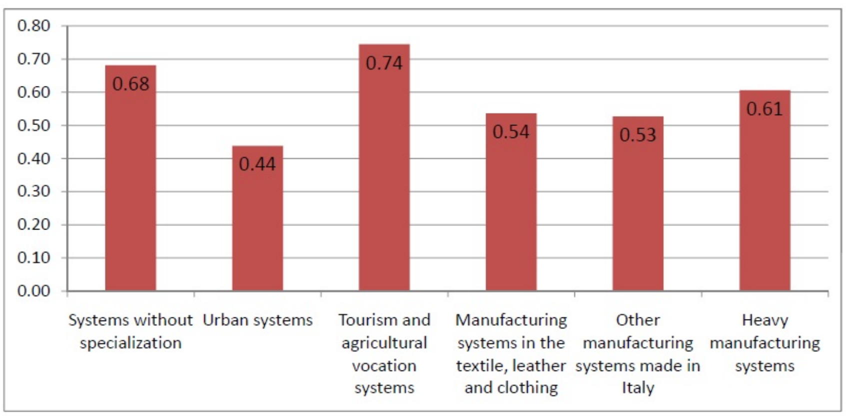


Finally, Table 4.73 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.54) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes. As for DEA1 results, the highest level of inefficiency is present in the tourism and agricultural vocation systems, while the opposite holds for the urban systems. Moreover, it's worth noting that almost all the typologies of systems have the minimum value of inefficiency equal to zero (so among them there are the efficient municipalities): however, among all these classes there are big values of standard deviation, meaning high level of variability within each class.

Table 4.73: DEA2. Descriptive statistics of inefficiency scores in local police by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.68	0.23	0.00	0.98
Urban systems	0.44	0.28	0.00	0.80
Tourism and agricultural vocation systems	0.74	0.21	0.00	0.99
Manufacturing systems in the textile, leather and clothing	0.54	0.24	0.06	0.95
Other manufacturing systems made in Italy	0.53	0.27	0.00	0.95
Heavy manufacturing systems	0.61	0.25	0.00	0.98

Figure 4.54: DEA2. Inefficiency scores in local police by local labour system classes. 2011



Environmental management

First of all, in order to give a consistent interpretation of the obtained efficiency results for this function, it's useful to take in mind what are the main services provided to the citizens by this area: the function for the environmental management provides services regarding the water provision, the waste collection, the maintenance of green areas and the construction industry, according to the municipal balance sheet items of expenditure. However, as already explained in section 3.1, it's worth pointing out that the main part of this function covers the services related to the waste collection and disposal: for this reason, the results are analyzed considering mostly this service.

Table 4.74 presents the overall technical inefficiency scores of the CRS analysis. The mean of the inefficiency scores is equal to 0.48 and implies that theoretically the 48% of the expenditure spent for this function could be reduced. In addition, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are the same. However, as already said, this level of inefficiency could be affected by the constant return to scale assumption: for this reason, municipal inefficiency is again estimated, just taking into account the mismanagement component, so in other words just considering the variable returns to scale.

So, Table 4.75 presents the inefficiency scores of the VRS analysis. The mean of the inefficiency scores is equal to 0.42, so it's a lower value than in the CRS case: certainly this implies that among some municipalities there is the presence of economies/diseconomies of scale. In addition, also in this case, the distribution of the estimated level of inefficiency is quite symmetric: in fact, the mean and the median (i.e. the 50 ° percentile) are the same. However, looking at the min and max values, it's possible to see how the extreme values are very distant from each other.

Table 4.74: DEA2. Descriptive statistics of CRS inefficiency scores in environmental management. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.48	0.16	0.00	0.93	0.29	0.38	0.48	0.60	0.68

Table 4.75: DEA2. Descriptive statistics of VRS inefficiency scores in environmental management. 2011

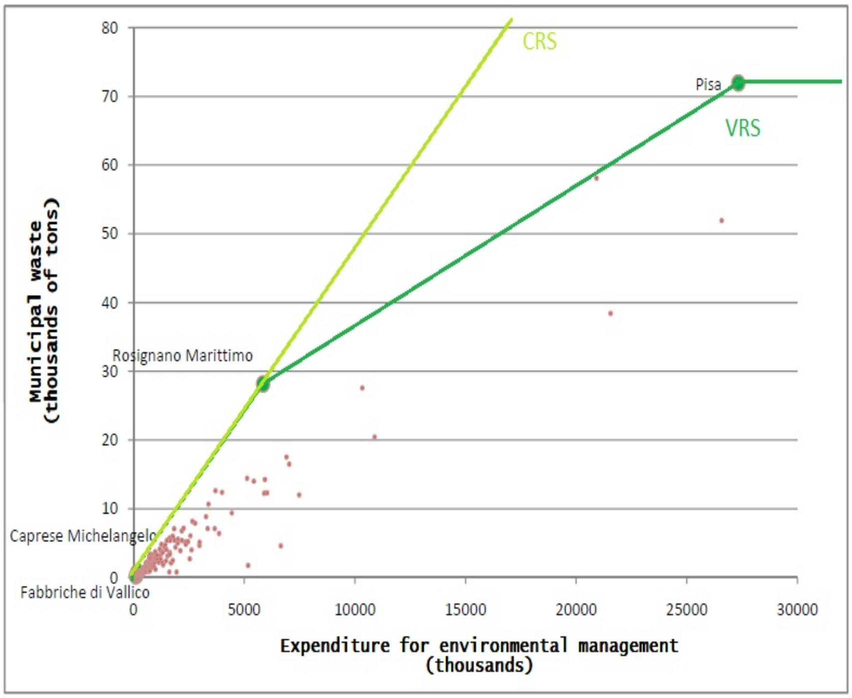
Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.42	0.18	0.00	0.93	0.19	0.32	0.42	0.54	0.63

By construction, in the CRS analysis, just a municipality is completely efficient: Rosignano Marittimo. Table 4.76 instead describes the municipalities that results to be efficient according to the VRS analysis. Half efficient municipalities belong to the highest dimensional classes, belong to the mountain class and have a high degree of tourism. It's worth noting the number of times each efficient municipality is a peer for the others. In fact, in this case, half of the municipalities is compared to a big municipality, while the other half is compared to a small municipalities. Moreover, Figure 4.55 presents the theoretical production possibility frontier associated with the aforementioned sets of efficient municipalities: also from a graphical point of view it's possible to observe how the two municipalities split into two groups the compared municipalities in the VRS case.

Table 4.76: DEA2. Details of efficient municipalities in environmental management. 2011

Municipality	Dimensional class	Mountain class	Tourism class	N°of times considered as a PEER	
				Absolute value	Percentage value
Fabbriche di Vallico	From 0 to 1.000 inhab.	Totally mountain	Low tourism	36	10%
Caprese Michelangelo	From 1.001 to 2.000 inhab.	Totally mountain	Low tourism	184	49%
Rosignano Marittimo	From 20.001 to 60.000 inhab.	Non-mountain	High tourism	152	41%
Pisa	Over 60.000 inhab.	Non-mountain	High tourism	3	1%
				375	100%

Figure 4.55: DEA2. Theorical production possibility frontier for environmental management. 2011



In order to disentangle the causes that affect the overall technical inefficiency, the level of inefficiency depending on the dimensional classes is observed. It's worth pointing out that actually the detected level of scale inefficiency is referred to the expenditure, from the input side, and to the quantity of produced municipal waste, from the output side: however, due to an increasing and positive relationship between the municipal size and the quantity of waste, the level of scale inefficiency can be seen along the dimensional classes; furthermore, it's reasonable to assume the same average behavior among Tuscan families regarding the production of waste, so the reasoning just now explained seems to be quite reasonable. Table 4.77 and Table 4.78 present the descriptive statistics of the inefficiency scores respectively for the CRS and the VRS case and the related graph (Figure 4.56) gives a graphical intuition of the two inefficiency distributions. From the comparison between CRS and VRS inefficiency scores, it's possible to observe that in the extreme classes the gap between CRS and VRS scores is higher than in the central classes: the differences between CRS and VRS is to be attributed to the scale inefficiency. For the same reason, the scale inefficiency scores presented graphically (Figure 4.57) also denotes higher scores at the extreme demographical classes. In addition, as described in Table 4.79, the scale inefficiencies especially for the smallest dimensional classes are related to missing economies of scale, in fact there are observed increasing returns to scale; while for the biggest municipalities the scale inefficiency are due to the presence of diseconomies of scale, as the prevalent presence of decreasing returns to scale shows. To be more detailed, just in the biggest class there are decreasing return to scale: in all the other classes there are not reached economies of scale. Furthermore, there is a very relevant aspect to underline: even taken into account the presence of scale inefficiencies, some of the smallest classes result to be the most technically inefficient ones. In others words, this implies that these small dimensional classes show technical inefficiency even taking into account that they can produce under variable returns to scale and this inefficiency can be attributed entirely to a bad municipal management. This does not hold for the municipalities belonging to the biggest dimensional class. In fact, these municipalities result to be technically inefficient under the global point of view. However, if they are evaluated under variable returns to scale, they result to be the most efficient class: so the main inefficiency problem in their case is related with their too big dimension and actually not to their municipal management.

In conclusion, the presence of increasing returns to scale among almost all the dimensional classes suggest that aggregation, at least as inter-municipal management or even as merger, in the provision of this service should be promoted in order to reach the missing economies of scale and so to improve the level of efficiency at least under this aspect. In fact, in presence of economies of scale, it should be sufficient to increase a little the expenditure in order to have a greater possibility to manage the disposal waste service: so, if some municipalities faced together the necessary expenditure, they certainly should use less resources than they would employ by themselves, reaching higher level of efficiency and saving municipal revenues.

So, at least in relation to this function, it is clear that it is not entirely correct to impute all the inefficiency to the municipal management, certainly not responsible for a wrong municipal size or more in general a wrong scale services production. Especially with regard to the small municipalities, the cause of the inefficiency results from the presence of too much small fragmented municipalities. As evident, also in this case there is the same conclusion that the small size represents a limit and a source of waste in the municipal expenditure.

Table 4.77: DEA2. Descriptive statistics of CRS inefficiency scores in environmental management by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.59	0.11	0.37	0.75
From 1.001 to 2.000 inhab.	0.50	0.18	0.11	0.92
From 2.001 to 3.000 inhab.	0.54	0.12	0.33	0.74
From 3.001 to 5.000 inhab.	0.46	0.16	0.09	0.93
From 5.001 to 10.000 inhab.	0.40	0.15	0.06	0.68
From 10.001 to 20.000 inhab.	0.46	0.16	0.20	0.86
From 20.001 to 60.000 inhab.	0.41	0.18	0.00	0.61
Over 60.000 inhab.	0.53	0.10	0.42	0.63

Table 4.78: DEA2. Descriptive statistics of VRS inefficiency scores in environmental management by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.34	0.20	0.00	0.65
From 1.001 to 2.000 inhab.	0.42	0.21	0.00	0.91
From 2.001 to 3.000 inhab.	0.50	0.13	0.29	0.73
From 3.001 to 5.000 inhab.	0.44	0.17	0.06	0.93
From 5.001 to 10.000 inhab.	0.38	0.15	0.04	0.68
From 10.001 to 20.000 inhab.	0.46	0.16	0.19	0.85
From 20.001 to 60.000 inhab.	0.41	0.18	0.00	0.61
Over 60.000 inhab.	0.21	0.24	0.00	0.50

Figure 4.56: DEA2. Inefficiency scores in environmental management by dimensional classes. 2011

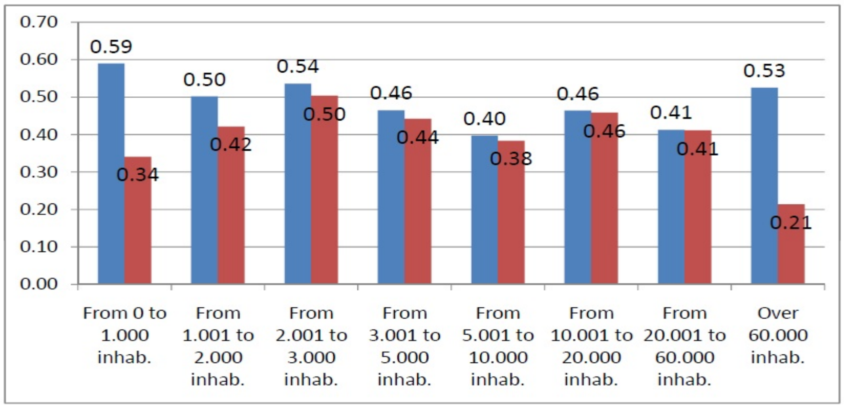
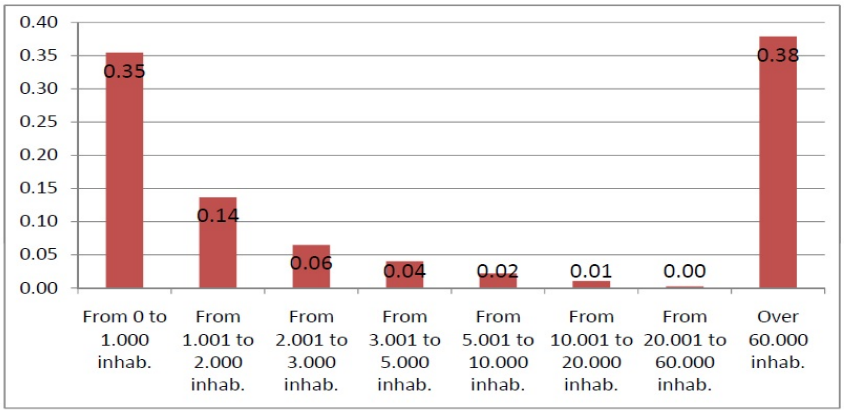


Table 4.79: DEA2. Descriptive statistics of scale inefficiency scores in environmental management by dimensional classes. 2011

Dimensional class	Mean	Std. dev.	Prevalent RTS
From 0 to 1.000 inhab.	0.35	0.14	irts
From 1.001 to 2.000 inhab.	0.14	0.06	irts
From 2.001 to 3.000 inhab.	0.06	0.02	irts
From 3.001 to 5.000 inhab.	0.04	0.01	irts
From 5.001 to 10.000 inhab.	0.02	0.01	irts
From 10.001 to 20.000 inhab.	0.01	0.00	irts
From 20.001 to 60.000 inhab.	0.00	0.01	irts
Over 60.000 inhab.	0.38	0.08	drts

Figure 4.57: DEA2. Scale inefficiency scores in environmental management by dimensional classes. 2011



Since, as already seen, the municipal inefficiency is strongly influenced by the characteristics of the municipalities themselves, a more detailed analysis of the inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by mountain, tourism and local labour system classes), and in particular just the VRS inefficiency scores are considered: so, the level of municipal mismanagement is under attention.

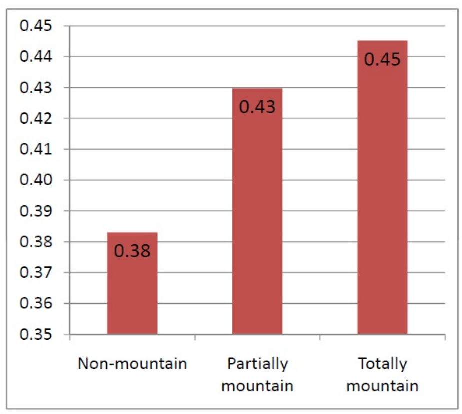
Table 4.80 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.58) gives a graphical intuition of the inefficiency distribution considering the municipal classification by mountain classes. The highest level of inefficiency is present in the totally mountain classes, while the opposite holds for the non-mountain classes. Moreover, it's worth noting that the non-mountain class has the lowest maximum value of inefficiency, while the totally mountain class has the highest value of maximum inefficiency. As already justified, certainly the local governments of the totally mountain places have to face more difficulties to accomplish their services and can be influenced in their municipal management. Moreover, certainly it is reasonable that in more impervious places services related to the management of the environment present higher cost that in other places, so to result inefficient.

Table 4.80: DEA2. Descriptive statistics of inefficiency scores in environmental management by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.38	0.18	0.00	0.77
Partially mountain	0.43	0.17	0.02	0.93
Totally mountain	0.45	0.18	0.00	0.91

Regarding the municipal classification by tourism classes, Table 4.81 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.59) gives a graphical intuition of the inefficiency distribution. The highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. In particular, it's possible to observe that considering an increasing level of tourism, the level of inefficiency systematically increases. So, the higher is the level of tourism for a municipality, the higher is the level of mismanagement. Certainly, this is the result that one could reasonably expect: the higher the level of tourist presence, the more the congested level of the required services, the more the level of inefficiency.

Figure 4.58: DEA2. Inefficiency scores in environmental management by mountain classes. 2011



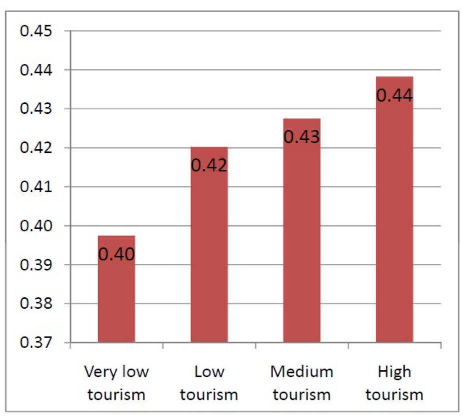
Regarding the municipal classification by tourism classes, Table 4.81 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.59) gives a graphical intuition of the inefficiency distribution. Differently from the other functions, the highest level of inefficiency is present in the municipalities with very low level of tourism, while the opposite holds for those municipalities with high and medium level of tourism.

Table 4.81: DEA2. Descriptive statistics of inefficiency scores in environmental management by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.40	0.18	0.04	0.88
Low tourism	0.42	0.18	0.00	0.77
Medium tourism	0.43	0.18	0.01	0.93
High tourism	0.44	0.19	0.00	0.73

Finally, Table 4.82 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.60) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. The highest level of inefficiency is present, consistently with what said earlier, in the tourism and agricultural vocation systems and more in the systems without specialization, while the opposite holds for the manufacturing systems in the textile, leather and clothing.

Figure 4.59: DEA2. Inefficiency scores in environmental management by tourism classes. 2011

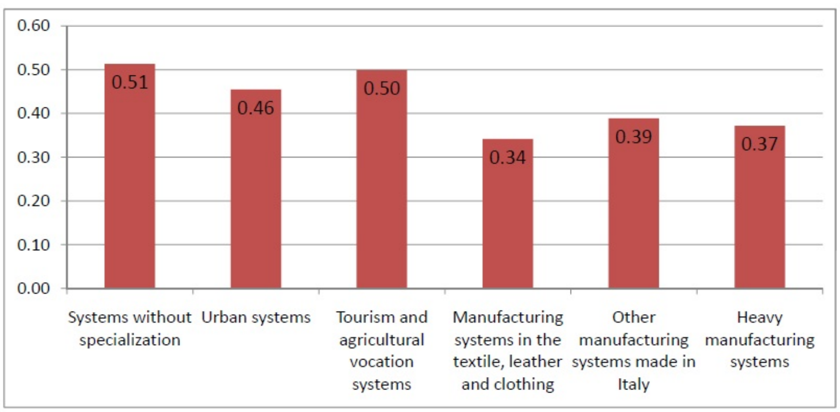


Finally, Table 4.82 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.60) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes. At least in this case, as for other function the highest level of inefficiency is present in the tourism and agricultural vocation systems, while the opposite holds for the systems without specialization. Moreover, among all these classes there are big values of standard deviation, meaning high level of variability within each class.

Table 4.82: DEA2. Descriptive statistics of inefficiency scores in environmental management by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.51	0.16	0.25	0.91
Urban systems	0.46	0.14	0.02	0.63
Tourism and agricultural vocation systems	0.50	0.18	0.00	0.93
Manufacturing systems in the textile, leather and clothing	0.34	0.16	0.00	0.88
Other manufacturing systems made in Italy	0.39	0.10	0.10	0.60
Heavy manufacturing systems	0.37	0.21	0.00	0.77

Figure 4.60: DEA2. Inefficiency scores in environmental management by local labour system classes. 2011



Average inefficiency among functions

In this part, as for the previous section, the average inefficiency results among Tuscan municipalities is described, considering the average municipal behaviour among the different functions. Just to recall it, these average inefficiency scores are obtained as the weighted average among each function efficiency scores according to the different weight they cover in the total expenditure (see section 3.2).

Obviously, the VRS DEA scores are used to compute the average inefficiency: so, in this context, the average waste of resources per function due to municipal mismanagement is evaluated.

In addition, it's worth recalling that differently from DEA1 results, in this case the average behaviour takes also into account the environmental management function, that specifically represents a big expenditure component over the total. In addition, there are just municipalities that apply TARSU.

Table 4.83 presents the statistics of the average inefficiency scores of the VRS analysis. The mean of the average inefficiency scores is equal to 0.55 and this implies that considering the weight of each function expenditure, in average a Tuscan municipalities could not waste the 55% of the resources. it's worth noting that this number is a slightly lower value than DEA1 average inefficiency scores. At first glance, this should suggest that considering also the environmental function, the average level of inefficiency decreases, or more probably, since the environmental management expenditure is a big component of the total expenditure, the already presented lower inefficiency scores of this function have a more weight.

Also in this case, the distribution of the level of inefficiencies is symmetric: in fact, the mean and the median are quite similar. Moreover, looking at the percentiles, it's possible to see that the inefficiency scores are more concentrated than in DEA1 case. This could be explained by the fact that adding one more function, the difference among municipalities efficiency becomes even more smaller.

Table 4.83: DEA2. Descriptive statistics of average inefficiency among functions. 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.55	0.12	0.00	0.87	0.40	0.49	0.56	0.62	0.68

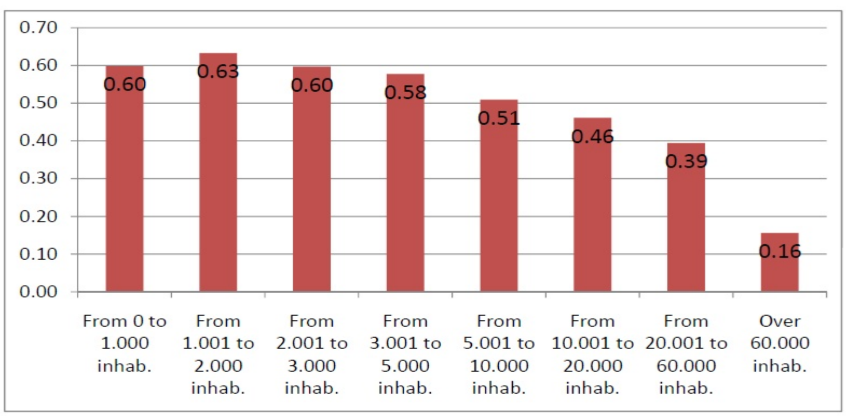
Since, as already seen, the municipal inefficiency is strongly influenced by the characteristics of the municipalities themselves, also in this case a more detailed analysis of the inefficiency results is presented, considering the aforementioned municipal classifications (i.e. by dimensional, mountain, tourism and local labour system classes).

Table 4.84 presents the descriptive statistics of the average inefficiency scores by dimensional classes and the related graph (Figure 4.61) gives a graphical intuition of the inefficiency distribution. The highest inefficiencies are present in the smallest dimensional classes, while the opposite holds for the biggest dimensional class. In this average analysis, a reverse "U-shaped form" of the inefficiency scores distribution can be observed. As in DEA1 case, here this trend is quite evident. Probably, the presence of increasing returns to scale in the environmental management heavily affects the average inefficiency. Moreover, it's worth noting that the biggest dimensional class has the lowest maximum value of inefficiency. More important, just in the biggest dimensional class there is zero as a minimum value of inefficiency: just in this class there is a complete efficient municipality, according to this analysis and it is Pisa. As already explained, it's useful to take into account that the resident population increases as the total resident population increases. The inefficiency results suggest that in the provision of the services a municipality works better with a larger catchment area than a smaller.

Table 4.84: DEA2. Descriptive statistics of average inefficiency among functions by dimensional classes. 2011

Dimensional classes	Mean	Std. dev.	Min	Max
From 0 to 1.000 inhab.	0.60	0.10	0.37	0.82
From 1.001 to 2.000 inhab.	0.63	0.08	0.51	0.85
From 2.001 to 3.000 inhab.	0.60	0.06	0.50	0.76
From 3.001 to 5.000 inhab.	0.58	0.10	0.34	0.87
From 5.001 to 10.000 inhab.	0.51	0.10	0.35	0.78
From 10.001 to 20.000 inhab.	0.46	0.11	0.30	0.68
From 20.001 to 60.000 inhab.	0.39	0.08	0.28	0.52
Over 60.000 inhab.	0.16	0.14	0.00	0.33

Figure 4.61: DEA2. Average inefficiency scores among functions by dimensional classes. 2011

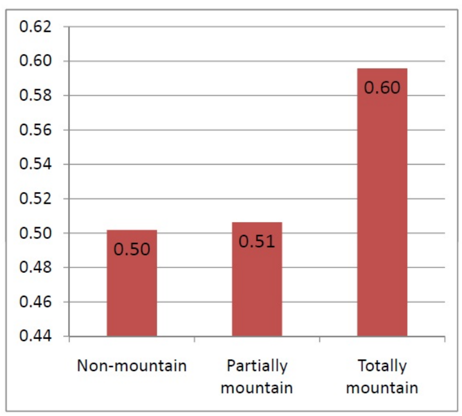


Considering also the municipal classification by mountain features, Table 4.85 presents the descriptive statistics of the average inefficiency scores and the related graph (Figure 4.62) gives a graphical intuition of the inefficiency distribution. As for DEA1 results, they both show that the highest inefficiencies are present in the mountain municipalities: certainly, the impervious territory and the smallest presence of resident population make more inefficient the provision of the services. As expected, the addition of the environmental management function in this average analysis confirms what already seen in the previous average analysis, for the reasons related to this function in the mountain feature.

Table 4.85: DEA2. Descriptive statistics of average inefficiency among functions by mountain classes. 2011

Mountain class	Mean	Std. dev.	Min	Max
Non-mountain	0.50	0.14	0.00	0.78
Partially mountain	0.51	0.15	0.15	0.87
Totally mountain	0.60	0.09	0.31	0.85

Figure 4.62: DEA2. Average inefficiency scores among functions by mountain classes. 2011

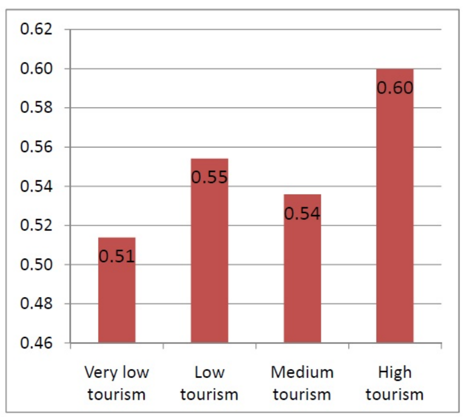


Regarding the municipal classification by tourism classes, Table 4.86 presents the descriptive statistics of the inefficiency scores and the related graph (Figure 4.63) gives a graphical intuition of the inefficiency distribution. As for DEA1 results, the highest level of inefficiency is present in the municipalities with high level of tourism, while the opposite holds for those municipalities with very low level of tourism. However, in this case it is not possible to observe that considering an increasing level of tourism, the average level of inefficiency systematically increases. Anyhow, it's relevant that the extreme inefficiency scores confirm what already seen. Moreover, with regards to this dataset, it must be into consideration the degree of congestion brought by the tourist presence that heavily affects the efficiency in the provision of the environmental services and, as a consequence, the average inefficiency.

Table 4.86: DEA2. Descriptive statistics of average inefficiency among functions by tourism classes. 2011

Tourism class	Mean	Std. dev.	Min	Max
Very low tourism	0.51	0.12	0.28	0.84
Low tourism	0.55	0.10	0.30	0.76
Medium tourism	0.54	0.13	0.14	0.87
High tourism	0.60	0.13	0.00	0.82

Figure 4.63: DEA2. Average inefficiency scores among functions by tourism classes. 2011



Finally, Table 4.87 presents the descriptive statistics of the average inefficiency scores and the related graph (Figure 4.64) gives a graphical intuition of the inefficiency distribution considering the municipal classification by local labour system classes, in order to understand also the effect of the municipal economic features. Consistently with what already said, the highest level of inefficiency is present in the tourism and agricultural vocation systems, while the opposite holds for the manufacturing systems in the textile, leather and clothing and also for the urban system (extra to DEA1 results). However, differently from the DEA1 results, the most efficient municipalities, Pisa, belongs precisely to the most inefficient class, that is as already said the tourism and agricultural vocation system. Moreover, all the capital provinces (that don't apply TIA) result to be the most efficient municipalities: this can be seen also graphically from Figure 4.65 [4]. Again, this evidence makes stronger the reasoning about the municipal size: the bigger is the municipal catchment area, the lower the average cost in the provision of municipal services; moreover, it's worth pointing out that this lower cost makes possible to provide more differentiated and complex services. In addition, at first glance it's possible to see also that the areas already put in evidence in section 1.1 in Figure 1.4, that are the areas with the lowest per capita expenditure, mainly correspond to the white area of Figure 4.65: this suggests that surely municipalities that apply TIA face lower costs. This reasoning could suggest the possibility to adopt an outsourced disposal waste services. Moreover, the areas with the highest per capita expenditure are those with the worst level of inefficiency.

Also from this reasoning it's possible to understand the importance to take into account the environmental management function in the municipal efficiency analysis (obviously before considering carefully all the peculiarities of the management).

Table 4.87: DEA2. Descriptive statistics of average inefficiency among functions by local labour system classes. 2011

Local labour system class	Mean	Std. dev.	Min	Max
Systems without specialization	0.59	0.08	0.47	0.85
Urban systems	0.50	0.15	0.14	0.71
Tourism and agricultural vocation systems	0.61	0.15	0.00	0.87
Manufacturing systems in the textile, leather and clothing	0.50	0.13	0.28	0.84
Other manufacturing systems made in Italy	0.55	0.10	0.40	0.81
Heavy manufacturing systems	0.56	0.10	0.36	0.78

[4] Figure 4.65 is obtained by "Stata" program.

Figure 4.64: DEA2. Average inefficiency scores among functions by local labour system classes. 2011

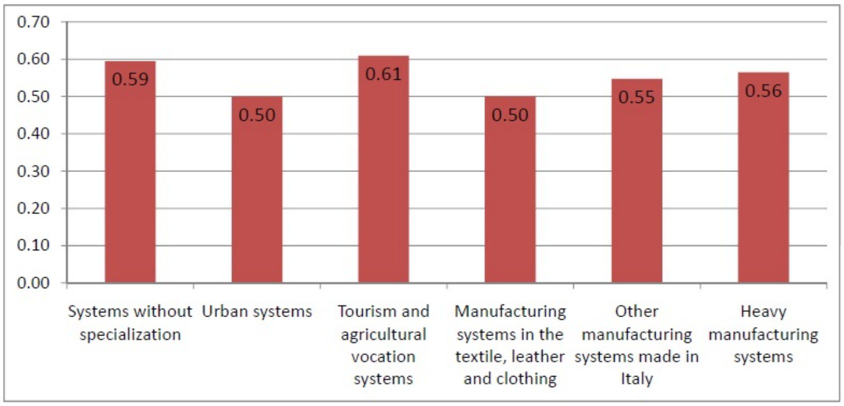
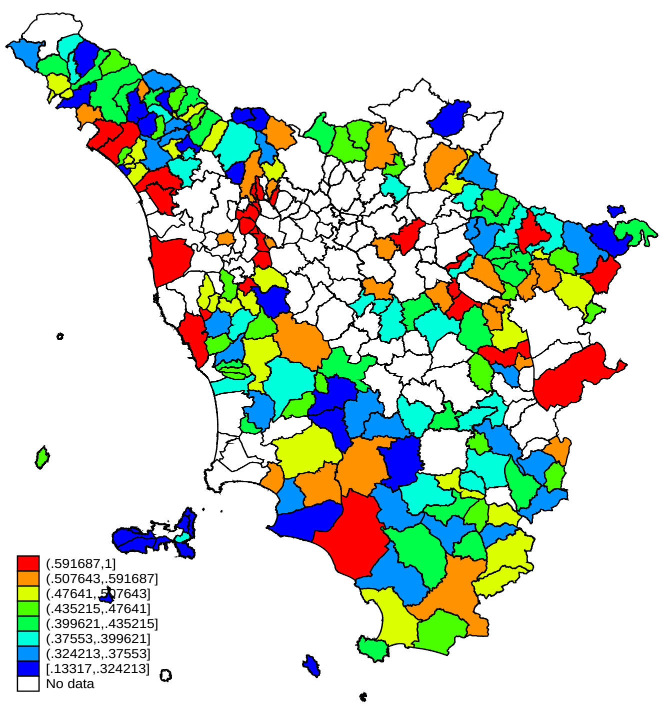


Figure 4.65: DEA2. Geographical distribution of the average efficiency scores. 2011



As in the previous section, to conclude this analysis, it's interesting to go into details about a last aspect: the comparison between the average inefficiency scores computed for each municipality considering its own expenditure composition and the average inefficiency scores computed considering the average Tuscan expenditure composition. From this comparisons, it could be possible to make some considerations about the effect on the average inefficiency of the municipal expenditure allocation among the different functions.

So, firstly the descriptive statistics of these new average inefficiency scores are presented in Table 4.88. As evident, also in this case the average inefficiency computed through these different weights is higher than in the previous case: this should suggest that in average, if the expenditure composition was different and in line with the Tuscan average, the level of average efficiency would be higher. Of course, also the percentiles denotes these lower scores.

Table 4.88: DEA2. Descriptive statistics of average inefficiency scores among functions (Tuscan weights). 2011

Mean	St. Dev.	Min	Max	Percentiles				
				10°	25°	50°	75°	90°
0.52	0.13	0.00	0.84	0.35	0.46	0.52	0.59	0.64

Finally, in order to go deeply in the differences among municipal performances, as already explained, municipalities have been divided according two features. The first regards the relative level of efficiency and the second feature regards the expenditure composition.

These two features are put in relationship in a graphical and intuitive way (Figure 4.66), so to distinguish four groups of municipalities: on the vertical axis there is the relative efficiency, while on the horizontal axis the expenditure composition aspect is considered. So, municipalities are laid out into four quadrants. In the North-East quadrant, there are the municipalities that result more efficient than the median and that have an expenditure composition that allows them to achieve a better level of average efficiency (in the following, this quadrant will be named Efficient-Better quadrant or shortly E-B quadrant). In the North-West quadrant, there are municipalities that result more efficient than the median, but have an expenditure composition that brings them to achieve a worse level of efficiency (in the following, this quadrant will be named Efficient-Worse quadrant or shortly E-W quadrant). In the South-East quadrant, there are the municipalities that result less efficient than the median but that have an expenditure composition that allows them to achieve a better level of average efficiency (in the following, this quadrant will be named Inefficient-Better quadrant or shortly I-B quadrant). In the South-West quadrant, there are municipalities that result less efficient than the median and also have an expenditure composition that brings them to achieve a worse level of efficiency (in the following, this quadrant will be named Efficient-Worse quadrant or shortly E-W quadrant).

So shortly it can be said that the municipalities in the Efficient-Worse and Inefficient-Worse quadrant have possible room of improvement in the efficiency level just changing a little the composition of the expenditure. Certainly, this suggestion should be handle carefully, especially for two reasons: the change in the expenditure brings to a change in the DEA model input, so to modify endogenously the level of the efficiency; secondly, especially for the smallest municipalities there are some binding thresholds of expenditure that cannot be avoided.

Furthermore, the municipalities in the Inefficient-Worse and Inefficient-Better quadrant certainly could improve their level of efficiency at least solving the present mismanagement problems and their causes. So, in conclusion, the Efficient- Better quadrant seems to collect the municipalities that behave better, according to this analysis.

In a synthetic way, Table 4.89 shows the main features of each quadrant according to the dimensional, mountain, tourism and local labour system classes and referring the number of present municipalities (shortly, DMUs). It's worth noting in a preliminary way that these results are quite different in comparison to DEA1 results.

In the Efficient-Better quadrant, there is the prevalence of municipalities belonging to the class ranging from two thousands to three thousands of inhabitants; these municipalities are non-mountain places and subject to medium level of tourism. Moreover, the tourism and agricultural vocation system represents the main class of these municipalities, even if it results to have the highest average level of inefficiency. In this case, these features recall those already presented in the description of the average inefficiency results just partially.

In the Efficient-Worse quadrant municipalities ranging from five thousands to ten thousands are prevalent and both the non-mountain and totally mountain feature represent the main characteristic of these municipalities. Moreover, they also belong to the very low and low tourism class and to the manufacturing systems in the textile, leather and clothing system (as in DEA1 results).

In the Inefficient-Better quadrant, there is the prevalence of a lower dimensional class, that is that three from one to five thousands of inhabitants. Furthermore, these municipalities are totally-mountain places and are subject to a high level of tourism (as for DEA1 results); related to this, there is the prevalence of municipalities that belong to the tourism and agricultural vocation system (again as for DEA1 results).

In the end, in the Inefficient-Worse quadrant there are municipalities that belong to the dimensional class ranging from one thousands to two thousands; they are totally mountain places, with high level of tourism and are prevalently system without specialization.

Certainly, the differences especially in the first two mentioned quadrants are due to the absence of all those municipalities that results to be efficient in the first model, but in this case there aren't since they apply TIA.

Figure 4.66: DEA2. Municipalities representation by relative efficiency and expenditure composition. 2011

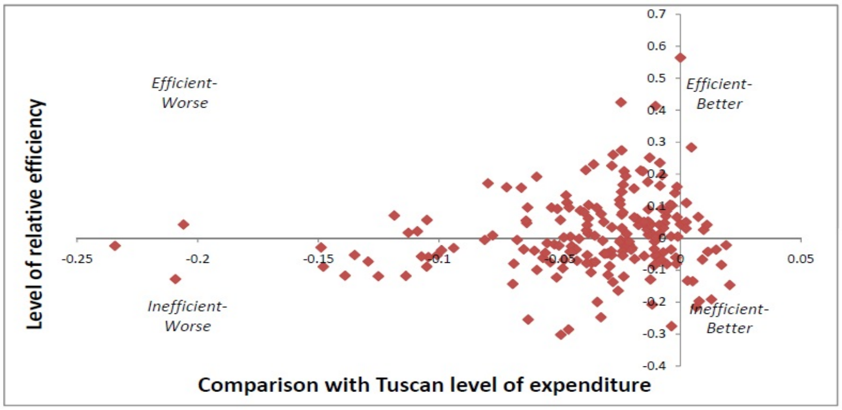


Table 4.89: DEA2. Descriptive statistics of each quadrant. 2011

	Efficient-Better quadrant		Efficient-Worse quadrant		Inefficient-Better quadrant		Inefficient-Worse quadrant		
Dimensional class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
From 0 to 1.000 inhab.	0	0%	8	9%	1	9%	9	11%	18
From 1.001 to 2.000 inhab.	1	11%	7	8%	1	9%	31	36%	40
From 2.001 to 3.000 inhab.	3	33%	7	8%	2	18%	16	19%	28
From 3.001 to 5.000 inhab.	1	11%	16	18%	5	45%	19	22%	41
From 5.001 to 10.000 inhab.	1	11%	25	29%	2	18%	6	7%	34
From 10.001 to 20.000 inhab.	1	11%	13	15%	0	0%	4	5%	18
From 20.001 to 60.000 inhab.	1	11%	8	9%	0	0%	0	0%	9
Over 60.000 inhab.	1	11%	3	3%	0	0%	0	0%	4
TOTAL	9	100%	87	100%	11	100%	85	100%	192
Mountain class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Non-mountain	7	78%	36	41%	5	45%	17	20%	65
Partially mountain	0	0%	15	17%	0	0%	8	9%	23
Totally mountain	2	22%	36	41%	6	55%	60	71%	104
TOTAL	9	100%	87	100%	11	100%	85	100%	192
Tourism class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Very low tourism	1	11%	24	28%	1	9%	16	19%	42
Low tourism	2	22%	24	28%	0	0%	18	21%	44
Medium tourism	4	44%	23	26%	1	9%	24	28%	52
High tourism	2	22%	16	18%	9	82%	27	32%	54
TOTAL	9	100%	87	100%	11	100%	85	100%	192
Local labour system class	DMUs	%	DMUs	%	DMUs	%	DMUs	%	TOTAL
Systems without specialization	2	22%	10	11%	0	0%	20	24%	32
Urban systems	1	11%	12	14%	2	18%	8	9%	23
Tourism and agricultural vocation systems	3	33%	7	8%	5	45%	17	20%	32
Manufacturing systems in the textile, leather and clothing	1	11%	25	29%	0	0%	15	18%	41
Other manufacturing systems made in Italy	2	22%	15	17%	0	0%	11	13%	28
Heavy manufacturing systems	0	0%	18	21%	4	36%	14	16%	36
TOTAL	9	100%	87	100%	11	100%	85	100%	192

4.3 TOBIT results

In this last section, the results of the Tobit regression are presented, so to better understand the possible municipal spending inefficiency causes.

Table 4.90 contains the findings of this analysis. In particular, DEA efficiency scores are regressed: if an explanatory variable has a positive sign, it positively affects the efficiency and if it has a negative sign, the opposite holds.

Table 4.90: DEA 1 and DEA 2 Tobit results. 2011

	DEA1	DEA2
AUTONOMY1	.14703811***	-
AUTONOMY2	-	.26977579***
REVENUES	-.00006794***	-.00005839***
TOURISM	-.38844573***	-.27532906*
DIM2	.0411038***	.04449868***
DIM3	.12657757***	.09712751***
DIM4	.19000678***	.18181137***
DIM5	.32902227***	.42124357***
DENSITY	.00004106*	4.146e-06
MOUNTAIN	-.03615654***	-.04235155***
SEA	-.10823416***	-.08429639***
SECOND MANDATE	-.0393868*	-.0517762**
SEA*TOURISM	.35181239**	.28726602*
SECOND*REVENUES	.00003669***	.00003557***
constant	.34677515***	.33759685***
σ	.06418401***	.06152456***
R^2	0.7893	0.7571
Adjusted R^2	0.7792	0.7394
N°observations	284	192

* denotes 5% significance level.

** denotes 1% significance level.

*** denotes 0.1% significance level.

First of all, it's worth noting that more or less all the explanatory variables are really very significant from a statistical point of view for both the models. Moreover, the R^2 and the Adjusted R^2 referred to the relative OLS regression are presented: it's possible to see that a quite good specification of the models is reached, both in DEA 1 and in DEA 2.

Since only few significance levels between DEA 1 and DEA 2 change but the effects of the exogenous variables on the efficiency are the same, the role of each variable is presented taking in mind both the first and the second sets of results.

In general, the Tobit results confirm the supposed inefficiency sources.

The variable AUTONOMY (both AUTONOMY1 and AUTONOMY2) has a positive effect on the efficiency score: for the same tax revenue, lower expenditure brings the municipality to be logically more efficient; considering another aspect, it's possible to say that this result makes look better those municipalities that try to spend in the better way the citizens contribution, because they are responsible of this.

It's interesting the outcome of the variable DIMENSION: DIM1 is the dropped variable and it's possible to observe that as the municipal size increases, the efficiency increases (as the increasing value of the intercept shows). So, as already evident from the DEA results comments, higher municipal size is preferable: certainly, the idea is linked to the discussed presence of missing increase returns to scale. Moreover, a higher municipal dimension could make possible to offer more differentiated services to the population. Furthermore, another consideration must be presented: dropping the DENSITY from the TOBIT regression model, the R^2 and the Adjusted R^2 still remains quite high. The same also applies for the variable DENSITY: dropping the variable DIMENSION, the R^2 and the Adjusted R^2 still remains quite high and in addition the variable becomes more statistically significant, in both DEA models. So, for these two variables a correlation problem is present in a certain way.

However, the variable DENSITY shows as expected a positive effect on the municipal expenditure efficiency: in DEA1 this element is reached for example in the lower per capita expenditure of the most densely populated municipalities; in DEA2 certainly this effect is mainly due to the impact of the environmental management function.

With regards to the mountain features, it's evident that the mountain feature negatively affects the level of efficiency: this is also the evidence stemming from the analysis of DEA results. The more impervious is the territory, the higher are the costs a municipality faces.

Another factor that negatively affects the municipal expenditure efficiency is the variable SEA: the sea features negatively affects the efficiency. Certainly, this sea places are subject to a greater seasonality and the resident population is lower than the effectively present. However, even if the variable TOURISM also has a negative effect on the efficiency, the interaction coefficient between TOURISM and SEA shows that the sea feature reduces the tourism negative effect: in this case such a phenomenon is justified by the highest variability in the non-sea municipality features. Furthermore it's worth noting that probably the greater tourist presence tends to increase the level of inefficiency because it brings more revenues in the municipal cash: so, there is a less felt need not to waste resources. This "wealth-effect" can be seen from the composition of the type expenditure among the different tourism classes: in the municipalities with high degree of tourism, actually there is a higher staff expenditure (the 35% vs the 31%in the other classes) necessary to maintain a heavier bureaucracy.

Finally, the variable SECOND MANDATE has a negative sign: probably, administrations that are at the second mandate tend to spend in a less prudent manner, since they have no possibility to be elected again. However, even if the variable REVENUES also has a negative effect on the efficiency, the interaction coefficient between REVENUES and SECOND MANDATE shows that second mandate makes lower the negative effect of the variable revenues: for this reason, it could be possible to say that the source of second mandate administration inefficiency is not related to a mismanagement of the municipal revenues, that instead is present in the first mandate administration, that can be unable to immediately manage in the most efficient way these resources. The overall meaning of a negative effect of the revenues could be related to an already expressed idea: the more resources are available for a municipality, the greater is the possibility to waste resources.

Conclusion

In this work I have studied the efficiency of Tuscan municipal spending by means of Data Envelopment Analysis. The data referred to municipal expenditure have been taken from the available municipal balance sheets (the so-called "Certificati consuntivi di bilancio") and the following functions have been considered: "General administration", "Environmental management", "Educational services", "Social services", "Road maintenance and local mobility" and "Local police"). The city of Firenze has been considered as an outlier because it is absolutely out of scale in comparison with all other municipalities. Therefore it has not been included in the analysis. Furthermore, the function "Environmental management" has been considered just for those municipalities which, in 2011, still applied the tax on waste (TARSU) and accordingly two different datasets have been used: the first one regards all the six fundamental functions except the function for the environmental management and considers 284 municipalities, while the second dataset is related to 192 "TARSU" municipalities and it is analyzed with respect to the whole set of functions.
It's necessary to notice that the efficiency analysis of the municipal expenditure is not seamless about the availability of suitable data to be used as input and output: as it has also captured in the literature, finding good proxies of the involved functions has been a very hard task. This has been one of the main difficult I had to face at the beginning of my thesis work. During my internship experience, it has become evident that there are missing or non-updated data; of course, this has strongly influenced the choice of good input and output.
Once the variables have been chosen, I have run a separate DEA model for each function and at the end I have constructed a global index through a weighted average, according to the weight that each function has in the total expenditure. As a further step, my work has regarded the application of Tobit regression in order to have econometric interpretation of the synthetic DEA scores. To run Tobit regression I used Stata program. I have decided the explanatory variables starting from the existing literature: I considered the municipal financial autonomy through the ratio between total tax revenues and total expenditures; the overall municipal resources, as the ratio between total revenues and the total population; the population density, as the ratio of total resident population over the municipal surface; the level of tourism through the ratio between the average annual tourist presence and the total population; as a categorical variable, 5 dimensional classes; as a dichotomous variable, the feature to be or

not sea municipalities, the feature to be or not mountain municipalities and the possibility to be or not at the second mandate of municipal government. The results of the Tobit regression confirm what one can expect in terms of positive or negative impact on the municipal efficiency, that is: the ratio between total tax revenues over total expenditures positively affects the efficiency, while the ratio between total revenues and the total population does not. Moreover, as municipal size increases, the positive impact on efficiency is always greater. The mountain municipalities turn out to have a negative impact on the efficiency and the same applies for municipalities whose government is at the second mandate. Despite the initial difficulties, the obtained results through a DEA analysis and explained by a Tobit regression appear consistent and could be a starting point to have suggestions to correct the expenditure of the inefficient municipality. Moreover, some expected evidences come out, especially regarding the long debated issue of the municipal size. In this analysis, the municipal size really affects the efficiency of the public expenditure: the bigger is a municipality, the greater is its level of public spending efficiency and the measures at regional level to reduce the present fragmentation of the Tuscan territory should actually bring to reduce waste. Certainly, through this work, strengths and limitations of the DEA analysis have been tested: as it is suggested in the related literature, to test the robustness and the confidence of the obtained results it could be preferable to further investigate this issue even with other methods, like Stochastic Frontier Analysis, and to make a comparison among results.

Appendix A

DEA model and Tobit regression

DEA

The DEA methodology originates from Farrell's (1957) seminal work, for the measurement of productive efficiency based on a production possibility set, and reformulated as a mathematical programming problem by Charnes, Cooper and Rhodes (1978) . This technique was initially born in operations research for measuring and comparing the relative efficiency of a set of decision-making units (DMUs). Since that seminal paper, numerous theoretical improvements and empirical applications of this technique have appeared in the productive efficiency literature.

The model developed in Charnes, Cooper and Rhodes (1978), known as the CCR model, imposes three restrictions on the frontier technology:

- constant returns to scale,
- convexity of the set of feasible input-output combinations and
- strong disposability of inputs and outputs.

The aim of DEA (and also of FDH) analysis is to calculate the so called "efficiency scores" (or "efficiency degrees"). The calculation is based on distance functions but can also stated as the solution to a linear programming. More precisely, the efficiency score can be calculated by means of the following mathematical programming formulation:

$$\min \theta \qquad (1)$$
$$\text{s.t.}\ \theta x_{ij} - \sum_{j \in N} \lambda_j x_{ij} \geq 0 \qquad \text{i} \in \text{H} \qquad (2)$$
$$\sum_{j \in N} \lambda_j y_{rj} \geq \text{y}_{rj} \qquad \text{r} \in \text{K} \qquad (3)$$
$$\lambda_j \geq 0 \qquad (\text{j} \in \text{N}) \qquad \theta \text{free} \qquad (4)$$

On the basis of the optimal value of the variable λ_j , j∈N, it's possible to construct an ideal unit, that lies on the efficient frontier and that is used as a benchmark for the DMU_j. The two constraints impose that this unit uses an amount of input equal to a fraction of that used by the DMU_j and produces an amount of output at least equal to that produced by DMU_j.

In addition, for each feasible solution (θ,λ) it's possible to define the slack variables

$$
\begin{aligned}
s_i^- &= \theta x_{ij} - \sum_{j \in N} \lambda_j x_{ij} \qquad && i \in H, \\
s_r^+ &= \sum_{j \in N} \lambda_j y - y_{rj} \qquad && r \in K.
\end{aligned}
$$

which mean that the DMU_j, respectively, uses more inputs it's necessary (s_i^-, $i \in H$)and produces lower level of outputs it can do (s_r^+, $r \in K$).

The DMU_j is *efficient* if $\theta^* = 1$ and if the optimal value of the slack variables is equal to zero.

If the optimal solution is $\theta^* = 1$ but some values of the slack variables are different from zero, then the DMU_j presents a *mix inefficiency*: if the slack variables related to inputs are positive, it means that the DMU can produce the same quantity of output reducing the level of some inputs; instead, if the slack variables related to the output are positive, it means that the DMU can produce more of some outputs using the same quantity of inputs and without reducing the production of other outputs.

If $\theta^* < 1$, the DMU has a *technical inefficiency*: it's possible to get the same level of output reducing simultaneously all the quantities of input.

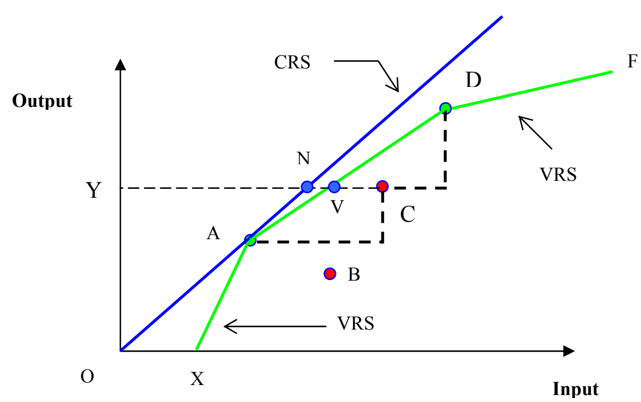
The dual version of the above model is often used in Operation Research techniques. This dual formulation can be obtained as the maximum of a ratio of weighted outputs to weighted inputs subject to the constraint that the similar ratios for every DMU be less than or equal to unity:

$$
\begin{aligned}
\max \varphi = \sum_{r \in K} u_r y_{rj} \qquad & & (1) \\
\text{s.t. } \sum_{i \in H} v_i x_{ij} = 1 \qquad & & (2) \\
\sum_{r \in K} u_r y_{rj} - \sum_{i \in H} v_i x_{ij} \le 0 \qquad & \text{j} \in \text{N} & (3) \\
u_r, v_i \ge 0 \qquad & \text{r} \in \text{K, i} \in \text{H} & (4)
\end{aligned}
$$

Charnes, Cooper and Rhodes (1978) assume Constant Returns to Scale (CRS) in their initial approach. The CRS restriction assumes that all DMU's under analysis are performing at an optimal scale. In the real world, however, this optimal behaviour is often precluded by a variety of circumstances such as different types of market power, constraints on finances, externalities, imperfect competition, etc. In all these cases, the CRS specification given by Charnes, Cooper and Rhodes (1978) yields misleading measures of technical efficiency in the sense that technical efficiency scores reported under that set of constraints are biased by scale efficiencies. This important shortcoming is corrected mostly by Banker, Charnes and Cooper (1984), who extended DEA to the case of Variable Returns to Scale (VRS). Variable Returns to Scale are modeled by adding the convexity constraint $\sum_{j \in N} \lambda_j = 1$ to the model formulated above . This final constraint simply guarantees that each DMU is only compared to others of similar size. This mode of operation avoids the damaging effect of scale efficiency on the technical efficiency scores. The resulting linear programming problem can be expressed as:

$$
\begin{aligned}
&\min \theta \\
&\text{s.t.}\theta x_{ij} - \sum_{j \in N} \lambda_j x_{ij} \geq 0 \qquad \text{i}\in\text{H} \\
&\sum_{j \in N} \lambda_j y_{rj} \geq \text{y}_{rj} \quad \text{r} \in \text{K} \\
&\sum_{j \in N} \lambda_j = 1 \\
&\lambda_j \geq 0 \qquad (\text{j} \in \text{N}) \qquad \theta\text{free}
\end{aligned}
$$

In order to see graphically these two different approaches, consider the following representation in one input-one output space:



Tobit regression

The Tobit model is a statistical model proposed by James Tobin (1958) to describe the relationship between a non-negative dependent variable and an independent variable. The term *Tobit* was derived from Tobin's name by truncating and adding *-it* by analogy to the probit model.

The formulation of the standard Tobit model censored at an upper value of one is the following:

$$\begin{aligned} \theta_k^* &= \beta' z_k + \epsilon_k \qquad & k=1,\dots,n \\ \text{where } \theta_k &= \theta_k^* \qquad & \text{if } 0 < \theta_k^* < 1 \\ \theta_k &= 0 \qquad & \text{if } \theta_k^* \leq 0 \ , \\ \theta_k &= 1 \qquad & \text{if } \theta_k^* \geq 1 \ , \end{aligned}$$

where θ_k denotes the efficiency score of the k-th municipality, β is a $r \times 1$ vector of unknown, z is a $r \times 1$ vector of independent variables and ϵ_k are assumed to be i.i.d. residuals from a N$(0,\sigma_\epsilon^2)$.

Behind the Tobit model there is the idea that θ_k^* has a latent character as it is not directly observed. The estimated efficiency value θ_k is used to determine θ_k^* depending on which values it takes: for θ_k^* between zero and one both θ_k and z_k are observed, while for $\theta_k^* \leq 0$ or for $\theta_k^* \geq 1$ the z_k is observed and the θ_k is censored respectively to zero or to one.

Regarding DEA applications, its efficiency scores can assume values ranging from 0 and 1. In general, a Tobit regression focuses on bound values, while a linear regression model covers values ranging from $-\infty$ to $+\infty$: for this reason, to regress DEA efficiency scores, it's preferable to use a Tobit regression rather than a general OLS, since it can focus just on the limited distribution and gives more efficient results.

Appendix B

Data sources

Municipal balance sheets

All municipalities are required to publish municipal balance sheets on an annual basis to certify their primary accounting data for the previous fiscal year: those data are collected by the Home office Ministry (Ministero degli Interni).

The municipal balance sheet is the instrument of planning and economic and financial management of Italian municipalities: it contains the details of all revenue and expenditure of the municipality in respect of both the fiscal year (assessments and commitments that are respectively revenues to be collected or expenditure to be paid by the municipality in a financial year, whether collected/paid or not) and the cash management (receipts and payments that are respectively the amount of money moving into and out in a financial year, regardless whether appropriations and assessed expenditures refer to the current or past financial years).

The balance sheet items represent the greatest aggregation of the revenue and expenditure transactions. The revenues are expressed in six items:

1. taxes;
2. contributes and current transfers;
3. extra-taxes;
4. alienation and amortization of property goods and credits collection;
5. loans apply;
6. services for third parties revenues.

The expenditures are expressed in four items:

1. current (of operation and maintenance);
2. in capital account (or of investment);

3. loans refund.
4. services for third parties expenditures.

In particular, the expenditure items is a macro-category that groups the expenditure functions: each function represents an abstract case of the municipal activities and it is divided into services, that are the singular operative fields of a municipality (for example, in the current expenditure item, the function for the general administration covers the services regarding the institutional bodies, the administrative office, the management of tax revenue, the technical office, military services, civil registration and electoral services, vital records and statistics).

Finally, it's worth mentioning that for this thesis specifically Tuscany Region elaborations from the data of the Home office Ministry (Ministero degli Interni) have been used. In particular, municipal balance sheets have been used for the general summary of the expenditures, for the current expenditures according to the different functions, for the tax and general revenues.

ISTAT

The Italian National Institute of Statistics is a public research organisation. It has been present in Italy since 1926 and it is the main producer of official statistics in the service of citizens and policy-makers. It operates in complete independence and continuous interaction with the academic and scientific communities.

In this thesis, the data taken from the ISTAT regard first of all the list and the official code of the Tuscan municipalities. Furthermore, the ISTAT municipalities "mountain" classification derived by UNCEM (Unione Nazionale Comuni Comunit Enti Montani), in line with the legislative definition, is considered. Also the classification by Local Labour Systems is based on ISTAT elaboration. In addition, the ISTAT classification regarding the capacity of accommodation establishments for the dummy variable "SEA" is used. Finally, data regarding the surface of each municipality are taken.

DEMO ISTAT

ISTAT provides in this section recent official data specifically on resident population in the Italian municipalities. Data are collected from the Population Register Offices and will be updated from time to time with the last available year. Elaborations on main demographic phenomena are also provided in this section.

In this thesis, DEMO ISTAT data are taken for resident population, population from 3 to 13 years old, population from 0 to 5 and over 65 years old and the immigrant population.

Tuscany Region

Tuscany Region also provides data stemming from researches focused mainly on the Tuscan reality. In particular, it is organized by Regional Observatories, linked with different research areas.

For example in this thesis data referred to kilometers of roads are taken from the Mobility and Transport Regional Observatory, while data referred to the tourist presence are taken from another survey.

ARRR

The "Agenzia Regionale Recupero Risorse Spa" (also known as ARRR SpA) is a company that performs instrumental services to the only shareholder, that is the Tuscany Region. The company is regulated by Regional Law 87/2009 which has changed the corporate structure to play an important role in assisting and supporting the activities of the of Tuscany Region in the field of waste management and remediation of contaminated sites.

Data regarding the produced municipal waste are taken from ARRR as a proxy for the environmental management function, in this context.

ANCI Toscana

The ANCI (i.e. the "Associazione Nazionale dei Comuni Italiani") is an unified association of national character: municipalities adhere to it without distinction of demographic importance. The main purpose of ANCI, and reason for its establishment, is the defense and affirmation of the principle of local autonomy, which finds recognition in the Italian Constitution.

The National Association shall consist of the regional associations: this is the case of ANCI TOSCANA, that obviously covers the Tuscan municipalities.

In this context, from ANCI TOSCANA data from the election timetables to define the "SECOND MANDATE" variable are considered.

Appendix C

Tables for DEA1 and DEA2

Table C.1: DEA1 results: general administration function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abbadia San Salvatore	0.678	0.683	0.991	irs
Abetone	0.138	0.215	0.64	irs
Agliana	0.942	0.969	0.972	drs
Altopascio	0.664	0.681	0.975	drs
Anghiari	0.642	0.654	0.982	irs
Arcidosso	0.455	0.474	0.959	irs
Arezzo	0.669	0.845	0.791	drs
Asciano	0.555	0.556	0.997	irs
Aulla	0.589	0.599	0.983	drs
Badia Tedalda	0.476	0.634	0.751	irs
Bagni di Lucca	0.453	0.458	0.988	irs
Bagno a Ripoli	0.652	0.676	0.964	drs
Bagnone	0.23	0.267	0.859	irs
Barberino di Mugello	0.597	0.605	0.986	drs
Barberino Val d'Elsa	0.315	0.328	0.961	irs
Barga	0.507	0.514	0.987	drs
Bibbiena	0.744	0.759	0.98	drs
Bibbona	0.274	0.294	0.93	irs
Bientina	0.773	0.774	0.999	drs
Borgo a Mozzano	0.515	0.517	0.997	irs

CRS TE-constant return to scale technical efficiency

VRS TE-variable return to scale "pure" technical efficiency

SCALE-scale efficiency

RTS-returns to scale

Municipality	CRS TE	VRS TE	SCALE	RTS
Borgo San Lorenzo	0.731	0.753	0.971	drs
Bucine	0.658	0.666	0.987	drs
Buggiano	0.701	0.706	0.993	drs
Buonconvento	0.435	0.468	0.929	irs
Buti	0.681	0.693	0.983	irs
Calci	0.551	0.557	0.99	irs
Calcinaia	0.68	0.693	0.982	drs
Calenzano	0.634	0.652	0.972	drs
Camaiore	0.622	0.659	0.945	drs
Campagnatico	0.439	0.488	0.899	irs
Campi Bisenzio	0.51	0.563	0.905	drs
Campiglia Marittima	0.629	0.643	0.978	drs
Campo nell'Elba	0.24	0.249	0.964	irs
Camporgiano	0.793	0.895	0.886	irs
Cantagallo	0.377	0.407	0.926	irs
Capalbio	0.416	0.436	0.954	irs
Capannoli	0.748	0.757	0.988	irs
Capannori	0.473	0.526	0.9	drs
Capoliveri	0.285	0.301	0.947	irs
Capolona	0.827	0.846	0.978	irs
Capraia e Limite	0.809	0.811	0.998	irs
Capraia Isola	0.188	0.488	0.386	irs
Caprese Michelangelo	0.508	0.622	0.818	irs
Careggine	0.271	0.47	0.576	irs
Carmignano	0.923	0.945	0.976	drs
Carrara	0.615	0.735	0.837	drs
Casale Marittimo	0.415	0.552	0.753	irs
Casciana Terme	0.496	0.526	0.943	irs
Cascina	0.728	0.807	0.903	drs
Casola in Lunigiana	0.389	0.529	0.735	irs
Casole d'Elsa	0.449	0.473	0.95	irs
Castagneto Carducci	0.447	0.449	0.994	drs
Castel del Piano	0.496	0.514	0.966	irs
Castel Focognano	0.618	0.664	0.931	irs
Castel San Niccolò	0.574	0.63	0.911	irs
Castelfiorentino	0.814	0.838	0.971	drs
Castelfranco di Sopra	0.665	0.72	0.924	irs
Castelfranco di Sotto	0.583	0.596	0.979	drs
Castell'Azzara	0.343	0.414	0.829	irs
Castellina in Chianti	0.408	0.445	0.917	irs
Castellina Marittima	0.432	0.499	0.865	irs
Castelnuovo Berardenga	0.615	0.619	0.993	drs
Castelnuovo di Garfagnana	0.519	0.526	0.986	irs
Castelnuovo di Val di Cecina	0.385	0.435	0.886	irs
Castiglion Fibocchi	0.477	0.541	0.882	irs
Castiglione della Pescaia	0.204	0.205	0.996	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castiglione di Garfagnana	0.597	0.7	0.854	irs
Castiglione d'Orcia	0.396	0.442	0.897	irs
Cavriglia	0.547	0.553	0.99	drs
Cecina	0.67	0.696	0.963	drs
Cerreto Guidi	0.86	0.872	0.986	drs
Certaldo	0.686	0.705	0.973	drs
Cetona	0.46	0.502	0.915	irs
Chianciano Terme	0.473	0.475	0.996	irs
Chianni	0.369	0.455	0.811	irs
Chiesina Uzzanese	0.786	0.816	0.963	irs
Chitignano	0.569	0.792	0.718	irs
Chiusdino	0.356	0.417	0.854	irs
Chiusi	0.673	0.678	0.993	drs
Chiusi della Verna	0.432	0.496	0.87	irs
Cinigiano	0.447	0.493	0.907	irs
Civitella in Val di Chiana	0.861	0.868	0.991	drs
Civitella Paganico	0.306	0.33	0.927	irs
Colle di Val d'Elsa	0.864	0.893	0.967	drs
Collesalvetti	0.643	0.661	0.972	drs
Comano	0.465	0.699	0.665	irs
Coreglia Antelminelli	0.529	0.541	0.976	irs
Cortona	0.768	0.795	0.966	drs
Crespina	0.504	0.527	0.956	irs
Cutigliano	0.27	0.327	0.825	irs
Dicomano	0.844	0.86	0.982	irs
Empoli	0.896	1	0.896	drs
Fabbriche di Vallico	0.167	0.345	0.483	irs
Fauglia	0.465	0.494	0.942	irs
Fiesole	0.41	0.42	0.976	drs
Figline Valdarno	0.762	0.784	0.972	drs
Filattiera	0.492	0.552	0.891	irs
Firenzuola	0.549	0.566	0.969	irs
Fivizzano	0.613	0.615	0.996	drs
Foiano della Chiana	0.746	0.753	0.99	drs
Follonica	0.389	0.402	0.967	drs
Forte dei Marmi	0.162	0.162	1	-
Fosciandora	0.244	0.399	0.611	irs
Fosdinovo	0.623	0.641	0.972	irs
Fucecchio	0.835	0.865	0.966	drs
Gaiole in Chianti	0.418	0.458	0.913	irs
Gallicano	0.352	0.371	0.95	irs
Gambassi Terme	0.801	0.825	0.971	irs
Gavorrano	0.616	0.62	0.994	drs
Giuncugnano	0.358	0.782	0.458	irs
Greve in Chianti	0.732	0.749	0.977	drs
Grosseto	0.762	0.938	0.813	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Guardistallo	0.375	0.48	0.781	irs
Impruneta	0.553	0.567	0.975	drs
Incisa in Val d'Arno	0.695	0.703	0.989	irs
Isola del Giglio	0.182	0.226	0.805	irs
Lajatico	0.367	0.458	0.8	irs
Lamporecchio	1	1	1	-
Larciano	0.712	0.719	0.99	irs
Lari	0.552	0.556	0.993	drs
Lastra a Signa	0.563	0.581	0.969	drs
Laterina	0.632	0.672	0.94	irs
Licciana Nardi	0.605	0.623	0.971	irs
Livorno	0.531	0.697	0.761	drs
Londa	0.444	0.521	0.852	irs
Lorenzana	0.511	0.662	0.772	irs
Loro Ciuffenna	0.759	0.771	0.984	irs
Lucca	0.75	0.935	0.802	drs
Lucignano	0.517	0.549	0.943	irs
Magliano in Toscana	0.401	0.425	0.943	irs
Manciano	0.497	0.498	0.998	irs
Marciana	0.225	0.255	0.88	irs
Marciana Marina	0.196	0.227	0.862	irs
Marciano della Chiana	0.76	0.812	0.937	irs
Marliana	0.518	0.557	0.93	irs
Marradi	0.544	0.584	0.932	irs
Massa	0.517	0.624	0.829	drs
Massa e Cozzile	0.865	0.867	0.999	drs
Massa Marittima	0.55	0.553	0.994	drs
Massarosa	0.563	0.582	0.966	drs
Minucciano	0.421	0.478	0.882	irs
Molazzana	0.394	0.518	0.76	irs
Monsummano Terme	0.755	0.78	0.968	drs
Montaione	0.376	0.397	0.947	irs
Montalcino	0.298	0.306	0.975	irs
Montale	0.752	0.763	0.985	drs
Monte Argentario	0.371	0.379	0.98	drs
Monte San Savino	0.787	0.792	0.993	drs
Montecarlo	0.866	0.899	0.963	irs
Montecatini Val di Cecina	0.36	0.424	0.85	irs
Montecatini-Terme	0.435	0.449	0.969	drs
Montelupo Fiorentino	0.811	0.83	0.977	drs
Montemignaio	0.28	0.502	0.558	irs
Montemurlo	0.497	0.512	0.971	drs
Montepulciano	0.552	0.566	0.976	drs
Monterchi	0.488	0.573	0.85	irs
Monteriggioni	0.669	0.675	0.99	drs
Monteroni d'Arbia	0.691	0.696	0.993	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Montescudaio	0.414	0.48	0.864	irs
Montespertoli	0.745	0.762	0.978	drs
Montevarchi	0.672	0.696	0.965	drs
Monteverdi Marittimo	0.177	0.262	0.673	irs
Monticiano	0.335	0.409	0.818	irs
Montieri	0.197	0.258	0.763	irs
Montignoso	0.599	0.608	0.987	drs
Montopoli in Val d'Arno	0.873	0.887	0.983	drs
Mulazzo	0.658	0.73	0.902	irs
Murlo	0.423	0.474	0.892	irs
Orbetello	0.443	0.455	0.975	drs
Orciano Pisano	0.624	1	0.624	irs
Ortignano Raggiolo	0.516	0.734	0.704	irs
Palaia	0.568	0.589	0.965	irs
Palazzuolo sul Senio	0.306	0.396	0.771	irs
Peccioli	0.29	0.298	0.971	irs
Pelago	0.648	0.649	0.999	-
Pergine Valdarno	0.739	0.794	0.93	irs
Pescaglia	0.595	0.631	0.943	irs
Pescia	0.673	0.695	0.969	drs
Pian di Sco	0.805	0.813	0.99	irs
Piancastagnaio	0.676	0.707	0.957	irs
Piazza al Serchio	0.654	0.73	0.896	irs
Pienza	0.406	0.464	0.876	irs
Pietrasanta	0.414	0.428	0.965	drs
Pieve a Nievole	0.975	0.985	0.99	drs
Pieve Fosciana	0.601	0.672	0.894	irs
Pieve Santo Stefano	0.53	0.571	0.929	irs
Piombino	0.611	0.654	0.933	drs
Pisa	0.444	0.553	0.804	drs
Pistoia	0.627	0.784	0.8	drs
Piteglio	0.298	0.351	0.849	irs
Pitigliano	0.461	0.485	0.949	irs
Podenzana	0.663	0.756	0.877	irs
Poggibonsi	0.963	1	0.963	drs
Poggio a Caiano	0.374	0.378	0.989	drs
Pomarance	0.305	0.31	0.984	irs
Ponsacco	0.87	0.893	0.974	drs
Pontassieve	0.575	0.594	0.968	drs
Ponte Buggianese	0.956	0.962	0.993	drs
Pontedera	0.475	0.493	0.963	drs
Pontremoli	0.457	0.457	1	-
Poppi	0.708	0.717	0.988	irs
Porcari	0.649	0.653	0.994	drs
Porto Azzurro	0.375	0.396	0.949	irs
Portoferraio	0.489	0.498	0.982	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Prato	0.754	1	0.754	drs
Pratovecchio	0.729	0.787	0.926	irs
Quarrata	0.866	0.898	0.964	drs
Radda in Chianti	0.324	0.387	0.838	irs
Radicofani	0.336	0.441	0.764	irs
Radicondoli	0.106	0.149	0.716	irs
Rapolano Terme	0.482	0.495	0.974	irs
Reggello	0.789	0.811	0.973	drs
Rignano sull'Arno	0.848	0.853	0.994	drs
Rio Marina	0.277	0.313	0.882	irs
Rio nell'Elba	0.142	0.185	0.768	irs
Riparbella	0.343	0.412	0.833	irs
Roccalbegna	0.315	0.419	0.752	irs
Roccastrada	0.678	0.685	0.99	drs
Rosignano Marittimo	0.498	0.527	0.946	drs
Rufina	0.779	0.78	0.998	irs
Sambuca Pistoiese	0.357	0.426	0.838	irs
San Casciano dei Bagni	0.336	0.403	0.833	irs
San Casciano in Val di Pesa	0.784	0.806	0.972	drs
San Gimignano	0.47	0.47	1	-
San Giovanni d'Asso	0.246	0.348	0.708	irs
San Giovanni Valdarno	0.631	0.649	0.972	drs
San Giuliano Terme	0.48	0.505	0.95	drs
San Godenzo	0.339	0.437	0.777	irs
San Marcello Pistoiese	0.619	0.624	0.992	irs
San Miniato	0.601	0.624	0.963	drs
San Piero a Sieve	0.678	0.708	0.958	irs
San Quirico d'Orcia	0.482	0.53	0.909	irs
San Romano in Garfagnana	0.367	0.453	0.81	irs
San Vincenzo	0.296	0.297	0.996	irs
Sansepolcro	0.724	0.745	0.973	drs
Santa Croce sull'Arno	0.643	0.658	0.976	drs
Santa Fiora	0.435	0.479	0.908	irs
Santa Luce	0.4	0.473	0.845	irs
Santa Maria a Monte	0.83	0.848	0.979	drs
Sarteano	0.534	0.551	0.968	irs
Sassetta	0.242	0.46	0.526	irs
Scandicci	0.838	0.95	0.882	drs
Scansano	0.396	0.41	0.964	irs
Scarlino	0.329	0.348	0.945	irs
Scarperia	0.515	0.516	0.999	drs
Seggiano	0.279	0.38	0.734	irs
Semproniano	0.385	0.506	0.761	irs
Seravezza	0.635	0.649	0.978	drs
Serravalle Pistoiese	0.823	0.837	0.982	drs
Sestino	0.572	0.71	0.806	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Sesto Fiorentino	0.737	0.827	0.891	drs
Siena	0.354	0.406	0.87	drs
Signa	0.72	0.742	0.971	drs
Sillano	0.312	0.488	0.641	irs
Sinalunga	0.689	0.703	0.98	drs
Sorano	0.525	0.557	0.942	irs
Sovicille	0.787	0.797	0.988	drs
Stazzema	0.512	0.549	0.933	irs
Stia	0.548	0.597	0.918	irs
Subbiano	0.764	0.772	0.989	irs
Suvereto	0.705	0.76	0.927	irs
Talla	0.467	0.616	0.759	irs
Tavarnelle Val di Pesa	0.585	0.585	0.999	-
Terranuova Bracciolini	0.439	0.448	0.98	drs
Terricciola	0.581	0.603	0.964	irs
Torrita di Siena	0.652	0.653	0.998	irs
Trequanda	0.331	0.417	0.794	irs
Tresana	0.481	0.551	0.874	irs
Uzzano	0.787	0.802	0.982	irs
Vagli Sotto	0.25	0.342	0.731	irs
Vaglia	0.504	0.518	0.973	irs
Vaiano	0.694	0.702	0.988	drs
Vecchiano	0.727	0.742	0.98	drs
Vergemoli	0.224	0.699	0.321	irs
Vernio	0.542	0.55	0.986	irs
Viareggio	0.366	0.434	0.844	drs
Vicchio	0.709	0.711	0.997	drs
Vicopisano	0.973	0.979	0.994	drs
Villa Basilica	0.178	0.213	0.84	irs
Villa Collemandina	0.634	0.795	0.798	irs
Villafranca in Lunigiana	0.579	0.599	0.968	irs
Vinci	0.736	0.754	0.976	drs
Volterra	0.557	0.565	0.985	drs
Zeri	0.402	0.521	0.772	irs

Table C.2: DEA1 results: educational services function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abbadia San Salvatore	0.159	0.166	0.955	irs
Abetone	0.065	0.119	0.548	irs
Agliana	0.184	0.394	0.466	drs
Altopascio	0.282	0.598	0.47	drs
Anghiari	0.191	0.2	0.954	irs
Arcidosso	0.109	0.118	0.923	irs
Arezzo	0.164	0.785	0.209	drs
Asciano	0.142	0.145	0.98	irs
Aulla	0.121	0.122	0.999	-
Badia Tedalda	0.047	0.076	0.62	irs
Bagni di Lucca	0.116	0.12	0.962	irs
Bagno a Ripoli	0.123	0.316	0.391	drs
Bagnone	0.111	0.141	0.789	irs
Barberino di Mugello	0.156	0.187	0.836	drs
Barberino Val d'Elsa	0.191	0.202	0.947	irs
Barga	0.088	0.088	0.996	-
Bibbiena	0.2	0.303	0.659	drs
Bibbona	0.068	0.076	0.892	irs
Bientina	0.193	0.195	0.992	irs
Borgo a Mozzano	0.163	0.166	0.977	irs
Borgo San Lorenzo	0.178	0.393	0.452	drs
Bucine	1	1	1	-
Buggiano	0.148	0.149	0.993	irs
Buonconvento	0.146	0.161	0.904	irs
Buti	0.204	0.212	0.962	irs
Calci	0.182	0.188	0.97	irs
Calcinaia	0.257	0.396	0.648	drs
Calenzano	0.195	0.397	0.491	drs
Camaiore	0.176	0.486	0.363	drs
Campagnatico	0.163	0.191	0.853	irs
Campi Bisenzio	0.319	1	0.319	drs
Campiglia Marittima	0.222	0.311	0.715	drs
Campo nell'Elba	0.101	0.107	0.94	irs
Camporgiano	0.103	0.123	0.834	irs
Cantagallo	0.339	0.376	0.902	irs
Capalbio	0.097	0.106	0.907	irs
Capannoli	0.254	0.26	0.975	irs
Capannori	0.197	0.61	0.324	drs
Capoliveri	0.109	0.119	0.917	irs
Capolona	0.144	0.15	0.963	irs
Capraia e Limite	0.232	0.235	0.988	irs
Capraia Isola	0.035	0.113	0.307	irs
Caprese Michelangelo	0.077	0.106	0.728	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Careggine	0.108	0.236	0.455	irs
Carmignano	0.183	0.377	0.486	drs
Carrara	0.169	0.607	0.279	drs
Casale Marittimo	0.105	0.164	0.641	irs
Casciana Terme	0.227	0.244	0.928	irs
Cascina	0.184	0.566	0.326	drs
Casola in Lunigiana	0.064	0.111	0.576	irs
Casole d'Elsa	0.096	0.102	0.941	irs
Castagneto Carducci	0.133	0.135	0.985	irs
Castel del Piano	0.152	0.163	0.937	irs
Castel Focognano	0.101	0.114	0.888	irs
Castel San Niccolò	0.099	0.114	0.868	irs
Castelfiorentino	0.148	0.312	0.474	drs
Castelfranco di Sopra	0.155	0.171	0.904	irs
Castelfranco di Sotto	0.395	0.637	0.62	drs
Castell'Azzara	0.065	0.099	0.659	irs
Castellina in Chianti	0.106	0.118	0.898	irs
Castellina Marittima	0.12	0.146	0.822	irs
Castelnuovo Berardenga	0.152	0.153	0.996	irs
Castelnuovo di Garfagnana	0.139	0.144	0.965	irs
Castelnuovo di Val di Cecina	0.113	0.135	0.837	irs
Castiglion Fibocchi	0.203	0.235	0.867	irs
Castiglione della Pescaia	0.096	0.1	0.954	irs
Castiglione di Garfagnana	0.118	0.148	0.795	irs
Castiglione d'Orcia	0.105	0.127	0.826	irs
Cavriglia	0.193	0.211	0.914	drs
Cecina	0.2	0.509	0.393	drs
Cerreto Guidi	0.145	0.187	0.778	drs
Certaldo	0.138	0.263	0.527	drs
Cetona	0.132	0.152	0.867	irs
Chianciano Terme	0.103	0.106	0.97	irs
Chianni	0.059	0.081	0.73	irs
Chiesina Uzzanese	0.203	0.215	0.947	irs
Chitignano	0.14	0.206	0.682	irs
Chiusdino	0.079	0.098	0.806	irs
Chiusi	0.182	0.186	0.981	irs
Chiusi della Verna	0.055	0.069	0.805	irs
Cinigiano	0.072	0.087	0.836	irs
Civitella in Val di Chiana	0.181	0.182	0.995	irs
Civitella Paganico	0.089	0.1	0.893	irs
Colle di Val d'Elsa	0.237	0.583	0.407	drs
Collesalvetti	0.148	0.299	0.495	drs
Comano	0.059	0.115	0.511	irs
Coreglia Antelminelli	0.2	0.208	0.962	irs
Cortona	0.122	0.273	0.447	drs
Crespina	0.124	0.132	0.946	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Cutigliano	0.079	0.11	0.718	irs
Dicomano	0.128	0.132	0.965	irs
Empoli	0.162	0.503	0.322	drs
Fabbriche di Vallico	0.119	0.267	0.448	irs
Fauglia	0.147	0.159	0.927	irs
Fiesole	0.199	0.321	0.622	drs
Figline Valdarno	0.246	0.51	0.484	drs
Filattiera	0.097	0.117	0.828	irs
Firenzuola	0.094	0.099	0.948	irs
Fivizzano	0.079	0.082	0.96	irs
Foiano della Chiana	0.113	0.113	0.998	-
Follonica	0.228	0.502	0.453	drs
Forte dei Marmi	0.05	0.052	0.971	irs
Fosciandora	0.117	0.247	0.475	irs
Fosdinovo	0.165	0.173	0.953	irs
Fucecchio	0.226	0.566	0.399	drs
Gaiole in Chianti	0.081	0.091	0.888	irs
Gallicano	0.103	0.112	0.919	irs
Gambassi Terme	0.126	0.133	0.948	irs
Gavorrano	0.162	0.165	0.986	irs
Giuncugnano	0.063	0.149	0.425	irs
Greve in Chianti	0.151	0.294	0.512	drs
Grosseto	0.121	0.525	0.23	drs
Guardistallo	0.128	0.181	0.707	irs
Impruneta	0.204	0.365	0.56	drs
Incisa in Val d'Arno	0.125	0.13	0.966	irs
Isola del Giglio	0.171	0.25	0.685	irs
Lajatico	0.144	0.191	0.754	irs
Lamporecchio	0.126	0.129	0.981	irs
Larciano	0.155	0.161	0.967	irs
Lari	0.123	0.124	0.994	irs
Lastra a Signa	0.197	0.454	0.433	drs
Laterina	0.165	0.18	0.918	irs
Licciana Nardi	0.098	0.104	0.937	irs
Livorno	0.122	0.665	0.183	drs
Londa	0.218	0.255	0.856	irs
Lorenzana	0.126	0.175	0.718	irs
Loro Ciuffenna	0.139	0.144	0.97	irs
Lucca	0.164	0.744	0.22	drs
Lucignano	0.148	0.163	0.911	irs
Magliano in Toscana	0.135	0.15	0.899	irs
Manciano	0.145	0.151	0.966	irs
Marciana	0.073	0.09	0.812	irs
Marciana Marina	0.104	0.13	0.801	irs
Marciano della Chiana	0.138	0.148	0.937	irs
Marliana	0.128	0.144	0.891	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Marradi	0.169	0.194	0.872	irs
Massa	0.192	0.742	0.259	drs
Massa e Cozzile	0.157	0.16	0.983	irs
Massa Marittima	0.213	0.219	0.972	irs
Massarosa	0.148	0.366	0.404	drs
Minucciano	0.08	0.103	0.776	irs
Molazzana	0.13	0.201	0.647	irs
Monsummano Terme	0.179	0.418	0.43	drs
Montaione	0.106	0.115	0.921	irs
Montalcino	0.138	0.146	0.944	irs
Montale	0.121	0.134	0.901	drs
Monte Argentario	0.235	0.322	0.731	drs
Monte San Savino	0.22	0.222	0.989	irs
Montecarlo	0.245	0.259	0.946	irs
Montecatini Val di Cecina	0.073	0.097	0.749	irs
Montecatini-Terme	0.158	0.328	0.48	drs
Montelupo Fiorentino	0.148	0.292	0.507	drs
Montemignaio	0.039	0.098	0.393	irs
Montemurlo	0.179	0.398	0.45	drs
Montepulciano	0.183	0.271	0.675	drs
Monterchi	0.106	0.133	0.793	irs
Monteriggioni	0.132	0.132	0.997	-
Monteroni d'Arbia	0.115	0.115	0.996	-
Montescudaio	0.198	0.238	0.834	irs
Montespertoli	0.21	0.394	0.533	drs
Montevarchi	0.16	0.404	0.396	drs
Monteverdi Marittimo	0.102	0.163	0.627	irs
Monticiano	0.079	0.1	0.789	irs
Montieri	0.083	0.12	0.695	irs
Montignoso	0.198	0.199	0.996	irs
Montopoli in Val d'Arno	0.206	0.291	0.71	drs
Mulazzo	0.183	0.218	0.843	irs
Murlo	0.12	0.135	0.888	irs
Orbetello	0.135	0.201	0.671	drs
Orciano Pisano	0.101	0.191	0.528	irs
Ortignano Raggiolo	0.075	0.129	0.585	irs
Palaia	0.149	0.157	0.95	irs
Palazzuolo sul Senio	0.154	0.23	0.668	irs
Peccioli	0.097	0.102	0.954	irs
Pelago	0.13	0.132	0.986	irs
Pergine Valdarno	0.166	0.187	0.887	irs
Pescaglia	0.117	0.128	0.92	irs
Pescia	0.157	0.336	0.467	drs
Pian di Sco	0.21	0.214	0.977	irs
Piancastagnaio	0.149	0.164	0.91	irs
Piazza al Serchio	0.116	0.138	0.844	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Pienza	0.089	0.106	0.841	irs
Pietrasanta	0.15	0.355	0.421	drs
Pieve a Nievole	0.153	0.153	0.998	-
Pieve Fosciana	0.167	0.195	0.853	irs
Pieve Santo Stefano	0.14	0.157	0.891	irs
Piombino	0.187	0.519	0.36	drs
Pisa	0.144	0.608	0.237	drs
Pistoia	0.107	0.487	0.219	drs
Piteglio	0.075	0.095	0.782	irs
Pitigliano	0.134	0.148	0.907	irs
Podenzana	0.124	0.147	0.847	irs
Poggibonsi	0.132	0.365	0.363	drs
Poggio a Caiano	0.158	0.159	0.992	drs
Pomarance	0.125	0.133	0.942	irs
Ponsacco	0.163	0.329	0.495	drs
Pontassieve	0.109	0.247	0.44	drs
Ponte Buggianese	0.164	0.165	0.994	irs
Pontedera	0.124	0.328	0.377	drs
Pontremoli	0.129	0.133	0.968	irs
Poppi	0.166	0.172	0.964	irs
Porcari	0.176	0.177	0.995	irs
Porto Azzurro	0.327	0.352	0.927	irs
Portoferraio	0.185	0.22	0.84	drs
Prato	0.172	1	0.172	drs
Pratovecchio	0.125	0.142	0.885	irs
Quarrata	0.154	0.414	0.373	drs
Radda in Chianti	0.145	0.177	0.82	irs
Radicofani	0.11	0.167	0.659	irs
Radicondoli	0.051	0.08	0.634	irs
Rapolano Terme	0.159	0.168	0.946	irs
Reggello	0.227	0.461	0.493	drs
Rignano sull'Arno	0.143	0.143	0.999	-
Rio Marina	0.07	0.087	0.801	irs
Rio nell'Elba	0.12	0.175	0.687	irs
Riparbella	0.162	0.202	0.801	irs
Roccalbegna	0.07	0.105	0.665	irs
Roccastrada	0.115	0.116	0.99	irs
Rosignano Marittimo	0.095	0.253	0.374	drs
Rufina	0.18	0.183	0.984	irs
Sambuca Pistoiese	0.131	0.157	0.83	irs
San Casciano dei Bagni	0.052	0.075	0.702	irs
San Casciano in Val di Pesa	0.135	0.29	0.467	drs
San Gimignano	0.11	0.112	0.98	irs
San Giovanni d'Asso	0.253	0.42	0.601	irs
San Giovanni Valdarno	0.162	0.323	0.502	drs
San Giuliano Terme	0.289	0.805	0.359	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
San Godenzo	0.138	0.2	0.69	irs
San Marcello Pistoiese	0.108	0.114	0.952	irs
San Miniato	0.202	0.539	0.375	drs
San Piero a Sieve	0.123	0.131	0.938	irs
San Quirico d'Orcia	0.145	0.164	0.885	irs
San Romano in Garfagnana	0.211	0.274	0.769	irs
San Vincenzo	0.16	0.166	0.964	irs
Sansepolcro	0.162	0.283	0.572	drs
Santa Croce sull'Arno	0.176	0.324	0.541	drs
Santa Fiora	0.122	0.143	0.849	irs
Santa Luce	0.084	0.106	0.791	irs
Santa Maria a Monte	0.214	0.35	0.611	drs
Sarteano	0.149	0.159	0.943	irs
Sassetta	0.101	0.199	0.511	irs
Scandicci	0.122	0.381	0.32	drs
Scansano	0.125	0.136	0.921	irs
Scarlino	0.16	0.171	0.931	irs
Scarperia	0.139	0.141	0.989	irs
Seggiano	0.102	0.151	0.671	irs
Semproniano	0.052	0.084	0.624	irs
Seravezza	0.156	0.192	0.814	drs
Serravalle Pistoiese	0.27	0.357	0.756	drs
Sestino	0.103	0.132	0.779	irs
Sesto Fiorentino	0.245	0.764	0.321	drs
Siena	0.082	0.253	0.325	drs
Signa	0.201	0.47	0.427	drs
Sillano	0.058	0.112	0.517	irs
Sinalunga	0.191	0.247	0.775	drs
Sorano	0.105	0.121	0.872	irs
Sovicille	0.121	0.121	1	-
Stazzema	0.093	0.104	0.892	irs
Stia	0.116	0.135	0.863	irs
Subbiano	0.181	0.185	0.98	irs
Suvereto	0.169	0.189	0.898	irs
Talla	0.083	0.126	0.659	irs
Tavarnelle Val di Pesa	0.218	0.221	0.986	irs
Terranuova Bracciolini	0.184	0.301	0.611	drs
Terricciola	0.186	0.194	0.957	irs
Torrita di Siena	0.158	0.161	0.977	irs
Trequanda	0.09	0.122	0.738	irs
Tresana	0.148	0.18	0.822	irs
Uzzano	0.197	0.203	0.971	irs
Vagli Sotto	0.077	0.141	0.543	irs
Vaglia	0.136	0.143	0.955	irs
Vaiano	0.121	0.121	0.994	irs
Vecchiano	0.221	0.298	0.74	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Vergemoli	0.307	1	0.307	irs
Vernio	0.12	0.126	0.954	irs
Viareggio	0.146	0.511	0.286	drs
Vicchio	0.167	0.168	0.991	irs
Vicopisano	0.206	0.208	0.988	irs
Villa Basilica	0.083	0.108	0.772	irs
Villa Collemandina	0.102	0.141	0.724	irs
Villafranca in Lunigiana	0.128	0.139	0.925	irs
Vinci	0.235	0.422	0.557	drs
Volterra	0.111	0.112	0.99	irs
Zeri	0.053	0.086	0.609	irs

Table C.3: DEA1 results: social services function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abbadia San Salvatore	0.253	0.771	0.328	drs
Abetone	0.311	0.394	0.789	drs
Agliana	0.075	0.427	0.175	drs
Altopascio	0.168	0.952	0.177	drs
Anghiari	0.067	0.177	0.38	drs
Arcidosso	0.217	0.511	0.424	drs
Arezzo	0.114	<u>1</u>	0.114	drs
Asciano	0.139	0.441	0.315	drs
Aulla	0.199	0.873	0.227	drs
Badia Tedalda	0.034	0.05	0.681	drs
Bagni di Lucca	0.198	0.578	0.343	drs
Bagno a Ripoli	0.098	0.695	0.142	drs
Bagnone	0.263	0.467	0.562	drs
Barberino di Mugello	0.106	0.414	0.256	drs
Barberino Val d'Elsa	0.096	0.196	0.491	drs
Barga	0.235	<u>1</u>	0.235	drs
Bibbiena	0.13	0.687	0.189	drs
Bibbona	0.119	0.231	0.514	drs
Bientina	0.087	0.242	0.36	drs
Borgo a Mozzano	0.173	0.517	0.334	drs
Borgo San Lorenzo	0.076	0.46	0.165	drs
Bucine	0.029	0.119	0.244	drs
Buggiano	0.118	0.374	0.316	drs
Buonconvento	0.068	0.134	0.508	drs
Buti	0.119	0.287	0.416	drs
Calci	0.098	0.239	0.41	drs
Calcinaia	0.118	0.457	0.258	drs
Calenzano	0.078	0.444	0.176	drs
Camaiore	0.079	0.571	0.138	drs
Campagnatico	0.173	0.31	0.558	drs
Campi Bisenzio	0.125	<u>1</u>	0.125	drs
Campiglia Marittima	0.098	0.505	0.194	drs
Campo nell'Elba	0.289	0.598	0.483	drs
Camporgiano	0.345	0.602	0.573	drs
Cantagallo	0.128	0.242	0.527	drs
Capalbio	0.138	0.284	0.485	drs
Capannoli	0.127	0.321	0.397	drs
Capannori	0.09	0.707	0.127	drs
Capoliveri	0.184	0.384	0.478	drs
Capolona	0.177	0.399	0.443	drs
Capraia e Limite	0.144	0.391	0.367	drs
Capraia Isola	<u>1</u>	<u>1</u>	1	-
Caprese Michelangelo	0.157	0.24	0.653	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Careggine	0.407	0.503	0.81	drs
Carmignano	0.092	0.437	0.211	drs
Carrara	0.115	0.956	0.12	drs
Casale Marittimo	0.109	0.159	0.686	drs
Casciana Terme	0.247	0.492	0.501	drs
Cascina	0.114	0.881	0.129	drs
Casola in Lunigiana	0.283	0.416	0.68	drs
Casole d'Elsa	0.101	0.203	0.495	drs
Castagneto Carducci	0.079	0.295	0.267	drs
Castel del Piano	0.28	0.711	0.393	drs
Castel Focognano	0.184	0.361	0.509	drs
Castel San Niccolò	0.058	0.112	0.523	drs
Castelfiorentino	0.13	0.831	0.157	drs
Castelfranco di Sopra	0.038	0.07	0.548	drs
Castelfranco di Sotto	0.106	0.533	0.199	drs
Castell'Azzara	0.227	0.378	0.6	drs
Castellina in Chianti	0.125	0.247	0.508	drs
Castellina Marittima	0.166	0.255	0.65	drs
Castelnuovo Berardenga	0.06	0.194	0.309	drs
Castelnuovo di Garfagnana	0.082	0.21	0.392	drs
Castelnuovo di Val di Cecina	0.118	0.227	0.518	drs
Castiglion Fibocchi	0.269	0.458	0.587	drs
Castiglione della Pescaia	0.089	0.261	0.341	drs
Castiglione di Garfagnana	0.266	0.408	0.652	drs
Castiglione d'Orcia	0.271	0.514	0.528	drs
Cavriglia	0.092	0.293	0.313	drs
Cecina	0.098	0.702	0.139	drs
Cerreto Guidi	0.099	0.398	0.249	drs
Certaldo	0.137	0.816	0.168	drs
Cetona	0.162	0.318	0.509	drs
Chianciano Terme	0.201	0.671	0.299	drs
Chianni	0.199	0.301	0.662	drs
Chiesina Uzzanese	0.249	0.521	0.479	drs
Chitignano	0.113	0.161	0.699	drs
Chiusdino	0.163	0.29	0.561	drs
Chiusi	0.176	0.739	0.238	drs
Chiusi della Verna	0.236	0.392	0.603	drs
Cinigiano	0.382	0.761	0.501	drs
Civitella in Val di Chiana	0.051	0.169	0.3	drs
Civitella Paganico	0.055	0.111	0.495	drs
Colle di Val d'Elsa	0.152	<u>1</u>	0.152	drs
Collesalvetti	0.126	0.682	0.185	drs
Comano	0.139	0.198	0.702	drs
Coreglia Antelminelli	0.115	0.254	0.454	drs
Cortona	0.105	0.715	0.146	drs
Crespina	0.138	0.273	0.506	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Cutigliano	0.476	0.727	0.654	drs
Dicomano	0.124	0.318	0.389	drs
Empoli	0.084	0.683	0.123	drs
Fabbriche di Vallico	0.126	0.158	0.799	drs
Fauglia	0.275	0.53	0.52	drs
Fiesole	0.149	0.83	0.179	drs
Figline Valdarno	0.091	0.54	0.168	drs
Filattiera	0.198	0.367	0.539	drs
Firenzuola	0.133	0.334	0.398	drs
Fivizzano	0.229	0.841	0.273	drs
Foiano della Chiana	0.086	0.34	0.252	drs
Follonica	0.124	0.827	0.15	drs
Forte dei Marmi	0.065	0.205	0.317	drs
Fosciandora	0.135	0.173	0.78	drs
Fosdinovo	0.474	1	0.474	drs
Fucecchio	0.119	0.833	0.143	drs
Gaiole in Chianti	0.201	0.408	0.491	drs
Gallicano	0.09	0.181	0.495	drs
Gambassi Terme	0.155	0.324	0.479	drs
Gavorrano	0.248	0.85	0.292	drs
Giuncugnano	0.247	0.279	0.885	drs
Greve in Chianti	0.102	0.563	0.18	drs
Grosseto	0.092	0.782	0.117	drs
Guardistallo	0.192	0.284	0.677	drs
Impruneta	0.123	0.701	0.176	drs
Incisa in Val d'Arno	0.087	0.239	0.366	drs
Isola del Giglio	0.539	0.818	0.659	drs
Lajatico	0.209	0.314	0.665	drs
Lamporecchio	0.188	0.589	0.319	drs
Larciano	0.166	0.452	0.368	drs
Lari	0.167	0.532	0.314	drs
Lastra a Signa	0.096	0.595	0.161	drs
Laterina	0.221	0.434	0.508	drs
Licciana Nardi	0.181	0.396	0.457	drs
Livorno	0.056	0.596	0.093	drs
Londa	0.12	0.181	0.661	drs
Lorenzana	0.24	0.341	0.704	drs
Loro Ciuffenna	0.104	0.251	0.414	drs
Lucca	0.054	0.472	0.115	drs
Lucignano	0.05	0.101	0.499	drs
Magliano in Toscana	0.228	0.455	0.5	drs
Manciano	0.307	1	0.307	drs
Marciana	0.109	0.193	0.565	drs
Marciana Marina	0.158	0.244	0.647	drs
Marciano della Chiana	0.28	0.527	0.531	drs
Marliana	0.168	0.32	0.525	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Marradi	0.103	0.203	0.507	drs
Massa	0.083	0.693	0.12	drs
Massa e Cozzile	0.167	0.523	0.319	drs
Massa Marittima	0.134	0.533	0.252	drs
Massarosa	0.078	0.474	0.164	drs
Minucciano	0.204	0.351	0.581	drs
Molazzana	0.126	0.184	0.688	drs
Monsummano Terme	0.093	0.575	0.162	drs
Montaione	0.01	0.02	0.488	drs
Montalcino	0.053	0.147	0.36	drs
Montale	0.105	0.4	0.263	drs
Monte Argentario	0.113	0.517	0.218	drs
Monte San Savino	0.153	0.516	0.297	drs
Montecarlo	0.141	0.293	0.481	drs
Montecatini Val di Cecina	0.238	0.388	0.614	drs
Montecatini-Terme	0.139	0.963	0.145	drs
Montelupo Fiorentino	0.125	0.605	0.206	drs
Montemignaio	0.058	0.074	0.788	drs
Montemurlo	0.098	0.596	0.165	drs
Montepulciano	0.102	0.57	0.178	drs
Monterchi	0.311	0.482	0.645	drs
Monteriggioni	0.104	0.359	0.289	drs
Monteroni d'Arbia	0.051	0.192	0.264	drs
Montescudaio	0.132	0.202	0.65	drs
Montespertoli	0.138	0.653	0.212	drs
Montevarchi	0.12	0.859	0.14	drs
Monteverdi Marittimo	0.169	0.239	0.707	drs
Monticiano	0.215	0.376	0.571	drs
Montieri	0.254	0.396	0.642	drs
Montignoso	0.122	0.429	0.285	drs
Montopoli in Val d'Arno	0.116	0.469	0.247	drs
Mulazzo	0.162	0.302	0.538	drs
Murlo	0.124	0.225	0.551	drs
Orbetello	0.066	0.35	0.189	drs
Orciano Pisano	0.141	0.178	0.796	drs
Ortignano Raggiolo	0.053	0.072	0.735	drs
Palaia	0.182	0.376	0.483	drs
Palazzuolo sul Senio	0.029	0.043	0.681	drs
Peccioli	0.031	0.069	0.451	drs
Pelago	0.113	0.333	0.339	drs
Pergine Valdarno	0.205	0.389	0.526	drs
Pescaglia	0.148	0.29	0.509	drs
Pescia	0.121	0.783	0.154	drs
Pian di Sco	0.154	0.36	0.429	drs
Piancastagnaio	0.134	0.274	0.488	drs
Piazza al Serchio	0.211	0.354	0.597	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Pienza	0.183	0.316	0.579	drs
Pietrasanta	0.076	0.503	0.151	drs
Pieve a Nievole	0.108	0.376	0.287	drs
Pieve Fosciana	0.24	0.42	0.572	drs
Pieve Santo Stefano	0.035	0.068	0.51	drs
Piombino	0.11	0.846	0.13	drs
Pisa	0.083	0.723	0.115	drs
Pistoia	0.088	0.763	0.115	drs
Piteglio	0.235	0.4	0.588	drs
Pitigliano	0.466	0.946	0.492	drs
Podenzana	0.223	0.348	0.643	drs
Poggibonsi	0.125	0.918	0.136	drs
Poggio a Caiano	0.126	0.442	0.286	drs
Pomarance	0.153	0.432	0.354	drs
Ponsacco	0.176	0.951	0.185	drs
Pontassieve	0.065	0.424	0.154	drs
Ponte Buggianese	0.224	0.725	0.309	drs
Pontedera	0.087	0.64	0.135	drs
Pontremoli	0.157	0.557	0.281	drs
Poppi	0.04	0.113	0.351	drs
Porcari	0.084	0.276	0.306	drs
Porto Azzurro	0.163	0.325	0.499	drs
Portoferraio	0.095	0.411	0.232	drs
Prato	0.084	1	0.084	drs
Pratovecchio	0.08	0.159	0.502	drs
Quarrata	0.101	0.704	0.144	drs
Radda in Chianti	0.257	0.426	0.603	drs
Radicofani	0.203	0.292	0.697	drs
Radicondoli	0.105	0.153	0.686	drs
Rapolano Terme	0.145	0.379	0.382	drs
Reggello	0.101	0.55	0.183	drs
Rignano sull'Arno	0.104	0.325	0.319	drs
Rio Marina	0.312	0.539	0.578	drs
Rio nell'Elba	0.135	0.198	0.684	drs
Riparbella	0.211	0.326	0.647	drs
Roccalbegna	0.303	0.451	0.672	drs
Roccastrada	0.23	0.995	0.231	drs
Rosignano Marittimo	0.061	0.453	0.135	drs
Rufina	0.091	0.262	0.346	drs
Sambuca Pistoiese	0.649	1	0.649	drs
San Casciano dei Bagni	0.172	0.267	0.643	drs
San Casciano in Val di Pesa	0.129	0.764	0.169	drs
San Gimignano	0.092	0.283	0.325	drs
San Giovanni d'Asso	0.271	0.399	0.679	drs
San Giovanni Valdarno	0.089	0.555	0.16	drs
San Giuliano Terme	0.11	0.791	0.139	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
San Godenzo	0.147	0.216	0.681	drs
San Marcello Pistoiese	0.194	0.6	0.323	drs
San Miniato	0.088	0.614	0.143	drs
San Piero a Sieve	0.129	0.266	0.486	drs
San Quirico d'Orcia	0.225	0.437	0.515	drs
San Romano in Garfagnana	0.068	0.101	0.671	drs
San Vincenzo	0.072	0.225	0.319	drs
Sansepolcro	0.152	0.919	0.165	drs
Santa Croce sull'Arno	0.073	0.444	0.165	drs
Santa Fiora	0.202	0.395	0.511	drs
Santa Luce	0.14	0.214	0.653	drs
Santa Maria a Monte	0.112	0.505	0.221	drs
Sarteano	0.036	0.087	0.421	drs
Sassetta	0.231	0.305	0.757	drs
Scandicci	0.105	0.857	0.123	drs
Scansano	0.207	0.518	0.4	drs
Scarlino	0.115	0.227	0.509	drs
Scarperia	0.118	0.355	0.333	drs
Seggiano	0.229	0.344	0.665	drs
Semproniano	0.188	0.283	0.663	drs
Seravezza	0.127	0.581	0.218	drs
Serravalle Pistoiese	0.093	0.386	0.241	drs
Sestino	0.14	0.215	0.653	drs
Sesto Fiorentino	0.07	0.564	0.124	drs
Siena	0.063	0.523	0.121	drs
Signa	0.109	0.659	0.165	drs
Sillano	0.184	0.236	0.777	drs
Sinalunga	0.163	0.834	0.196	drs
Sorano	0.275	0.56	0.491	drs
Sovicille	0.126	0.529	0.239	drs
Stazzema	0.117	0.224	0.52	drs
Stia	0.163	0.321	0.507	drs
Subbiano	0.164	0.422	0.389	drs
Suvereto	0.137	0.274	0.499	drs
Talla	0.138	0.205	0.676	drs
Tavarnelle Val di Pesa	0.118	0.371	0.318	drs
Terranuova Bracciolini	0.088	0.398	0.221	drs
Terricciola	0.152	0.311	0.488	drs
Torrita di Siena	0.316	0.99	0.319	drs
Trequanda	0.173	0.261	0.661	drs
Tresana	0.248	0.437	0.568	drs
Uzzano	0.15	0.333	0.45	drs
Vagli Sotto	0.342	0.478	0.715	drs
Vaglia	0.069	0.143	0.48	drs
Vaiano	0.125	0.447	0.28	drs
Vecchiano	0.138	0.592	0.234	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Vergemoli	0.068	0.071	0.965	irs
Vernio	0.101	0.264	0.382	drs
Viareggio	0.06	0.493	0.121	drs
Vicchio	0.105	0.329	0.319	drs
Vicopisano	0.147	0.46	0.32	drs
Villa Basilica	0.127	0.194	0.655	drs
Villa Collemandina	0.254	0.378	0.672	drs
Villafranca in Lunigiana	0.143	0.328	0.436	drs
Vinci	0.093	0.505	0.184	drs
Volterra	0.117	0.509	0.229	drs
Zeri	0.333	0.508	0.655	drs

Table C.4: DEA1 results: road maintenance and local mobility function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abbadia San Salvatore	0.236	0.263	0.897	drs
Abetone	0.025	0.032	0.79	irs
Agliana	0.38	0.43	0.884	drs
Altopascio	0.656	0.842	0.779	drs
Anghiari	0.202	0.224	0.901	drs
Arcidosso	0.267	0.294	0.909	drs
Arezzo	0.283	1	0.283	drs
Asciano	0.253	0.304	0.831	drs
Aulla	0.186	0.209	0.888	drs
Badia Tedalda	0.13	0.138	0.941	irs
Bagni di Lucca	0.138	0.17	0.814	drs
Bagno a Ripoli	0.326	0.371	0.881	drs
Bagnone	0.121	0.133	0.909	drs
Barberino di Mugello	0.299	0.336	0.889	drs
Barberino Val d'Elsa	0.435	0.543	0.801	drs
Barga	0.217	0.246	0.882	drs
Bibbiena	0.298	0.336	0.887	drs
Bibbona	0.297	0.331	0.899	drs
Bientina	0.427	0.478	0.894	drs
Borgo a Mozzano	0.16	0.187	0.857	drs
Borgo San Lorenzo	0.213	0.241	0.883	drs
Bucine	0.321	0.361	0.889	drs
Buggiano	0.658	0.738	0.892	drs
Buonconvento	0.316	0.369	0.854	drs
Buti	0.25	0.278	0.901	drs
Calci	0.309	0.345	0.894	drs
Calcinaia	0.401	0.452	0.887	drs
Calenzano	0.403	0.46	0.876	drs
Camaiore	0.244	0.288	0.847	drs
Campagnatico	0.155	0.17	0.911	drs
Campi Bisenzio	0.318	0.362	0.878	drs
Campiglia Marittima	0.507	0.573	0.886	drs
Campo nell'Elba	0.155	0.172	0.899	drs
Camporgiano	0.139	0.159	0.876	drs
Cantagallo	0.161	0.199	0.812	drs
Capalbio	0.324	0.364	0.892	drs
Capannoli	0.568	0.635	0.894	drs
Capannori	0.466	1	0.466	drs
Capoliveri	0.185	0.215	0.86	drs
Capolona	0.276	0.313	0.88	drs
Capraia e Limite	0.427	0.477	0.895	drs
Capraia Isola	0.514	1	0.514	irs
Caprese Michelangelo	0.138	0.141	0.981	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Careggine	0.116	0.181	0.642	irs
Carmignano	0.458	0.517	0.885	drs
Carrara	0.143	0.363	0.395	drs
Casale Marittimo	1	1	1	-
Casciana Terme	0.36	0.393	0.915	drs
Cascina	0.878	1	0.878	drs
Casola in Lunigiana	0.085	0.101	0.849	irs
Casole d'Elsa	0.271	0.298	0.911	drs
Castagneto Carducci	0.424	0.486	0.873	drs
Castel del Piano	0.249	0.274	0.907	drs
Castel Focognano	0.126	0.15	0.837	drs
Castel San Niccolò	0.13	0.181	0.72	drs
Castelfiorentino	0.548	0.621	0.883	drs
Castelfranco di Sopra	0.219	0.237	0.925	drs
Castelfranco di Sotto	0.359	0.405	0.886	drs
Castell'Azzara	0.181	0.185	0.975	drs
Castellina in Chianti	0.314	0.422	0.743	drs
Castellina Marittima	0.252	0.295	0.855	drs
Castelnuovo Berardenga	0.313	0.569	0.551	drs
Castelnuovo di Garfagnana	0.281	0.316	0.89	drs
Castelnuovo di Val di Cecina	0.389	0.711	0.546	drs
Castiglion Fibocchi	0.133	0.14	0.945	drs
Castiglione della Pescaia	0.112	0.143	0.781	drs
Castiglione di Garfagnana	0.126	0.149	0.848	drs
Castiglione d'Orcia	0.205	0.272	0.753	drs
Cavriglia	0.474	0.532	0.89	drs
Cecina	0.28	0.319	0.88	drs
Cerreto Guidi	0.543	0.611	0.889	drs
Certaldo	0.234	0.264	0.884	drs
Cetona	0.277	0.343	0.807	drs
Chianciano Terme	0.24	0.269	0.891	drs
Chianni	0.143	0.16	0.898	drs
Chiesina Uzzanese	0.293	0.323	0.907	drs
Chitignano	0.209	0.258	0.808	irs
Chiusdino	0.254	0.267	0.949	drs
Chiusi	0.241	0.275	0.876	drs
Chiusi della Verna	0.141	0.149	0.95	drs
Cinigiano	0.166	0.178	0.932	drs
Civitella in Val di Chiana	0.302	0.399	0.758	drs
Civitella Paganico	0.177	0.2	0.884	drs
Colle di Val d'Elsa	0.256	0.299	0.857	drs
Collesalvetti	0.356	0.403	0.884	drs
Comano	0.125	0.179	0.702	irs
Coreglia Antelminelli	0.21	0.233	0.903	drs
Cortona	0.248	0.282	0.878	drs
Crespina	0.226	0.266	0.847	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Cutigliano	0.069	0.079	0.874	drs
Dicomano	0.225	0.25	0.901	drs
Empoli	0.439	0.617	0.711	drs
Fabbriche di Vallico	0.105	0.18	0.583	irs
Fauglia	0.352	0.41	0.857	drs
Fiesole	0.28	0.317	0.885	drs
Figline Valdarno	0.295	0.334	0.883	drs
Filattiera	0.132	0.14	0.941	drs
Firenzuola	0.135	0.277	0.488	drs
Fivizzano	0.171	0.21	0.818	drs
Foiano della Chiana	0.52	0.584	0.891	drs
Follonica	0.3	0.341	0.881	drs
Forte dei Marmi	0.148	0.167	0.883	drs
Fosciandora	0.332	0.348	0.954	irs
Fosdinovo	0.285	0.315	0.905	drs
Fucecchio	0.32	0.363	0.881	drs
Gaiole in Chianti	0.431	0.491	0.879	drs
Gallicano	0.158	0.172	0.914	drs
Gambassi Terme	0.379	0.422	0.897	drs
Gavorrano	0.296	0.332	0.891	drs
Giuncugnano	0.13	0.232	0.56	irs
Greve in Chianti	0.452	1	0.452	drs
Grosseto	0.317	0.994	0.319	drs
Guardistallo	0.27	0.274	0.985	drs
Impruneta	0.282	0.319	0.885	drs
Incisa in Val d'Arno	0.281	0.313	0.898	drs
Isola del Giglio	0.287	0.296	0.97	drs
Lajatico	0.179	0.202	0.888	drs
Lamporecchio	0.352	0.398	0.883	drs
Larciano	0.336	0.388	0.865	drs
Lari	0.294	0.402	0.732	drs
Lastra a Signa	0.786	0.893	0.88	drs
Laterina	0.298	0.325	0.917	drs
Licciana Nardi	0.193	0.213	0.905	drs
Livorno	0.138	0.674	0.205	drs
Londa	0.104	0.112	0.929	drs
Lorenzana	0.274	0.276	0.992	irs
Loro Ciuffenna	0.22	0.254	0.865	drs
Lucca	0.169	0.559	0.302	drs
Lucignano	0.254	0.277	0.917	drs
Magliano in Toscana	0.445	0.487	0.914	drs
Manciano	0.248	0.277	0.894	drs
Marciana	0.111	0.138	0.805	drs
Marciana Marina	0.142	0.151	0.943	drs
Marciano della Chiana	0.302	0.328	0.919	drs
Marliana	0.314	0.399	0.788	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Marradi	0.166	0.187	0.887	drs
Massa	0.33	0.924	0.357	drs
Massa e Cozzile	0.391	0.437	0.894	drs
Massa Marittima	0.329	0.369	0.891	drs
Massarosa	0.538	0.611	0.88	drs
Minucciano	0.096	0.117	0.822	drs
Molazzana	0.142	0.142	0.995	drs
Monsummano Terme	0.507	0.574	0.882	drs
Montaione	0.55	0.606	0.908	drs
Montalcino	0.144	0.168	0.859	drs
Montale	0.634	0.713	0.889	drs
Monte Argentario	0.431	0.505	0.854	drs
Monte San Savino	0.247	0.28	0.88	drs
Montecarlo	0.226	0.334	0.676	drs
Montecatini Val di Cecina	0.351	0.927	0.378	drs
Montecatini-Terme	0.178	0.202	0.881	drs
Montelupo Fiorentino	0.234	0.264	0.886	drs
Montemignaio	0.084	0.114	0.743	irs
Montemurlo	0.295	0.334	0.883	drs
Montepulciano	0.224	0.284	0.788	drs
Monterchi	0.148	0.172	0.859	drs
Monteriggioni	0.265	0.298	0.89	drs
Monteroni d'Arbia	0.433	0.485	0.892	drs
Montescudaio	0.302	0.319	0.946	drs
Montespertoli	0.608	0.735	0.828	drs
Montevarchi	0.303	0.361	0.84	drs
Monteverdi Marittimo	1	1	1	-
Monticiano	0.178	0.211	0.846	drs
Montieri	0.193	0.206	0.937	irs
Montignoso	0.142	0.159	0.889	drs
Montopoli in Val d'Arno	0.417	0.469	0.888	drs
Mulazzo	0.092	0.099	0.935	drs
Murlo	0.23	0.502	0.458	drs
Orbetello	0.344	0.389	0.883	drs
Orciano Pisano	0.312	0.504	0.619	irs
Ortignano Raggiolo	0.122	0.15	0.816	irs
Palaia	0.183	0.263	0.697	drs
Palazzuolo sul Senio	0.176	0.186	0.943	drs
Peccioli	0.14	0.257	0.543	drs
Pelago	0.344	0.384	0.895	drs
Pergine Valdarno	0.285	0.309	0.922	drs
Pescaglia	0.101	0.114	0.881	drs
Pescia	0.241	0.285	0.843	drs
Pian di Sco	0.309	0.344	0.898	drs
Piancastagnaio	0.196	0.251	0.781	drs
Piazza al Serchio	0.173	0.191	0.908	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Pienza	0.173	0.184	0.94	drs
Pietrasanta	0.206	0.259	0.794	drs
Pieve a Nievole	0.485	0.544	0.891	drs
Pieve Fosciana	0.39	0.416	0.938	drs
Pieve Santo Stefano	0.176	0.192	0.915	drs
Piombino	0.181	0.207	0.874	drs
Pisa	0.132	0.442	0.298	drs
Pistoia	0.144	0.49	0.293	drs
Piteglio	0.125	0.137	0.911	drs
Pitigliano	0.235	0.257	0.914	drs
Podenzana	0.237	0.25	0.947	drs
Poggibonsi	0.355	0.404	0.88	drs
Poggio a Caiano	0.657	0.738	0.89	drs
Pomarance	0.235	0.282	0.835	drs
Ponsacco	0.497	0.562	0.885	drs
Pontassieve	0.379	0.429	0.882	drs
Ponte Buggianese	0.664	0.744	0.892	drs
Pontedera	0.129	0.151	0.851	drs
Pontremoli	0.188	0.273	0.688	drs
Poppi	0.202	0.239	0.848	drs
Porcari	0.384	0.431	0.892	drs
Porto Azzurro	0.201	0.221	0.91	drs
Portoferraio	0.22	0.253	0.868	drs
Prato	0.192	1	0.192	drs
Pratovecchio	0.136	0.159	0.858	drs
Quarrata	0.292	0.331	0.881	drs
Radda in Chianti	0.177	0.298	0.593	drs
Radicofani	0.11	0.118	0.935	irs
Radicondoli	0.187	0.224	0.835	irs
Rapolano Terme	0.29	0.321	0.903	drs
Reggello	0.212	0.24	0.884	drs
Rignano sull'Arno	0.54	0.706	0.765	drs
Rio Marina	0.188	0.207	0.907	drs
Rio nell'Elba	0.153	0.154	0.995	drs
Riparbella	0.773	1	0.773	drs
Roccalbegna	0.129	0.143	0.905	irs
Roccastrada	0.345	0.4	0.864	drs
Rosignano Marittimo	0.154	0.177	0.867	drs
Rufina	0.455	0.509	0.895	drs
Sambuca Pistoiese	0.104	0.116	0.894	drs
San Casciano dei Bagni	0.189	0.217	0.873	drs
San Casciano in Val di Pesa	0.25	0.286	0.875	drs
San Gimignano	0.094	0.105	0.892	drs
San Giovanni d'Asso	0.12	0.142	0.846	irs
San Giovanni Valdarno	0.278	0.315	0.884	drs
San Giuliano Terme	0.344	0.448	0.768	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
San Godenzo	0.084	0.087	0.969	irs
San Marcello Pistoiese	0.175	0.21	0.836	drs
San Miniato	0.376	0.428	0.88	drs
San Piero a Sieve	0.281	0.309	0.91	drs
San Quirico d'Orcia	0.31	0.336	0.924	drs
San Romano in Garfagnana	0.096	0.104	0.924	drs
San Vincenzo	0.235	0.264	0.889	drs
Sansepolcro	0.233	0.264	0.884	drs
Santa Croce sull'Arno	0.316	0.357	0.885	drs
Santa Fiora	0.212	0.228	0.932	drs
Santa Luce	0.346	0.432	0.801	drs
Santa Maria a Monte	0.427	0.482	0.886	drs
Sarteano	0.311	0.343	0.905	drs
Sassetta	0.387	0.65	0.595	irs
Scandicci	0.27	0.45	0.601	drs
Scansano	0.23	0.254	0.907	drs
Scarlino	0.222	0.244	0.909	drs
Scarperia	0.25	0.279	0.894	drs
Seggiano	0.152	0.175	0.871	irs
Semproniano	0.213	0.226	0.942	irs
Seravezza	0.378	0.427	0.886	drs
Serravalle Pistoiese	0.348	0.427	0.816	drs
Sestino	0.13	0.131	0.991	drs
Sesto Fiorentino	0.331	0.514	0.645	drs
Siena	0.163	0.335	0.487	drs
Signa	0.401	0.454	0.883	drs
Sillano	0.087	0.106	0.817	irs
Sinalunga	0.318	0.39	0.815	drs
Sorano	0.299	0.326	0.916	drs
Sovicille	0.398	0.59	0.674	drs
Stazzema	0.1	0.109	0.921	drs
Stia	0.184	0.198	0.928	drs
Subbiano	0.176	0.196	0.898	drs
Suvereto	0.496	0.539	0.921	drs
Talla	0.142	0.143	0.994	irs
Tavarnelle Val di Pesa	0.138	0.16	0.86	drs
Terranuova Bracciolini	0.301	0.404	0.746	drs
Terricciola	0.162	0.217	0.746	drs
Torrita di Siena	0.227	0.262	0.867	drs
Trequanda	0.18	0.182	0.991	drs
Tresana	0.289	0.304	0.95	drs
Uzzano	0.584	0.648	0.901	drs
Vagli Sotto	0.116	0.129	0.902	irs
Vaglia	0.233	0.258	0.902	drs
Vaiano	0.406	0.456	0.89	drs
Vecchiano	0.383	0.459	0.834	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Vergemoli	0.064	0.095	0.667	irs
Vernio	0.336	0.38	0.885	drs
Viareggio	0.173	0.436	0.396	drs
Vicchio	0.345	0.402	0.86	drs
Vicopisano	0.253	0.295	0.859	drs
Villa Basilica	0.18	0.186	0.969	drs
Villa Collemandina	0.131	0.136	0.963	drs
Villafranca in Lunigiana	0.207	0.229	0.907	drs
Vinci	0.25	0.293	0.854	drs
Volterra	0.245	0.282	0.87	drs
Zeri	0.072	0.076	0.943	irs

Table C.5: DEA1 results: local police function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abbadia San Salvatore	0.026	0.422	0.062	drs
Abetone	0.006	0.013	0.504	drs
Agliana	0.031	0.604	0.052	drs
Altopascio	0.027	0.522	0.051	drs
Anghiari	0.029	0.453	0.064	drs
Arcidosso	0.025	0.352	0.072	drs
Arezzo	0.019	1	0.019	drs
Asciano	0.032	0.572	0.056	drs
Aulla	0.041	0.75	0.055	drs
Badia Tedalda	0.045	0.231	0.196	drs
Bagni di Lucca	0.02	0.343	0.057	drs
Bagno a Ripoli	0.023	0.467	0.05	drs
Bagnone	0.027	0.241	0.111	drs
Barberino di Mugello	0.03	0.538	0.055	drs
Barberino Val d'Elsa	0.046	0.76	0.06	drs
Barga	0.021	0.38	0.055	drs
Bibbiena	0.045	0.828	0.054	drs
Bibbona	0.027	0.419	0.064	drs
Bientina	0.031	0.511	0.06	drs
Borgo a Mozzano	0.025	0.44	0.058	drs
Borgo San Lorenzo	0.031	0.606	0.052	drs
Bucine	0.037	0.658	0.056	drs
Buggiano	0.039	0.67	0.058	drs
Buonconvento	0.019	0.253	0.073	drs
Buti	0.023	0.356	0.066	drs
Calci	0.029	0.473	0.061	drs
Calcinaia	0.029	0.531	0.055	drs
Calenzano	0.021	0.404	0.052	drs
Camaiore	0.018	0.373	0.049	drs
Campagnatico	0.024	0.258	0.094	drs
Campi Bisenzio	0.033	0.683	0.049	drs
Campiglia Marittima	0.02	0.381	0.054	drs
Campo nell'Elba	0.024	0.374	0.063	drs
Camporgiano	0.015	0.159	0.095	drs
Cantagallo	0.028	0.407	0.07	drs
Capalbio	0.022	0.323	0.069	drs
Capannoli	0.041	0.668	0.062	drs
Capannori	0.048	1	0.048	drs
Capoliveri	0.015	0.257	0.06	drs
Capolona	0.041	0.653	0.063	drs
Capraia e Limite	0.061	1	0.061	drs
Capraia Isola	0.013	0.02	0.658	drs
Caprese Michelangelo	0.038	0.158	0.241	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Careggine	0.052	0.087	0.593	drs
Carmignano	0.03	0.556	0.053	drs
Carrara	0.023	0.585	0.039	drs
Casale Marittimo	0.024	0.135	0.175	drs
Casciana Terme	0.033	0.419	0.08	drs
Cascina	0.046	0.952	0.048	drs
Casola in Lunigiana	0.022	0.046	0.49	drs
Casole d'Elsa	0.041	0.551	0.075	drs
Castagneto Carducci	0.018	0.319	0.055	drs
Castel del Piano	0.038	0.546	0.069	drs
Castel Focognano	0.033	0.465	0.071	drs
Castel San Niccolò	0.035	0.579	0.061	drs
Castelfiorentino	0.032	0.612	0.052	drs
Castelfranco di Sopra	0.039	0.415	0.094	drs
Castelfranco di Sotto	0.037	0.689	0.054	drs
Castell'Azzara	0.05	0.22	0.225	drs
Castellina in Chianti	0.016	0.261	0.062	drs
Castellina Marittima	0.029	0.305	0.095	drs
Castelnuovo Berardenga	0.031	0.862	0.036	drs
Castelnuovo di Garfagnana	0.018	0.289	0.062	drs
Castelnuovo di Val di Cecina	0.017	0.329	0.053	drs
Castiglion Fibocchi	0.025	0.192	0.13	drs
Castiglione della Pescaia	0.01	0.192	0.053	drs
Castiglione di Garfagnana	0.039	0.451	0.087	drs
Castiglione d'Orcia	0.017	0.266	0.064	drs
Cavriglia	0.042	0.733	0.057	drs
Cecina	0.025	0.501	0.049	drs
Cerreto Guidi	0.029	0.508	0.056	drs
Certaldo	0.034	0.643	0.052	drs
Cetona	0.021	0.287	0.072	drs
Chianciano Terme	0.017	0.302	0.057	drs
Chianni	0.016	0.171	0.095	drs
Chiesina Uzzanese	0.02	0.281	0.072	drs
Chitignano	0.025	0.049	0.5	drs
Chiusdino	0.158	<u>1</u>	0.158	drs
Chiusi	0.021	0.37	0.056	drs
Chiusi della Verna	0.03	0.243	0.122	drs
Cinigiano	0.02	0.203	0.101	drs
Civitella in Val di Chiana	0.053	<u>1</u>	0.053	drs
Civitella Paganico	0.016	0.205	0.077	drs
Colle di Val d'Elsa	0.028	0.555	0.051	drs
Collesalvetti	0.03	0.576	0.052	drs
Comano	0.04	0.076	0.534	drs
Coreglia Antelminelli	0.05	0.757	0.066	drs
Cortona	0.035	0.688	0.05	drs
Crespina	0.023	0.353	0.066	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Cutigliano	0.015	0.163	0.094	drs
Dicomano	0.052	0.789	0.066	drs
Empoli	0.026	0.552	0.047	drs
Fabbriche di Vallico	0.012	0.018	0.654	drs
Fauglia	0.037	0.525	0.071	drs
Fiesole	0.017	0.328	0.053	drs
Figline Valdarno	0.015	0.295	0.052	drs
Filattiera	0.02	0.157	0.13	drs
Firenzuola	0.021	0.646	0.032	drs
Fivizzano	0.016	0.285	0.055	drs
Foiano della Chiana	0.03	0.514	0.058	drs
Follonica	0.019	0.368	0.05	drs
Forte dei Marmi	0.006	0.104	0.057	drs
Fosciandora	0.096	1	0.096	drs
Fosdinovo	0.041	0.582	0.07	drs
Fucecchio	0.03	0.599	0.05	drs
Gaiole in Chianti	0.027	0.332	0.08	drs
Gallicano	0.02	0.265	0.074	drs
Gambassi Terme	0.033	0.511	0.065	drs
Gavorrano	0.038	0.66	0.058	drs
Giuncugnano	0.014	0.022	0.659	drs
Greve in Chianti	0.021	1	0.021	drs
Grosseto	0.017	0.575	0.03	drs
Guardistallo	0.026	0.162	0.162	drs
Impruneta	0.029	0.542	0.053	drs
Incisa in Val d'Arno	0.026	0.413	0.064	drs
Isola del Giglio	0.01	0.049	0.209	drs
Lajatico	0.016	0.19	0.083	drs
Lamporecchio	0.036	0.618	0.058	drs
Larciano	0.029	0.478	0.06	drs
Lari	0.019	0.357	0.053	drs
Lastra a Signa	0.039	0.763	0.051	drs
Laterina	0.037	0.452	0.081	drs
Licciana Nardi	0.02	0.3	0.067	drs
Livorno	0.018	0.935	0.019	drs
Londa	0.045	0.384	0.118	drs
Lorenzana	0.016	0.104	0.157	drs
Loro Ciuffenna	0.028	0.464	0.061	drs
Lucca	0.014	0.613	0.023	drs
Lucignano	0.022	0.278	0.078	drs
Magliano in Toscana	0.02	0.248	0.079	drs
Manciano	0.028	0.467	0.06	drs
Marciana	0.012	0.167	0.072	drs
Marciana Marina	0.011	0.08	0.137	drs
Marciano della Chiana	0.034	0.397	0.086	drs
Marliana	0.028	0.428	0.066	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Marradi	0.022	0.29	0.077	drs
Massa	0.038	1	0.038	drs
Massa e Cozzile	0.028	0.479	0.059	drs
Massa Marittima	0.022	0.383	0.058	drs
Massarosa	0.03	0.588	0.051	drs
Minucciano	0.058	0.69	0.084	drs
Molazzana	0.016	0.123	0.131	drs
Monsummano Terme	0.026	0.503	0.051	drs
Montaione	0.024	0.344	0.069	drs
Montalcino	0.015	0.244	0.062	drs
Montale	0.024	0.43	0.056	drs
Monte Argentario	0.011	0.205	0.053	drs
Monte San Savino	0.025	0.442	0.057	drs
Montecarlo	0.028	0.509	0.055	drs
Montecatini Val di Cecina	0.016	0.576	0.028	drs
Montecatini-Terme	0.01	0.206	0.05	drs
Montelupo Fiorentino	0.029	0.534	0.053	drs
Montemignaio	0.017	0.08	0.219	drs
Montemurlo	0.021	0.409	0.052	drs
Montepulciano	0.026	0.505	0.051	drs
Monterchi	0.019	0.213	0.09	drs
Monteriggioni	0.03	0.526	0.057	drs
Monteroni d'Arbia	0.022	0.384	0.058	drs
Montescudaio	0.007	0.062	0.118	drs
Montespertoli	0.029	0.554	0.052	drs
Montevarchi	0.026	0.515	0.05	drs
Monteverdi Marittimo	0.021	0.252	0.082	drs
Monticiano	0.016	0.215	0.075	drs
Montieri	0.02	0.041	0.474	drs
Montignoso	0.016	0.285	0.056	drs
Montopoli in Val d'Arno	0.027	0.483	0.055	drs
Mulazzo	0.021	0.189	0.113	drs
Murlo	0.048	1	0.048	drs
Orbetello	0.017	0.327	0.052	drs
Orciano Pisano	0.013	0.022	0.573	drs
Ortignano Raggiolo	0.024	0.059	0.41	drs
Palaia	0.019	0.333	0.056	drs
Palazzuolo sul Senio	0.021	0.206	0.103	drs
Peccioli	0.019	0.428	0.044	drs
Pelago	0.022	0.379	0.059	drs
Pergine Valdarno	0.028	0.32	0.088	drs
Pescaglia	0.018	0.246	0.073	drs
Pescia	0.022	0.435	0.051	drs
Pian di Sco	0.037	0.582	0.064	drs
Piancastagnaio	0.029	0.487	0.06	drs
Piazza al Serchio	0.038	0.401	0.096	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Pienza	0.024	0.207	0.118	drs
Pietrasanta	0.014	0.274	0.05	drs
Pieve a Nievole	0.022	0.381	0.057	drs
Pieve Fosciana	0.054	0.476	0.113	drs
Pieve Santo Stefano	0.068	0.837	0.082	drs
Piombino	0.018	0.362	0.049	drs
Pisa	0.014	0.555	0.025	drs
Pistoia	0.017	0.858	0.02	drs
Piteglio	0.02	0.177	0.115	drs
Pitigliano	0.03	0.376	0.079	drs
Podenzana	0.018	0.119	0.152	drs
Poggibonsi	0.023	0.46	0.05	drs
Poggio a Caiano	0.033	0.583	0.057	drs
Pomarance	0.028	0.477	0.059	drs
Ponsacco	0.034	0.647	0.053	drs
Pontassieve	0.025	0.495	0.051	drs
Ponte Buggianese	0.049	0.843	0.058	drs
Pontedera	0.019	0.384	0.05	drs
Pontremoli	0.026	0.494	0.052	drs
Poppi	0.023	0.382	0.059	drs
Porcari	0.029	0.509	0.057	drs
Porto Azzurro	0.02	0.272	0.075	drs
Portoferraio	0.023	0.432	0.053	drs
Prato	0.018	1	0.018	drs
Pratovecchio	0.033	0.437	0.075	drs
Quarrata	0.03	0.6	0.05	drs
Radda in Chianti	0.015	0.276	0.054	drs
Radicofani	0.024	0.076	0.311	drs
Radicondoli	0.023	0.047	0.494	drs
Rapolano Terme	0.025	0.371	0.067	drs
Reggello	0.042	0.808	0.052	drs
Rignano sull'Arno	0.034	0.624	0.054	drs
Rio Marina	0.02	0.216	0.092	drs
Rio nell'Elba	0.024	0.096	0.247	drs
Riparbella	0.049	0.802	0.061	drs
Roccalbegna	0.032	0.067	0.479	drs
Roccastrada	0.029	0.518	0.056	drs
Rosignano Marittimo	0.019	0.393	0.049	drs
Rufina	0.017	0.277	0.061	drs
Sambuca Pistoiese	0.049	0.446	0.111	drs
San Casciano dei Bagni	0.023	0.234	0.099	drs
San Casciano in Val di Pesa	0.024	0.459	0.052	drs
San Gimignano	0.016	0.279	0.058	drs
San Giovanni d'Asso	0.029	0.059	0.492	drs
San Giovanni Valdarno	0.025	0.478	0.052	drs
San Giuliano Terme	0.023	0.459	0.049	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
San Godenzo	0.468	1	0.468	drs
San Marcello Pistoiese	0.025	0.426	0.058	drs
San Miniato	0.026	0.519	0.05	drs
San Piero a Sieve	0.037	0.507	0.073	drs
San Quirico d'Orcia	0.03	0.337	0.089	drs
San Romano in Garfagnana	0.028	0.249	0.113	drs
San Vincenzo	0.02	0.359	0.056	drs
Sansepolcro	0.03	0.578	0.052	drs
Santa Croce sull'Arno	0.027	0.5	0.053	drs
Santa Fiora	0.019	0.186	0.103	drs
Santa Luce	0.057	0.839	0.068	drs
Santa Maria a Monte	0.052	0.965	0.054	drs
Sarteano	0.028	0.409	0.068	drs
Sassetta	0.055	0.094	0.589	drs
Scandicci	0.024	0.529	0.045	drs
Scansano	0.021	0.296	0.071	drs
Scarlino	0.018	0.246	0.073	drs
Scarperia	0.031	0.522	0.06	drs
Seggiano	0.029	0.059	0.486	drs
Semproniano	0.033	0.069	0.473	drs
Seravezza	0.025	0.463	0.054	drs
Serravalle Pistoiese	0.03	0.565	0.053	drs
Sestino	0.034	0.113	0.303	drs
Sesto Fiorentino	0.017	0.36	0.046	drs
Siena	0.014	0.329	0.042	drs
Signa	0.035	0.677	0.052	drs
Sillano	0.063	0.319	0.198	drs
Sinalunga	0.04	0.758	0.053	drs
Sorano	0.035	0.456	0.076	drs
Sovicille	0.047	0.942	0.05	drs
Stazzema	0.034	0.41	0.083	drs
Stia	0.044	0.474	0.092	drs
Subbiano	0.053	0.863	0.062	drs
Suvereto	0.033	0.375	0.089	drs
Talla	0.028	0.2	0.138	drs
Tavarnelle Val di Pesa	0.041	0.715	0.057	drs
Terranuova Bracciolini	0.023	0.443	0.052	drs
Terricciola	0.023	0.403	0.057	drs
Torrita di Siena	0.04	0.686	0.058	drs
Trequanda	0.043	0.216	0.199	drs
Tresana	0.055	0.426	0.13	drs
Uzzano	0.04	0.602	0.066	drs
Vagli Sotto	0.092	0.389	0.238	drs
Vaglia	0.021	0.318	0.066	drs
Vaiano	0.03	0.538	0.056	drs
Vecchiano	0.02	0.37	0.053	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Vergemoli	1	1	1	-
Vernio	0.033	0.538	0.062	drs
Viareggio	0.013	0.32	0.039	drs
Vicchio	0.031	0.553	0.057	drs
Vicopisano	0.025	0.45	0.056	drs
Villa Basilica	0.019	0.114	0.17	drs
Villa Collemandina	0.047	0.331	0.143	drs
Villafranca in Lunigiana	0.015	0.214	0.071	drs
Vinci	0.032	0.601	0.053	drs
Volterra	0.031	0.567	0.054	drs
Zeri	0.033	0.07	0.473	drs

Table C.6: DEA1 results: average efficiency results among functions. 2011

Municipality	VRS TE municipal average	VRS TE Tuscan average
Abbadia San Salvatore	0.517	0.547
Abetone	0.123	0.203
Agliana	0.601	0.653
Altopascio	0.714	0.738
Anghiari	0.372	0.399
Arcidosso	0.380	0.392
Arezzo	0.903	0.902
Asciano	0.426	0.432
Aulla	0.470	0.549
Badia Tedalda	0.225	0.313
Bagni di Lucca	0.350	0.386
Bagno a Ripoli	0.559	0.567
Bagnone	0.246	0.275
Barberino di Mugello	0.451	0.453
Barberino Val d'Elsa	0.317	0.337
Barga	0.402	0.514
Bibbiena	0.613	0.621
Bibbona	0.256	0.258
Bientina	0.478	0.497
Borgo a Mozzano	0.398	0.413
Borgo San Lorenzo	0.526	0.551
Bucine	0.324	0.556
Buggiano	0.502	0.537
Buonconvento	0.309	0.310
Buti	0.451	0.441
Calci	0.407	0.389
Calcinaia	0.563	0.547
Calenzano	0.518	0.518
Camaiore	0.539	0.542
Campagnatico	0.357	0.341
Campi Bisenzio	0.693	0.723
Campiglia Marittima	0.533	0.526
Campo nell'Elba	0.239	0.308
Camporgiano	0.427	0.551
Cantagallo	0.348	0.338
Capalbio	0.336	0.328
Capannoli	0.559	0.551
Capannori	0.629	0.677
Capoliveri	0.265	0.276
Capolona	0.511	0.547
Capraia e Limite	0.587	0.592

VRS TE-variable return to scale "pure" technical efficiency

Municipality	VRS TE municipal average	VRS TE Tuscan average
Capraia Isola	0.394	0.570
Caprese Michelangelo	0.346	0.352
Careggine	0.378	0.374
Carmignano	0.610	0.649
Carrara	0.673	0.709
Casale Marittimo	0.390	0.417
Casciana Terme	0.460	0.447
Cascina	0.792	0.819
Casola in Lunigiana	0.314	0.343
Casole d'Elsa	0.317	0.334
Castagneto Carducci	0.353	0.355
Castel del Piano	0.445	0.476
Castel Focognano	0.381	0.424
Castel San Niccolò	0.299	0.365
Castelfiorentino	0.682	0.705
Castelfranco di Sopra	0.308	0.394
Castelfranco di Sotto	0.570	0.572
Castell'Azzara	0.321	0.310
Castellina in Chianti	0.327	0.327
Castellina Marittima	0.370	0.343
Castelnuovo Berardenga	0.409	0.456
Castelnuovo di Garfagnana	0.348	0.345
Castelnuovo di Val di Cecina	0.356	0.362
Castiglion Fibocchi	0.383	0.395
Castiglione della Pescaia	0.190	0.192
Castiglione di Garfagnana	0.416	0.454
Castiglione d'Orcia	0.357	0.372
Cavriglia	0.441	0.447
Cecina	0.611	0.605
Cerreto Guidi	0.528	0.587
Certaldo	0.568	0.600
Cetona	0.383	0.365
Chianciano Terme	0.377	0.421
Chianni	0.284	0.299
Chiesina Uzzanese	0.532	0.545
Chitignano	0.431	0.424
Chiusdino	0.316	0.363
Chiusi	0.529	0.538
Chiusi della Verna	0.295	0.339
Cinigiano	0.346	0.428
Civitella in Val di Chiana	0.423	0.545
Civitella Paganico	0.217	0.215
Colle di Val d'Elsa	0.743	0.768
Collesalvetti	0.557	0.568
Comano	0.373	0.373

Municipality	VRS TE municipal average	VRS TE Tuscan average
Coreglia Antelminelli	0.400	0.399
Cortona	0.593	0.620
Crespina	0.361	0.357
Cutigliano	0.232	0.342
Dicomano	0.462	0.533
Empoli	0.731	0.762
Fabbriche di Vallico	0.276	0.242
Fauglia	0.420	0.439
Fiesole	0.451	0.480
Figline Valdarno	0.564	0.588
Filattiera	0.340	0.356
Firenzuola	0.374	0.406
Fivizzano	0.416	0.505
Foiano della Chiana	0.443	0.511
Follonica	0.475	0.508
Forte dei Marmi	0.144	0.150
Fosciandora	0.359	0.363
Fosdinovo	0.512	0.604
Fucecchio	0.731	0.726
Gaiole in Chianti	0.346	0.380
Gallicano	0.264	0.251
Gambassi Terme	0.492	0.520
Gavorrano	0.524	0.567
Giuncugnano	0.450	0.433
Greve in Chianti	0.640	0.680
Grosseto	0.773	0.811
Guardistallo	0.372	0.334
Impruneta	0.537	0.533
Incisa in Val d'Arno	0.403	0.429
Isola del Giglio	0.227	0.363
Lajatico	0.344	0.328
Lamporecchio	0.575	0.657
Larciano	0.504	0.505
Lari	0.419	0.445
Lastra a Signa	0.586	0.615
Laterina	0.485	0.476
Licciana Nardi	0.383	0.409
Livorno	0.677	0.684
Londa	0.340	0.337
Lorenzana	0.431	0.415
Loro Ciuffenna	0.423	0.459
Lucca	0.661	0.724
Lucignano	0.299	0.326
Magliano in Toscana	0.372	0.380
Manciano	0.455	0.529

Municipality	VRS TE municipal average	VRS TE Tuscan average
Marciana	0.200	0.192
Marciana Marina	0.195	0.194
Marciano della Chiana	0.493	0.544
Marliana	0.419	0.404
Marradi	0.367	0.359
Massa	0.703	0.726
Massa e Cozzile	0.561	0.587
Massa Marittima	0.480	0.457
Massarosa	0.516	0.525
Minucciano	0.318	0.360
Molazzana	0.333	0.311
Monsummano Terme	0.621	0.625
Montaione	0.115	0.283
Montalcino	0.226	0.221
Montale	0.484	0.541
Monte Argentario	0.378	0.403
Monte San Savino	0.539	0.543
Montecarlo	0.542	0.552
Montecatini Val di Cecina	0.422	0.434
Montecatini-Terme	0.438	0.500
Montelupo Fiorentino	0.551	0.596
Montemignaio	0.250	0.255
Montemurlo	0.488	0.483
Montepulciano	0.487	0.479
Monterchi	0.373	0.402
Monteriggioni	0.431	0.454
Monteroni d'Arbia	0.347	0.432
Montescudaio	0.316	0.322
Montespertoli	0.645	0.656
Montevarchi	0.632	0.631
Monteverdi Marittimo	0.264	0.328
Monticiano	0.297	0.311
Montieri	0.234	0.244
Montignoso	0.401	0.419
Montopoli in Val d'Arno	0.593	0.608
Mulazzo	0.374	0.426
Murlo	0.383	0.405
Orbetello	0.376	0.370
Orciano Pisano	0.513	0.536
Ortignano Raggiolo	0.310	0.355
Palaia	0.403	0.408
Palazzuolo sul Senio	0.216	0.245
Peccioli	0.196	0.217
Pelago	0.420	0.436
Pergine Valdarno	0.515	0.503

Municipality	VRS TE municipal average	VRS TE Tuscan average
Pescaglia	0.331	0.375
Pescia	0.575	0.586
Pian di Sco	0.540	0.533
Piancastagnaio	0.445	0.443
Piazza al Serchio	0.437	0.453
Pienza	0.312	0.316
Pietrasanta	0.400	0.401
Pieve a Nievole	0.532	0.603
Pieve Fosciana	0.514	0.488
Pieve Santo Stefano	0.258	0.360
Piombino	0.575	0.599
Pisa	0.578	0.589
Pistoia	0.677	0.700
Piteglio	0.264	0.280
Pitigliano	0.411	0.501
Podenzana	0.430	0.448
Poggibonsi	0.704	0.761
Poggio a Caiano	0.375	0.417
Pomarance	0.309	0.319
Ponsacco	0.708	0.754
Pontassieve	0.454	0.469
Ponte Buggianese	0.673	0.739
Pontedera	0.434	0.450
Pontremoli	0.400	0.408
Poppi	0.306	0.401
Porcari	0.437	0.448
Porto Azzurro	0.349	0.341
Portoferraio	0.406	0.397
Prato	1	1
Pratovecchio	0.358	0.430
Quarrata	0.652	0.680
Radda in Chianti	0.336	0.342
Radicofani	0.309	0.293
Radicondoli	0.141	0.139
Rapolano Terme	0.398	0.383
Reggello	0.595	0.623
Rignano sull'Arno	0.506	0.576
Rio Marina	0.263	0.308
Rio nell'Elba	0.179	0.176
Riparbella	0.412	0.459
Roccalbegna	0.298	0.313
Roccastrada	0.541	0.616
Rosignano Marittimo	0.401	0.411
Rufina	0.455	0.487
Sambuca Pistoiese	0.326	0.480

Municipality	VRS TE municipal average	VRS TE Tuscan average
San Casciano dei Bagni	0.285	0.281
San Casciano in Val di Pesa	0.576	0.620
San Gimignano	0.279	0.308
San Giovanni d'Asso	0.307	0.324
San Giovanni Valdarno	0.523	0.519
San Giuliano Terme	0.581	0.611
San Godenzo	0.299	0.349
San Marcello Pistoiese	0.434	0.468
San Miniato	0.585	0.576
San Piero a Sieve	0.426	0.445
San Quirico d'Orcia	0.415	0.409
San Romano in Garfagnana	0.280	0.283
San Vincenzo	0.271	0.259
Sansepolcro	0.613	0.638
Santa Croce sull'Arno	0.496	0.504
Santa Fiora	0.359	0.350
Santa Luce	0.357	0.376
Santa Maria a Monte	0.637	0.650
Sarteano	0.269	0.341
Sassetta	0.407	0.374
Scandicci	0.698	0.740
Scansano	0.355	0.362
Scarlino	0.288	0.270
Scarperia	0.386	0.388
Seggiano	0.301	0.283
Semproniano	0.324	0.315
Seravezza	0.519	0.516
Serravalle Pistoiese	0.575	0.581
Sestino	0.357	0.381
Sesto Fiorentino	0.649	0.680
Siena	0.393	0.393
Signa	0.640	0.638
Sillano	0.293	0.307
Sinalunga	0.615	0.625
Sorano	0.438	0.450
Sovicille	0.538	0.609
Stazzema	0.305	0.335
Stia	0.397	0.398
Subbiano	0.482	0.531
Suvereto	0.493	0.494
Talla	0.349	0.349
Tavarnelle Val di Pesa	0.410	0.434
Terranuova Bracciolini	0.412	0.406
Terricciola	0.406	0.404
Torrita di Siena	0.523	0.606

Municipality	VRS TE municipal average	VRS TE Tuscan average
Trequanda	0.307	0.287
Tresana	0.441	0.423
Uzzano	0.556	0.559
Vagli Sotto	0.284	0.319
Vaglia	0.321	0.321
Vaiano	0.478	0.503
Vecchiano	0.572	0.570
Vergemoli	0.369	0.553
Vernio	0.391	0.391
Viareggio	0.446	0.452
Vicchio	0.470	0.482
Vicopisano	0.571	0.605
Villa Basilica	0.191	0.180
Villa Collemandina	0.432	0.473
Villafranca in Lunigiana	0.383	0.384
Vinci	0.566	0.573
Volterra	0.433	0.443
Zeri	0.292	0.356

Table C.7: DEA2 results: general administration function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.141	0.215	0.655	irs
Altopascio	0.681	0.762	0.894	drs
Anghiari	0.658	0.676	0.974	irs
Arcidosso	0.466	0.489	0.954	irs
Aulla	0.604	0.636	0.95	drs
Badia Tedalda	0.489	0.642	0.762	irs
Bagni di Lucca	0.464	0.474	0.979	irs
Bagno a Ripoli	0.669	0.802	0.834	drs
Bagnone	0.236	0.273	0.862	irs
Barberino di Mugello	0.612	0.632	0.968	drs
Barberino Val d'Elsa	0.323	0.338	0.955	irs
Barga	0.52	0.532	0.978	drs
Bibbiena	0.764	0.82	0.931	drs
Bibbona	0.281	0.303	0.927	irs
Bucine	0.675	0.689	0.98	drs
Buggiano	0.719	0.721	0.997	irs
Buonconvento	0.446	0.482	0.926	irs
Buti	0.699	0.717	0.975	irs
Camaiore	0.638	0.781	0.817	drs
Campagnatico	0.45	0.501	0.898	irs
Campo nell'Elba	0.246	0.257	0.958	irs
Camporgiano	0.814	0.918	0.887	irs
Cantagallo	0.386	0.418	0.923	irs
Capalbio	0.427	0.45	0.949	irs
Capannoli	0.767	0.783	0.979	irs
Capoliveri	0.292	0.31	0.942	irs
Capolona	0.849	0.874	0.971	irs
Capraia Isola	0.193	0.488	0.396	irs
Caprese Michelangelo	0.522	0.633	0.824	irs
Careggine	0.278	0.47	0.591	irs
Carrara	0.631	0.802	0.787	drs
Casale Marittimo	0.426	0.559	0.763	irs
Casciana Terme	0.508	0.542	0.939	irs
Casola in Lunigiana	0.399	0.535	0.746	irs
Casole d'Elsa	0.46	0.487	0.945	irs
Castel del Piano	0.509	0.53	0.96	irs
Castel Focognano	0.634	0.684	0.927	irs
Castel San Niccolò	0.588	0.647	0.909	irs
Castelfranco di Sopra	0.682	0.74	0.921	irs
Castelfranco di Sotto	0.598	0.649	0.921	drs
Castell'Azzara	0.352	0.422	0.834	irs
Castellina in Chianti	0.419	0.457	0.915	irs
Castellina Marittima	0.443	0.51	0.867	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.532	0.544	0.978	irs
Castelnuovo di Val di Cecina	0.395	0.446	0.887	irs
Castiglion Fibocchi	0.489	0.554	0.883	irs
Castiglione della Pescaia	0.209	0.212	0.987	irs
Castiglione di Garfagnana	0.613	0.715	0.857	irs
Castiglione d'Orcia	0.406	0.453	0.896	irs
Cavriglia	0.561	0.562	0.997	drs
Cetona	0.472	0.516	0.913	irs
Chianni	0.379	0.463	0.818	irs
Chiesina Uzzanese	0.806	0.842	0.957	irs
Chitignano	0.583	0.799	0.729	irs
Chiusdino	0.365	0.426	0.857	irs
Chiusi	0.691	0.692	0.997	irs
Chiusi della Verna	0.443	0.508	0.872	irs
Cinigiano	0.459	0.506	0.906	irs
Civitella in Val di Chiana	0.883	0.884	0.999	irs
Civitella Paganico	0.314	0.339	0.925	irs
Comano	0.477	0.702	0.679	irs
Coreglia Antelminelli	0.542	0.56	0.969	irs
Cortona	0.788	0.933	0.844	drs
Cutigliano	0.277	0.333	0.83	irs
Dicomano	0.866	0.89	0.974	irs
Fabbriche di Vallico	0.171	0.345	0.496	irs
Fauglia	0.477	0.509	0.938	irs
Filattiera	0.505	0.566	0.891	irs
Fivizzano	0.629	0.632	0.994	irs
Follonica	0.398	0.469	0.849	drs
Forte dei Marmi	0.166	0.168	0.991	irs
Fosciandora	0.25	0.399	0.626	irs
Fosdinovo	0.639	0.662	0.965	irs
Gaiole in Chianti	0.429	0.471	0.911	irs
Gallicano	0.361	0.382	0.945	irs
Gavorrano	0.632	0.634	0.996	irs
Giuncugnano	0.367	0.782	0.47	irs
Grosseto	0.782	1	0.782	drs
Guardistallo	0.384	0.487	0.789	irs
Impruneta	0.568	0.632	0.898	drs
Isola del Giglio	0.187	0.23	0.812	irs
Lajatico	0.376	0.466	0.807	irs
Lari	0.566	0.567	0.997	irs
Laterina	0.648	0.693	0.936	irs
Licciana Nardi	0.62	0.643	0.964	irs
Londa	0.455	0.532	0.856	irs
Lorenzana	0.524	0.671	0.781	irs
Loro Ciuffenna	0.778	0.797	0.976	irs
Lucignano	0.531	0.566	0.938	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.411	0.438	0.939	irs
Manciano	0.51	0.516	0.988	irs
Marciana	0.231	0.262	0.881	irs
Marciana Marina	0.201	0.232	0.864	irs
Marciano della Chiana	0.78	0.836	0.933	irs
Marliana	0.532	0.574	0.927	irs
Massa	0.53	0.675	0.785	drs
Massa Marittima	0.564	0.566	0.996	irs
Massarosa	0.577	0.683	0.845	drs
Minucciano	0.432	0.489	0.883	irs
Molazzana	0.404	0.525	0.77	irs
Monte Argentario	0.38	0.411	0.927	drs
Monte San Savino	0.807	0.809	0.997	irs
Montecatini Val di Cecina	0.37	0.433	0.853	irs
Montecatini-Terme	0.446	0.52	0.859	drs
Montemignaio	0.287	0.502	0.572	irs
Monterchi	0.5	0.586	0.854	irs
Montescudaio	0.425	0.491	0.866	irs
Montevarchi	0.689	0.822	0.838	drs
Monteverdi Marittimo	0.181	0.264	0.687	irs
Monticiano	0.343	0.417	0.824	irs
Montieri	0.202	0.262	0.773	irs
Montignoso	0.615	0.63	0.975	drs
Montopoli in Val d'Arno	0.895	0.939	0.953	drs
Mulazzo	0.675	0.749	0.901	irs
Murlo	0.434	0.486	0.892	irs
Orbetello	0.455	0.507	0.898	drs
Orciano Pisano	0.639	1	0.639	irs
Ortignano Raggiolo	0.529	0.739	0.716	irs
Palaia	0.583	0.608	0.959	irs
Palazzuolo sul Senio	0.313	0.402	0.78	irs
Peccioli	0.297	0.308	0.964	irs
Pergine Valdarno	0.758	0.818	0.927	irs
Pescaglia	0.611	0.65	0.939	irs
Pescia	0.691	0.804	0.859	drs
Pian di Sco	0.826	0.841	0.981	irs
Piancastagnaio	0.694	0.729	0.951	irs
Piazza al Serchio	0.671	0.748	0.896	irs
Pienza	0.417	0.475	0.878	irs
Pietrasanta	0.424	0.506	0.838	drs
Pieve a Nievole	1	1	1	-
Pieve Fosciana	0.616	0.689	0.894	irs
Pieve Santo Stefano	0.544	0.587	0.926	irs
Pisa	0.456	1	0.456	drs
Piteglio	0.306	0.359	0.852	irs
Pitigliano	0.472	0.5	0.944	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.68	0.774	0.879	irs
Pomarance	0.313	0.321	0.976	irs
Poppi	0.726	0.742	0.979	irs
Porto Azzurro	0.385	0.408	0.944	irs
Pratovecchio	0.747	0.809	0.923	irs
Radda in Chianti	0.333	0.395	0.843	irs
Radicofani	0.345	0.446	0.773	irs
Radicondoli	0.109	0.15	0.728	irs
Rapolano Terme	0.494	0.511	0.967	irs
Rio Marina	0.284	0.321	0.883	irs
Rio nell'Elba	0.146	0.188	0.777	irs
Riparbella	0.352	0.42	0.838	irs
Roccalbegna	0.323	0.424	0.762	irs
Roccastrada	0.696	0.696	1	-
Rosignano Marittimo	0.511	0.625	0.817	drs
Sambuca Pistoiese	0.366	0.435	0.843	irs
San Casciano dei Bagni	0.345	0.411	0.837	irs
San Giovanni d'Asso	0.252	0.35	0.72	irs
San Giovanni Valdarno	0.647	0.738	0.877	drs
San Godenzo	0.348	0.443	0.785	irs
San Marcello Pistoiese	0.635	0.646	0.983	irs
San Piero a Sieve	0.696	0.73	0.953	irs
San Quirico d'Orcia	0.494	0.545	0.907	irs
San Romano in Garfagnana	0.377	0.461	0.817	irs
Sansepolcro	0.743	0.841	0.884	drs
Santa Croce sull'Arno	0.659	0.729	0.905	drs
Santa Fiora	0.447	0.492	0.907	irs
Santa Luce	0.41	0.483	0.848	irs
Sarteano	0.547	0.569	0.961	irs
Sassetta	0.249	0.46	0.54	irs
Scansano	0.406	0.423	0.958	irs
Scarlino	0.338	0.359	0.941	irs
Seggiano	0.286	0.384	0.745	irs
Semproniano	0.395	0.513	0.771	irs
Seravezza	0.651	0.711	0.916	drs
Sestino	0.587	0.723	0.812	irs
Sillano	0.32	0.489	0.656	irs
Sorano	0.538	0.574	0.938	irs
Stazzema	0.525	0.565	0.929	irs
Stia	0.562	0.614	0.916	irs
Subbiano	0.783	0.799	0.98	irs
Talla	0.479	0.624	0.768	irs
Tavarnelle Val di Pesa	0.6	0.605	0.991	irs
Terricciola	0.596	0.622	0.957	irs
Trequanda	0.339	0.423	0.801	irs
Tresana	0.493	0.564	0.875	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.808	0.829	0.974	irs
Vagli Sotto	0.257	0.346	0.742	irs
Vaglia	0.517	0.535	0.966	irs
Vergemoli	0.23	0.699	0.329	irs
Vernio	0.556	0.569	0.977	irs
Vicchio	0.727	0.731	0.994	irs
Villa Basilica	0.183	0.217	0.844	irs
Villa Collemandina	0.65	0.808	0.805	irs
Villafranca in Lunigiana	0.594	0.618	0.961	irs
Volterra	0.571	0.592	0.964	drs
Zeri	0.413	0.529	0.781	irs

Table C.8: DEA2 results: educational services function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.065	0.119	0.548	irs
Altopascio	0.282	0.874	0.322	drs
Anghiari	0.191	0.2	0.954	irs
Arcidosso	0.109	0.118	0.923	irs
Aulla	0.121	0.122	0.999	-
Badia Tedalda	0.047	0.076	0.62	irs
Bagni di Lucca	0.116	0.12	0.962	irs
Bagno a Ripoli	0.123	0.483	0.255	drs
Bagnone	0.111	0.141	0.789	irs
Barberino di Mugello	0.156	0.214	0.731	drs
Barberino Val d'Elsa	0.191	0.202	0.947	irs
Barga	0.088	0.088	0.996	-
Bibbiena	0.2	0.393	0.509	drs
Bibbona	0.068	0.076	0.892	irs
Bucine	1	1	1	-
Buggiano	0.148	0.149	0.993	irs
Buonconvento	0.146	0.161	0.904	irs
Buti	0.204	0.212	0.962	irs
Camaiore	0.176	0.755	0.233	drs
Campagnatico	0.163	0.191	0.853	irs
Campo nell'Elba	0.101	0.107	0.94	irs
Camporgiano	0.103	0.123	0.834	irs
Cantagallo	0.339	0.376	0.902	irs
Capalbio	0.097	0.106	0.907	irs
Capannoli	0.254	0.26	0.975	irs
Capoliveri	0.109	0.119	0.917	irs
Capolona	0.144	0.15	0.963	irs
Capraia Isola	0.035	0.113	0.307	irs
Caprese Michelangelo	0.077	0.106	0.728	irs
Careggine	0.108	0.236	0.455	irs
Carrara	0.169	0.867	0.195	drs
Casale Marittimo	0.105	0.164	0.641	irs
Casciana Terme	0.227	0.244	0.928	irs
Casola in Lunigiana	0.064	0.111	0.576	irs
Casole d'Elsa	0.096	0.102	0.941	irs
Castel del Piano	0.152	0.163	0.937	irs
Castel Focognano	0.101	0.114	0.888	irs
Castel San Niccolò	0.099	0.114	0.868	irs
Castelfranco di Sopra	0.155	0.171	0.904	irs
Castelfranco di Sotto	0.395	0.848	0.466	drs
Castell'Azzara	0.065	0.099	0.659	irs
Castellina in Chianti	0.106	0.118	0.898	irs
Castellina Marittima	0.12	0.146	0.822	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.139	0.144	0.965	irs
Castelnuovo di Val di Cecina	0.113	0.135	0.837	irs
Castiglion Fibocchi	0.203	0.235	0.867	irs
Castiglione della Pescaia	0.096	0.1	0.954	irs
Castiglione di Garfagnana	0.118	0.148	0.795	irs
Castiglione d'Orcia	0.105	0.127	0.826	irs
Cavriglia	0.193	0.227	0.85	drs
Cetona	0.132	0.152	0.867	irs
Chianni	0.059	0.081	0.73	irs
Chiesina Uzzanese	0.203	0.215	0.947	irs
Chitignano	0.14	0.206	0.682	irs
Chiusdino	0.079	0.098	0.806	irs
Chiusi	0.182	0.186	0.981	irs
Chiusi della Verna	0.055	0.069	0.805	irs
Cinigiano	0.072	0.087	0.836	irs
Civitella in Val di Chiana	0.181	0.182	0.995	irs
Civitella Paganico	0.089	0.1	0.893	irs
Comano	0.059	0.115	0.511	irs
Coreglia Antelminelli	0.2	0.208	0.962	irs
Cortona	0.122	0.404	0.302	drs
Cutigliano	0.079	0.11	0.718	irs
Dicomano	0.128	0.132	0.965	irs
Fabbriche di Vallico	0.119	0.267	0.448	irs
Fauglia	0.147	0.159	0.927	irs
Filattiera	0.097	0.117	0.828	irs
Fivizzano	0.079	0.082	0.96	irs
Follonica	0.228	0.741	0.307	drs
Forte dei Marmi	0.05	0.052	0.971	irs
Fosciandora	0.117	0.247	0.475	irs
Fosdinovo	0.165	0.173	0.953	irs
Gaiole in Chianti	0.081	0.091	0.888	irs
Gallicano	0.103	0.112	0.919	irs
Gavorrano	0.162	0.165	0.986	irs
Giuncugnano	0.063	0.149	0.425	irs
Grosseto	0.121	1	0.121	drs
Guardistallo	0.128	0.181	0.707	irs
Impruneta	0.204	0.504	0.405	drs
Isola del Giglio	0.171	0.25	0.685	irs
Lajatico	0.144	0.191	0.754	irs
Lari	0.123	0.124	0.994	irs
Laterina	0.165	0.18	0.918	irs
Licciana Nardi	0.098	0.104	0.937	irs
Londa	0.218	0.255	0.856	irs
Lorenzana	0.126	0.175	0.718	irs
Loro Ciuffenna	0.139	0.144	0.97	irs
Lucignano	0.148	0.163	0.911	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.135	0.15	0.899	irs
Manciano	0.145	0.151	0.966	irs
Marciana	0.073	0.09	0.812	irs
Marciana Marina	0.104	0.13	0.801	irs
Marciano della Chiana	0.138	0.148	0.937	irs
Marliana	0.128	0.144	0.891	irs
Massa	0.192	1	0.192	drs
Massa Marittima	0.213	0.219	0.972	irs
Massarosa	0.148	0.556	0.266	drs
Minucciano	0.08	0.103	0.776	irs
Molazzana	0.13	0.201	0.647	irs
Monte Argentario	0.235	0.397	0.592	drs
Monte San Savino	0.22	0.222	0.989	irs
Montecatini Val di Cecina	0.073	0.097	0.749	irs
Montecatini-Terme	0.158	0.477	0.331	drs
Montemignaio	0.039	0.098	0.393	irs
Monterchi	0.106	0.133	0.793	irs
Montescudaio	0.198	0.238	0.834	irs
Montevarchi	0.16	0.616	0.26	drs
Monteverdi Marittimo	0.102	0.163	0.627	irs
Monticiano	0.079	0.1	0.789	irs
Montieri	0.083	0.12	0.695	irs
Montignoso	0.198	0.199	0.996	irs
Montopoli in Val d'Arno	0.206	0.364	0.566	drs
Mulazzo	0.183	0.218	0.843	irs
Murlo	0.12	0.135	0.888	irs
Orbetello	0.135	0.259	0.522	drs
Orciano Pisano	0.101	0.191	0.528	irs
Ortignano Raggiolo	0.075	0.129	0.585	irs
Palaia	0.149	0.157	0.95	irs
Palazzuolo sul Senio	0.154	0.23	0.668	irs
Peccioli	0.097	0.102	0.954	irs
Pergine Valdarno	0.166	0.187	0.887	irs
Pescaglia	0.117	0.128	0.92	irs
Pescia	0.157	0.491	0.319	drs
Pian di Sco	0.21	0.214	0.977	irs
Piancastagnaio	0.149	0.164	0.91	irs
Piazza al Serchio	0.116	0.138	0.844	irs
Pienza	0.089	0.106	0.841	irs
Pietrasanta	0.15	0.534	0.28	drs
Pieve a Nievole	0.153	0.153	0.998	-
Pieve Fosciana	0.167	0.195	0.853	irs
Pieve Santo Stefano	0.14	0.157	0.891	irs
Pisa	0.144	1	0.144	drs
Piteglio	0.075	0.095	0.782	irs
Pitigliano	0.134	0.148	0.907	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.124	0.147	0.847	irs
Pomarance	0.125	0.133	0.942	irs
Poppi	0.166	0.172	0.964	irs
Porto Azzurro	0.327	0.352	0.927	irs
Pratovecchio	0.125	0.142	0.885	irs
Radda in Chianti	0.145	0.177	0.82	irs
Radicofani	0.11	0.167	0.659	irs
Radicondoli	0.051	0.08	0.634	irs
Rapolano Terme	0.159	0.168	0.946	irs
Rio Marina	0.07	0.087	0.801	irs
Rio nell'Elba	0.12	0.175	0.687	irs
Riparbella	0.162	0.202	0.801	irs
Roccalbegna	0.07	0.105	0.665	irs
Roccastrada	0.115	0.116	0.99	irs
Rosignano Marittimo	0.095	0.391	0.242	drs
Sambuca Pistoiese	0.131	0.157	0.83	irs
San Casciano dei Bagni	0.052	0.075	0.702	irs
San Giovanni d'Asso	0.253	0.42	0.601	irs
San Giovanni Valdarno	0.162	0.463	0.35	drs
San Godenzo	0.138	0.2	0.69	irs
San Marcello Pistoiese	0.108	0.114	0.952	irs
San Piero a Sieve	0.123	0.131	0.938	irs
San Quirico d'Orcia	0.145	0.164	0.885	irs
San Romano in Garfagnana	0.211	0.274	0.769	irs
Sansepolcro	0.162	0.388	0.417	drs
Santa Croce sull'Arno	0.176	0.454	0.387	drs
Santa Fiora	0.122	0.143	0.849	irs
Santa Luce	0.084	0.106	0.791	irs
Sarteano	0.149	0.159	0.943	irs
Sassetta	0.101	0.199	0.511	irs
Scansano	0.125	0.136	0.921	irs
Scarlino	0.16	0.171	0.931	irs
Seggiano	0.102	0.151	0.671	irs
Semproniano	0.052	0.084	0.624	irs
Seravezza	0.156	0.223	0.701	drs
Sestino	0.103	0.132	0.779	irs
Sillano	0.058	0.112	0.517	irs
Sorano	0.105	0.121	0.872	irs
Stazzema	0.093	0.104	0.892	irs
Stia	0.116	0.135	0.863	irs
Subbiano	0.181	0.185	0.98	irs
Talla	0.083	0.126	0.659	irs
Tavarnelle Val di Pesa	0.218	0.221	0.986	irs
Terricciola	0.186	0.194	0.957	irs
Trequanda	0.09	0.122	0.738	irs
Tresana	0.148	0.18	0.822	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.197	0.203	0.971	irs
Vagli Sotto	0.077	0.141	0.543	irs
Vaglia	0.136	0.143	0.955	irs
Vergemoli	0.307	1	0.307	irs
Vernio	0.12	0.126	0.954	irs
Vicchio	0.167	0.168	0.991	irs
Villa Basilica	0.083	0.108	0.772	irs
Villa Collemandina	0.102	0.141	0.724	irs
Villafranca in Lunigiana	0.128	0.139	0.925	irs
Volterra	0.111	0.112	0.99	irs
Zeri	0.053	0.086	0.609	irs

Table C.9: DEA2 results: social services function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.311	0.394	0.789	drs
Altopascio	0.168	0.979	0.172	drs
Anghiari	0.067	0.177	0.38	drs
Arcidosso	0.217	0.511	0.424	drs
Aulla	0.199	0.876	0.227	drs
Badia Tedalda	0.034	0.05	0.681	drs
Bagni di Lucca	0.198	0.578	0.343	drs
Bagno a Ripoli	0.098	0.723	0.136	drs
Bagnone	0.263	0.467	0.562	drs
Barberino di Mugello	0.106	0.414	0.256	drs
Barberino Val d'Elsa	0.096	0.196	0.491	drs
Barga	0.235	1	0.235	drs
Bibbiena	0.13	0.702	0.184	drs
Bibbona	0.119	0.231	0.514	drs
Bucine	0.029	0.119	0.244	drs
Buggiano	0.118	0.374	0.316	drs
Buonconvento	0.068	0.134	0.508	drs
Buti	0.119	0.287	0.416	drs
Camaiore	0.079	0.596	0.132	drs
Campagnatico	0.173	0.31	0.558	drs
Campo nell'Elba	0.289	0.598	0.483	drs
Camporgiano	0.345	0.602	0.573	drs
Cantagallo	0.128	0.242	0.527	drs
Capalbio	0.138	0.284	0.485	drs
Capannoli	0.127	0.321	0.397	drs
Capoliveri	0.184	0.384	0.478	drs
Capolona	0.177	0.399	0.443	drs
Capraia Isola	1	1	1	-
Caprese Michelangelo	0.157	0.24	0.653	drs
Careggine	0.407	0.503	0.81	drs
Carrara	0.115	1	0.115	drs
Casale Marittimo	0.109	0.159	0.686	drs
Casciana Terme	0.247	0.492	0.501	drs
Casola in Lunigiana	0.283	0.416	0.68	drs
Casole d'Elsa	0.101	0.203	0.495	drs
Castel del Piano	0.28	0.711	0.393	drs
Castel Focognano	0.184	0.361	0.509	drs
Castel San Niccolò	0.058	0.112	0.523	drs
Castelfranco di Sopra	0.038	0.07	0.548	drs
Castelfranco di Sotto	0.106	0.542	0.196	drs
Castell'Azzara	0.227	0.378	0.6	drs
Castellina in Chianti	0.125	0.247	0.508	drs
Castellina Marittima	0.166	0.255	0.65	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.082	0.21	0.392	drs
Castelnuovo di Val di Cecina	0.118	0.227	0.518	drs
Castiglion Fibocchi	0.269	0.458	0.587	drs
Castiglione della Pescaia	0.089	0.261	0.341	drs
Castiglione di Garfagnana	0.266	0.408	0.652	drs
Castiglione d'Orcia	0.271	0.514	0.528	drs
Cavriglia	0.092	0.293	0.313	drs
Cetona	0.162	0.318	0.509	drs
Chianni	0.199	0.301	0.662	drs
Chiesina Uzzanese	0.249	0.521	0.479	drs
Chitignano	0.113	0.161	0.699	drs
Chiusdino	0.163	0.29	0.561	drs
Chiusi	0.176	0.739	0.238	drs
Chiusi della Verna	0.236	0.392	0.603	drs
Cinigiano	0.382	0.761	0.501	drs
Civitella in Val di Chiana	0.051	0.169	0.3	drs
Civitella Paganico	0.055	0.111	0.495	drs
Comano	0.139	0.198	0.702	drs
Coreglia Antelminelli	0.115	0.254	0.454	drs
Cortona	0.105	0.743	0.141	drs
Cutigliano	0.476	0.727	0.654	drs
Dicomano	0.124	0.318	0.389	drs
Fabbriche di Vallico	0.126	0.158	0.799	drs
Fauglia	0.275	0.53	0.52	drs
Filattiera	0.198	0.367	0.539	drs
Fivizzano	0.229	0.841	0.273	drs
Follonica	0.124	0.86	0.144	drs
Forte dei Marmi	0.065	0.205	0.317	drs
Fosciandora	0.135	0.173	0.78	drs
Fosdinovo	0.474	1	0.474	drs
Gaiole in Chianti	0.201	0.408	0.491	drs
Gallicano	0.09	0.181	0.495	drs
Gavorrano	0.248	0.85	0.292	drs
Giuncugnano	0.247	0.279	0.885	drs
Grosseto	0.092	0.951	0.096	drs
Guardistallo	0.192	0.284	0.677	drs
Impruneta	0.123	0.72	0.171	drs
Isola del Giglio	0.539	0.818	0.659	drs
Lajatico	0.209	0.314	0.665	drs
Lari	0.167	0.532	0.314	drs
Laterina	0.221	0.434	0.508	drs
Licciana Nardi	0.181	0.396	0.457	drs
Londa	0.12	0.181	0.661	drs
Lorenzana	0.24	0.341	0.704	drs
Loro Ciuffenna	0.104	0.251	0.414	drs
Lucignano	0.05	0.101	0.499	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.228	0.455	0.5	drs
Manciano	0.307	1	0.307	drs
Marciana	0.109	0.193	0.565	drs
Marciana Marina	0.158	0.244	0.647	drs
Marciano della Chiana	0.28	0.527	0.531	drs
Marliana	0.168	0.32	0.525	drs
Massa	0.083	0.725	0.115	drs
Massa Marittima	0.134	0.533	0.252	drs
Massarosa	0.078	0.49	0.158	drs
Minucciano	0.204	0.351	0.581	drs
Molazzana	0.126	0.184	0.688	drs
Monte Argentario	0.113	0.521	0.216	drs
Monte San Savino	0.153	0.516	0.297	drs
Montecatini Val di Cecina	0.238	0.388	0.614	drs
Montecatini-Terme	0.139	1	0.139	drs
Montemignaio	0.058	0.074	0.788	drs
Monterchi	0.311	0.482	0.645	drs
Montescudaio	0.132	0.202	0.65	drs
Montevarchi	0.12	0.895	0.134	drs
Monteverdi Marittimo	0.169	0.239	0.707	drs
Monticiano	0.215	0.376	0.571	drs
Montieri	0.254	0.396	0.642	drs
Montignoso	0.122	0.429	0.285	drs
Montopoli in Val d'Arno	0.116	0.469	0.247	drs
Mulazzo	0.162	0.302	0.538	drs
Murlo	0.124	0.225	0.551	drs
Orbetello	0.066	0.358	0.185	drs
Orciano Pisano	0.141	0.178	0.796	drs
Ortignano Raggiolo	0.053	0.072	0.735	drs
Palaia	0.182	0.376	0.483	drs
Palazzuolo sul Senio	0.029	0.043	0.681	drs
Peccioli	0.031	0.069	0.451	drs
Pergine Valdarno	0.205	0.389	0.526	drs
Pescaglia	0.148	0.29	0.509	drs
Pescia	0.121	0.813	0.149	drs
Pian di Sco	0.154	0.36	0.429	drs
Piancastagnaio	0.134	0.274	0.488	drs
Piazza al Serchio	0.211	0.354	0.597	drs
Pienza	0.183	0.316	0.579	drs
Pietrasanta	0.076	0.523	0.145	drs
Pieve a Nievole	0.108	0.376	0.287	drs
Pieve Fosciana	0.24	0.42	0.572	drs
Pieve Santo Stefano	0.035	0.068	0.51	drs
Pisa	0.083	1	0.083	drs
Piteglio	0.235	0.4	0.588	drs
Pitigliano	0.466	0.946	0.492	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.223	0.348	0.643	drs
Pomarance	0.153	0.432	0.354	drs
Poppi	0.04	0.113	0.351	drs
Porto Azzurro	0.163	0.325	0.499	drs
Pratovecchio	0.08	0.159	0.502	drs
Radda in Chianti	0.257	0.426	0.603	drs
Radicofani	0.203	0.292	0.697	drs
Radicondoli	0.105	0.153	0.686	drs
Rapolano Terme	0.145	0.379	0.382	drs
Rio Marina	0.312	0.539	0.578	drs
Rio nell'Elba	0.135	0.198	0.684	drs
Riparbella	0.211	0.326	0.647	drs
Roccalbegna	0.303	0.451	0.672	drs
Roccastrada	0.23	0.997	0.231	drs
Rosignano Marittimo	0.061	0.474	0.129	drs
Sambuca Pistoiese	0.649	1	0.649	drs
San Casciano dei Bagni	0.172	0.267	0.643	drs
San Giovanni d'Asso	0.271	0.399	0.679	drs
San Giovanni Valdarno	0.089	0.575	0.154	drs
San Godenzo	0.147	0.216	0.681	drs
San Marcello Pistoiese	0.194	0.6	0.323	drs
San Piero a Sieve	0.129	0.266	0.486	drs
San Quirico d'Orcia	0.225	0.437	0.515	drs
San Romano in Garfagnana	0.068	0.101	0.671	drs
Sansepolcro	0.152	0.95	0.16	drs
Santa Croce sull'Arno	0.073	0.458	0.16	drs
Santa Fiora	0.202	0.395	0.511	drs
Santa Luce	0.14	0.214	0.653	drs
Sarteano	0.036	0.087	0.421	drs
Sassetta	0.231	0.305	0.757	drs
Scansano	0.207	0.518	0.4	drs
Scarlino	0.115	0.227	0.509	drs
Seggiano	0.229	0.344	0.665	drs
Semproniano	0.188	0.283	0.663	drs
Seravezza	0.127	0.585	0.216	drs
Sestino	0.14	0.215	0.653	drs
Sillano	0.184	0.236	0.777	drs
Sorano	0.275	0.56	0.491	drs
Stazzema	0.117	0.224	0.52	drs
Stia	0.163	0.321	0.507	drs
Subbiano	0.164	0.422	0.389	drs
Talla	0.138	0.205	0.676	drs
Tavarnelle Val di Pesa	0.118	0.371	0.318	drs
Terricciola	0.152	0.311	0.488	drs
Trequanda	0.173	0.261	0.661	drs
Tresana	0.248	0.437	0.568	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.15	0.333	0.45	drs
Vagli Sotto	0.342	0.478	0.715	drs
Vaglia	0.069	0.143	0.48	drs
Vergemoli	0.068	0.071	0.965	irs
Vernio	0.101	0.264	0.382	drs
Vicchio	0.105	0.329	0.319	drs
Villa Basilica	0.127	0.194	0.655	drs
Villa Collemandina	0.254	0.378	0.672	drs
Villafranca in Lunigiana	0.143	0.328	0.436	drs
Volterra	0.117	0.511	0.228	drs
Zeri	0.333	0.508	0.655	drs

Table C.10: DEA2 results: road maintenance and local mobility function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.025	0.032	0.79	irs
Altopascio	0.656	1	0.656	drs
Anghiari	0.202	0.291	0.694	drs
Arcidosso	0.267	0.374	0.713	drs
Aulla	0.186	0.28	0.663	drs
Badia Tedalda	0.13	0.138	0.941	irs
Bagni di Lucca	0.138	0.206	0.67	drs
Bagno a Ripoli	0.326	0.679	0.481	drs
Bagnone	0.121	0.146	0.827	drs
Barberino di Mugello	0.299	0.449	0.665	drs
Barberino Val d'Elsa	0.435	0.647	0.672	drs
Barga	0.217	0.326	0.666	drs
Bibbiena	0.298	0.451	0.661	drs
Bibbona	0.297	0.432	0.689	drs
Bucine	0.321	0.482	0.666	drs
Buggiano	0.658	0.979	0.672	drs
Buonconvento	0.316	0.435	0.725	drs
Buti	0.25	0.361	0.693	drs
Camaiore	0.244	0.718	0.339	drs
Campagnatico	0.155	0.198	0.785	drs
Campo nell'Elba	0.155	0.225	0.689	drs
Camporgiano	0.139	0.179	0.776	drs
Cantagallo	0.161	0.231	0.699	drs
Capalbio	0.324	0.455	0.712	drs
Capannoli	0.568	0.825	0.689	drs
Capoliveri	0.185	0.268	0.689	drs
Capolona	0.276	0.396	0.697	drs
Capraia Isola	0.514	1	0.514	irs
Caprese Michelangelo	0.138	0.148	0.929	drs
Careggine	0.116	0.181	0.642	irs
Carrara	0.143	0.427	0.336	drs
Casale Marittimo	1	1	1	-
Casciana Terme	0.36	0.494	0.729	drs
Casola in Lunigiana	0.085	0.101	0.849	irs
Casole d'Elsa	0.271	0.378	0.719	drs
Castel del Piano	0.249	0.352	0.707	drs
Castel Focognano	0.126	0.176	0.714	drs
Castel San Niccolò	0.13	0.195	0.669	drs
Castelfranco di Sopra	0.219	0.291	0.754	drs
Castelfranco di Sotto	0.359	0.544	0.66	drs
Castell'Azzara	0.181	0.2	0.906	drs
Castellina in Chianti	0.314	0.476	0.659	drs
Castellina Marittima	0.252	0.325	0.776	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.281	0.408	0.689	drs
Castelnuovo di Val di Cecina	0.389	0.8	0.486	drs
Castiglion Fibocchi	0.133	0.163	0.812	drs
Castiglione della Pescaia	0.112	0.171	0.657	drs
Castiglione di Garfagnana	0.126	0.161	0.784	drs
Castiglione d'Orcia	0.205	0.293	0.7	drs
Cavriglia	0.474	0.708	0.669	drs
Cetona	0.277	0.394	0.702	drs
Chianni	0.143	0.164	0.872	drs
Chiesina Uzzanese	0.293	0.413	0.709	drs
Chitignano	0.209	0.258	0.808	irs
Chiusdino	0.254	0.309	0.821	drs
Chiusi	0.241	0.359	0.671	drs
Chiusi della Verna	0.141	0.171	0.825	drs
Cinigiano	0.166	0.215	0.772	drs
Civitella in Val di Chiana	0.302	0.467	0.647	drs
Civitella Paganico	0.177	0.238	0.746	drs
Comano	0.125	0.179	0.702	irs
Coreglia Antelminelli	0.21	0.301	0.699	drs
Cortona	0.248	0.479	0.517	drs
Cutigliano	0.069	0.084	0.823	drs
Dicomano	0.225	0.324	0.694	drs
Fabbriche di Vallico	0.105	0.18	0.583	irs
Fauglia	0.352	0.489	0.72	drs
Filattiera	0.132	0.165	0.799	drs
Fivizzano	0.171	0.258	0.665	drs
Follonica	0.3	0.568	0.529	drs
Forte dei Marmi	0.148	0.22	0.672	drs
Fosciandora	0.332	0.348	0.954	irs
Fosdinovo	0.285	0.405	0.703	drs
Gaiole in Chianti	0.431	0.575	0.75	drs
Gallicano	0.158	0.217	0.725	drs
Gavorrano	0.296	0.44	0.671	drs
Giuncugnano	0.13	0.232	0.56	irs
Grosseto	0.317	1	0.317	drs
Guardistallo	0.27	0.276	0.979	drs
Impruneta	0.282	0.43	0.656	drs
Isola del Giglio	0.287	0.322	0.89	drs
Lajatico	0.179	0.208	0.86	drs
Lari	0.294	0.477	0.617	drs
Laterina	0.298	0.406	0.734	drs
Licciana Nardi	0.193	0.274	0.704	drs
Londa	0.104	0.122	0.85	drs
Lorenzana	0.274	0.276	0.992	irs
Loro Ciuffenna	0.22	0.318	0.691	drs
Lucignano	0.254	0.347	0.732	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.445	0.613	0.727	drs
Manciano	0.248	0.366	0.677	drs
Marciana	0.111	0.159	0.701	drs
Marciana Marina	0.142	0.176	0.806	drs
Marciano della Chiana	0.302	0.408	0.739	drs
Marliana	0.314	0.46	0.684	drs
Massa	0.33	1	0.33	drs
Massa Marittima	0.329	0.49	0.671	drs
Massarosa	0.538	1	0.538	drs
Minucciano	0.096	0.13	0.737	drs
Molazzana	0.142	0.143	0.993	drs
Monte Argentario	0.431	0.654	0.66	drs
Monte San Savino	0.247	0.367	0.672	drs
Montecatini Val di Cecina	0.351	1	0.351	drs
Montecatini-Terme	0.178	0.359	0.496	drs
Montemignaio	0.084	0.114	0.743	irs
Monterchi	0.148	0.185	0.8	drs
Montescudaio	0.302	0.371	0.814	drs
Montevarchi	0.303	0.669	0.454	drs
Monteverdi Marittimo	1	1	1	-
Monticiano	0.178	0.217	0.822	drs
Montieri	0.193	0.206	0.937	irs
Montignoso	0.142	0.213	0.666	drs
Montopoli in Val d'Arno	0.417	0.628	0.663	drs
Mulazzo	0.092	0.118	0.781	drs
Murlo	0.23	0.573	0.401	drs
Orbetello	0.344	0.575	0.598	drs
Orciano Pisano	0.312	0.504	0.619	irs
Ortignano Raggiolo	0.122	0.15	0.816	irs
Palaia	0.183	0.301	0.608	drs
Palazzuolo sul Senio	0.176	0.189	0.928	drs
Peccioli	0.14	0.416	0.336	drs
Pergine Valdarno	0.285	0.382	0.745	drs
Pescaglia	0.101	0.137	0.732	drs
Pescia	0.241	0.444	0.541	drs
Pian di Sco	0.309	0.45	0.687	drs
Piancastagnaio	0.196	0.294	0.667	drs
Piazza al Serchio	0.173	0.219	0.79	drs
Pienza	0.173	0.218	0.795	drs
Pietrasanta	0.206	0.735	0.28	drs
Pieve a Nievole	0.485	0.724	0.669	drs
Pieve Fosciana	0.39	0.494	0.791	drs
Pieve Santo Stefano	0.176	0.236	0.747	drs
Pisa	0.132	1	0.132	drs
Piteglio	0.125	0.149	0.841	drs
Pitigliano	0.235	0.324	0.725	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.237	0.289	0.817	drs
Pomarance	0.235	0.346	0.681	drs
Poppi	0.202	0.295	0.686	drs
Porto Azzurro	0.201	0.28	0.717	drs
Pratovecchio	0.136	0.186	0.731	drs
Radda in Chianti	0.177	0.316	0.559	drs
Radicofani	0.11	0.118	0.935	irs
Radicondoli	0.187	0.224	0.835	irs
Rapolano Terme	0.29	0.415	0.698	drs
Rio Marina	0.188	0.24	0.781	drs
Rio nell'Elba	0.153	0.156	0.98	drs
Riparbella	0.773	1	0.773	drs
Roccalbegna	0.129	0.143	0.905	irs
Roccastrada	0.345	0.516	0.669	drs
Rosignano Marittimo	0.154	0.393	0.391	drs
Sambuca Pistoiese	0.104	0.124	0.838	drs
San Casciano dei Bagni	0.189	0.233	0.812	drs
San Giovanni d'Asso	0.12	0.142	0.846	irs
San Giovanni Valdarno	0.278	0.453	0.614	drs
San Godenzo	0.084	0.087	0.969	irs
San Marcello Pistoiese	0.175	0.259	0.678	drs
San Piero a Sieve	0.281	0.394	0.714	drs
San Quirico d'Orcia	0.31	0.413	0.752	drs
San Romano in Garfagnana	0.096	0.107	0.901	drs
Sansepolcro	0.233	0.37	0.629	drs
Santa Croce sull'Arno	0.316	0.48	0.658	drs
Santa Fiora	0.212	0.275	0.773	drs
Santa Luce	0.346	0.444	0.779	drs
Sarteano	0.311	0.441	0.704	drs
Sassetta	0.387	0.65	0.595	irs
Scansano	0.23	0.325	0.709	drs
Scarlino	0.222	0.312	0.712	drs
Seggiano	0.152	0.175	0.871	irs
Semproniano	0.213	0.226	0.942	irs
Seravezza	0.378	0.574	0.659	drs
Sestino	0.13	0.135	0.965	drs
Sillano	0.087	0.106	0.817	irs
Sorano	0.299	0.409	0.73	drs
Stazzema	0.1	0.135	0.744	drs
Stia	0.184	0.241	0.761	drs
Subbiano	0.176	0.256	0.687	drs
Talla	0.142	0.143	0.994	irs
Tavarnelle Val di Pesa	0.138	0.204	0.676	drs
Terricciola	0.162	0.249	0.651	drs
Trequanda	0.18	0.187	0.966	drs
Tresana	0.289	0.35	0.825	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.584	0.841	0.694	drs
Vagli Sotto	0.116	0.129	0.902	irs
Vaglia	0.233	0.332	0.701	drs
Vergemoli	0.064	0.095	0.667	irs
Vernio	0.336	0.487	0.69	drs
Vicchio	0.345	0.512	0.675	drs
Villa Basilica	0.18	0.203	0.887	drs
Villa Collemandina	0.131	0.138	0.949	drs
Villafranca in Lunigiana	0.207	0.293	0.707	drs
Volterra	0.245	0.369	0.664	drs
Zeri	0.072	0.076	0.943	irs

Table C.11: DEA2 results: local police function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.006	0.013	0.504	drs
Altopascio	0.027	0.684	0.039	drs
Anghiari	0.029	0.477	0.061	drs
Arcidosso	0.025	0.371	0.068	drs
Aulla	0.041	0.846	0.049	drs
Badia Tedalda	0.045	0.231	0.196	drs
Bagni di Lucca	0.02	0.343	0.057	drs
Bagno a Ripoli	0.023	0.572	0.041	drs
Bagnone	0.027	0.241	0.111	drs
Barberino di Mugello	0.03	0.599	0.05	drs
Barberino Val d'Elsa	0.046	0.76	0.06	drs
Barga	0.021	0.415	0.051	drs
Bibbiena	0.045	0.945	0.048	drs
Bibbona	0.027	0.456	0.059	drs
Bucine	0.037	0.73	0.051	drs
Buggiano	0.039	0.721	0.054	drs
Buonconvento	0.019	0.253	0.073	drs
Buti	0.023	0.387	0.061	drs
Camaiore	0.018	0.532	0.034	drs
Campagnatico	0.024	0.258	0.094	drs
Campo nell'Elba	0.024	0.398	0.059	drs
Camporgiano	0.015	0.159	0.095	drs
Cantagallo	0.028	0.407	0.07	drs
Capalbio	0.022	0.326	0.068	drs
Capannoli	0.041	0.698	0.059	drs
Capoliveri	0.015	0.261	0.059	drs
Capolona	0.041	0.668	0.062	drs
Capraia Isola	0.013	0.02	0.658	drs
Caprese Michelangelo	0.038	0.158	0.241	drs
Careggine	0.052	0.087	0.593	drs
Carrara	0.023	0.606	0.038	drs
Casale Marittimo	0.024	0.135	0.175	drs
Casciana Terme	0.033	0.445	0.075	drs
Casola in Lunigiana	0.022	0.046	0.49	drs
Casole d'Elsa	0.041	0.585	0.071	drs
Castel del Piano	0.038	0.576	0.066	drs
Castel Focognano	0.033	0.465	0.071	drs
Castel San Niccolò	0.035	0.579	0.061	drs
Castelfranco di Sopra	0.039	0.441	0.089	drs
Castelfranco di Sotto	0.037	0.793	0.047	drs
Castell'Azzara	0.05	0.22	0.225	drs
Castellina in Chianti	0.016	0.261	0.062	drs
Castellina Marittima	0.029	0.305	0.095	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.018	0.301	0.059	drs
Castelnuovo di Val di Cecina	0.017	0.329	0.053	drs
Castiglion Fibocchi	0.025	0.192	0.13	drs
Castiglione della Pescaia	0.01	0.201	0.051	drs
Castiglione di Garfagnana	0.039	0.451	0.087	drs
Castiglione d'Orcia	0.017	0.266	0.064	drs
Cavriglia	0.042	0.799	0.052	drs
Cetona	0.021	0.287	0.072	drs
Chianni	0.016	0.171	0.095	drs
Chiesina Uzzanese	0.02	0.304	0.067	drs
Chitignano	0.025	0.049	0.5	drs
Chiusdino	0.158	1	0.158	drs
Chiusi	0.021	0.389	0.054	drs
Chiusi della Verna	0.03	0.243	0.122	drs
Cinigiano	0.02	0.203	0.101	drs
Civitella in Val di Chiana	0.053	1	0.053	drs
Civitella Paganico	0.016	0.205	0.077	drs
Comano	0.04	0.076	0.534	drs
Coreglia Antelminelli	0.05	0.795	0.063	drs
Cortona	0.035	0.836	0.042	drs
Cutigliano	0.015	0.163	0.094	drs
Dicomano	0.052	0.858	0.061	drs
Fabbriche di Vallico	0.012	0.018	0.654	drs
Fauglia	0.037	0.525	0.071	drs
Filattiera	0.02	0.161	0.127	drs
Fivizzano	0.016	0.288	0.055	drs
Follonica	0.019	0.447	0.042	drs
Forte dei Marmi	0.006	0.109	0.054	drs
Fosciandora	0.096	1	0.096	drs
Fosdinovo	0.041	0.631	0.064	drs
Gaiole in Chianti	0.027	0.332	0.08	drs
Gallicano	0.02	0.269	0.073	drs
Gavorrano	0.038	0.715	0.054	drs
Giuncugnano	0.014	0.022	0.659	drs
Grosseto	0.017	0.942	0.018	drs
Guardistallo	0.026	0.162	0.162	drs
Impruneta	0.029	0.635	0.045	drs
Isola del Giglio	0.01	0.049	0.209	drs
Lajatico	0.016	0.19	0.083	drs
Lari	0.019	0.38	0.05	drs
Laterina	0.037	0.473	0.078	drs
Licciana Nardi	0.02	0.313	0.065	drs
Londa	0.045	0.384	0.118	drs
Lorenzana	0.016	0.104	0.157	drs
Loro Ciuffenna	0.028	0.472	0.06	drs
Lucignano	0.022	0.282	0.077	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.02	0.265	0.074	drs
Manciano	0.028	0.505	0.055	drs
Marciana	0.012	0.167	0.072	drs
Marciana Marina	0.011	0.082	0.135	drs
Marciano della Chiana	0.034	0.424	0.081	drs
Marliana	0.028	0.428	0.066	drs
Massa	0.038	1	0.038	drs
Massa Marittima	0.022	0.411	0.054	drs
Massarosa	0.03	0.713	0.042	drs
Minucciano	0.058	0.69	0.084	drs
Molazzana	0.016	0.123	0.131	drs
Monte Argentario	0.011	0.231	0.047	drs
Monte San Savino	0.025	0.466	0.054	drs
Montecatini Val di Cecina	0.016	0.978	0.017	drs
Montecatini-Terme	0.01	0.252	0.041	drs
Montemignaio	0.017	0.08	0.219	drs
Monterchi	0.019	0.213	0.09	drs
Montescudaio	0.007	0.062	0.118	drs
Montevarchi	0.026	0.66	0.039	drs
Monteverdi Marittimo	0.021	0.252	0.082	drs
Monticiano	0.016	0.215	0.075	drs
Montieri	0.02	0.041	0.474	drs
Montignoso	0.016	0.317	0.051	drs
Montopoli in Val d'Arno	0.027	0.542	0.049	drs
Mulazzo	0.021	0.197	0.109	drs
Murlo	0.048	1	0.048	drs
Orbetello	0.017	0.39	0.043	drs
Orciano Pisano	0.013	0.022	0.573	drs
Ortignano Raggiolo	0.024	0.059	0.41	drs
Palaia	0.019	0.333	0.056	drs
Palazzuolo sul Senio	0.021	0.206	0.103	drs
Peccioli	0.019	0.927	0.02	drs
Pergine Valdarno	0.028	0.339	0.084	drs
Pescaglia	0.018	0.246	0.073	drs
Pescia	0.022	0.523	0.043	drs
Pian di Sco	0.037	0.635	0.058	drs
Piancastagnaio	0.029	0.487	0.06	drs
Piazza al Serchio	0.038	0.401	0.096	drs
Pienza	0.024	0.207	0.118	drs
Pietrasanta	0.014	0.49	0.028	drs
Pieve a Nievole	0.022	0.416	0.053	drs
Pieve Fosciana	0.054	0.476	0.113	drs
Pieve Santo Stefano	0.068	0.837	0.082	drs
Pisa	0.014	1	0.014	drs
Piteglio	0.02	0.177	0.115	drs
Pitigliano	0.03	0.405	0.073	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.018	0.12	0.151	drs
Pomarance	0.028	0.477	0.059	drs
Poppi	0.023	0.385	0.059	drs
Porto Azzurro	0.02	0.291	0.07	drs
Pratovecchio	0.033	0.437	0.075	drs
Radda in Chianti	0.015	0.276	0.054	drs
Radicofani	0.024	0.076	0.311	drs
Radicondoli	0.023	0.047	0.494	drs
Rapolano Terme	0.025	0.398	0.062	drs
Rio Marina	0.02	0.216	0.092	drs
Rio nell'Elba	0.024	0.096	0.247	drs
Riparbella	0.049	0.802	0.061	drs
Roccalbegna	0.032	0.067	0.479	drs
Roccastrada	0.029	0.546	0.053	drs
Rosignano Marittimo	0.019	0.499	0.039	drs
Sambuca Pistoiese	0.049	0.446	0.111	drs
San Casciano dei Bagni	0.023	0.234	0.099	drs
San Giovanni d'Asso	0.029	0.059	0.492	drs
San Giovanni Valdarno	0.025	0.568	0.044	drs
San Godenzo	0.468	1	0.468	drs
San Marcello Pistoiese	0.025	0.428	0.058	drs
San Piero a Sieve	0.037	0.542	0.069	drs
San Quirico d'Orcia	0.03	0.341	0.088	drs
San Romano in Garfagnana	0.028	0.249	0.113	drs
Sansepolcro	0.03	0.683	0.044	drs
Santa Croce sull'Arno	0.027	0.582	0.046	drs
Santa Fiora	0.019	0.188	0.102	drs
Santa Luce	0.057	0.839	0.068	drs
Sarteano	0.028	0.429	0.065	drs
Sassetta	0.055	0.094	0.589	drs
Scansano	0.021	0.317	0.066	drs
Scarlino	0.018	0.265	0.068	drs
Seggiano	0.029	0.059	0.486	drs
Semproniano	0.033	0.069	0.473	drs
Seravezza	0.025	0.535	0.046	drs
Sestino	0.034	0.113	0.303	drs
Sillano	0.063	0.319	0.198	drs
Sorano	0.035	0.459	0.076	drs
Stazzema	0.034	0.413	0.083	drs
Stia	0.044	0.474	0.092	drs
Subbiano	0.053	0.907	0.059	drs
Talla	0.028	0.2	0.138	drs
Tavarnelle Val di Pesa	0.041	0.739	0.055	drs
Terricciola	0.023	0.403	0.057	drs
Trequanda	0.043	0.216	0.199	drs
Tresana	0.055	0.426	0.13	drs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.04	0.653	0.061	drs
Vagli Sotto	0.092	0.389	0.238	drs
Vaglia	0.021	0.329	0.063	drs
Vergemoli	1	1	1	-
Vernio	0.033	0.558	0.06	drs
Vicchio	0.031	0.572	0.055	drs
Villa Basilica	0.019	0.114	0.17	drs
Villa Collemandina	0.047	0.331	0.143	drs
Villafranca in Lunigiana	0.015	0.231	0.066	drs
Volterra	0.031	0.626	0.049	drs
Zeri	0.033	0.07	0.473	drs

Table C.12: DEA2 results: environmental management function. 2011

Municipality	CRS TE	VRS TE	SCALE	RTS
Abetone	0.312	0.349	0.894	irs
Altopascio	0.442	0.447	0.99	irs
Anghiari	0.938	0.962	0.975	irs
Arcidosso	0.475	0.493	0.963	irs
Aulla	0.144	0.147	0.982	irs
Badia Tedalda	0.68	0.922	0.738	irs
Bagni di Lucca	0.462	0.473	0.976	irs
Bagno a Ripoli	0.499	0.501	0.997	irs
Bagnone	0.522	0.568	0.919	irs
Barberino di Mugello	0.589	0.595	0.991	irs
Barberino Val d'Elsa	0.596	0.618	0.966	irs
Barga	0.441	0.448	0.984	irs
Bibbiena	0.647	0.654	0.989	irs
Bibbona	0.61	0.619	0.985	irs
Bucine	0.734	0.744	0.986	irs
Buggiano	0.797	0.811	0.983	irs
Buonconvento	0.735	0.764	0.962	irs
Buti	0.654	0.674	0.971	irs
Camaiore	0.554	0.555	1	-
Campagnatico	0.339	0.368	0.921	irs
Campo nell'Elba	0.359	0.365	0.984	irs
Camporgiano	0.294	0.324	0.908	irs
Cantagallo	0.794	0.829	0.958	irs
Capalbio	0.643	0.661	0.973	irs
Capannoli	0.79	0.812	0.973	irs
Capoliveri	0.325	0.331	0.982	irs
Capolona	0.499	0.52	0.96	irs
Capraia Isola	0.383	0.582	0.658	irs
Caprese Michelangelo	0.89	<u>1</u>	0.89	irs
Careggine	0.322	0.606	0.531	irs
Carrara	0.37	0.505	0.734	drs
Casale Marittimo	0.571	0.634	0.9	irs
Casciana Terme	0.524	0.548	0.955	irs
Casola in Lunigiana	0.558	0.725	0.77	irs
Casole d'Elsa	0.603	0.626	0.963	irs
Castel del Piano	0.571	0.59	0.967	irs
Castel Focognano	0.514	0.542	0.948	irs
Castel San Niccolò	0.473	0.5	0.946	irs
Castelfranco di Sopra	0.563	0.594	0.947	irs
Castelfranco di Sotto	0.658	0.665	0.99	irs
Castell'Azzara	0.36	0.446	0.808	irs
Castellina in Chianti	0.463	0.486	0.954	irs
Castellina Marittima	0.618	0.656	0.942	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Castelnuovo di Garfagnana	0.319	0.325	0.979	irs
Castelnuovo di Val di Cecina	0.662	0.707	0.937	irs
Castiglion Fibocchi	0.638	0.674	0.946	irs
Castiglione della Pescaia	0.424	0.426	0.995	irs
Castiglione di Garfagnana	0.374	0.433	0.865	irs
Castiglione d'Orcia	0.397	0.428	0.929	irs
Cavriglia	0.693	0.705	0.983	irs
Cetona	0.583	0.62	0.941	irs
Chianni	0.88	0.986	0.893	irs
Chiesina Uzzanese	0.91	0.937	0.972	irs
Chitignano	0.479	0.663	0.723	irs
Chiusdino	0.412	0.444	0.927	irs
Chiusi	0.513	0.521	0.985	irs
Chiusi della Verna	0.546	0.578	0.945	irs
Cinigiano	0.449	0.481	0.933	irs
Civitella in Val di Chiana	0.71	0.719	0.987	irs
Civitella Paganico	0.071	0.074	0.949	irs
Comano	0.496	0.625	0.794	irs
Coreglia Antelminelli	0.636	0.654	0.973	irs
Cortona	0.709	0.712	0.996	irs
Cutigliano	0.601	0.653	0.921	irs
Dicomano	0.459	0.474	0.967	irs
Fabbriche di Vallico	0.487	<u>1</u>	0.487	irs
Fauglia	0.554	0.58	0.956	irs
Filattiera	0.499	0.541	0.922	irs
Fivizzano	0.384	0.393	0.978	irs
Follonica	0.527	0.528	0.998	irs
Forte dei Marmi	0.334	0.336	0.995	irs
Fosciandora	0.365	0.746	0.489	irs
Fosdinovo	0.489	0.512	0.956	irs
Gaiole in Chianti	0.437	0.46	0.949	irs
Gallicano	0.344	0.357	0.963	irs
Gavorrano	0.52	0.528	0.984	irs
Giuncugnano	0.398	0.727	0.548	irs
Grosseto	0.406	0.659	0.616	drs
Guardistallo	0.661	0.768	0.861	irs
Impruneta	0.403	0.407	0.989	irs
Isola del Giglio	0.367	0.389	0.944	irs
Lajatico	0.824	0.936	0.88	irs
Lari	0.482	0.491	0.981	irs
Laterina	0.591	0.624	0.947	irs
Licciana Nardi	0.405	0.422	0.96	irs
Londa	0.429	0.487	0.882	irs
Lorenzana	0.514	0.603	0.853	irs
Loro Ciuffenna	0.797	0.816	0.977	irs
Lucignano	0.57	0.595	0.957	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Magliano in Toscana	0.254	0.274	0.926	irs
Manciano	0.66	0.672	0.981	irs
Marciana	0.289	0.3	0.964	irs
Marciana Marina	0.286	0.301	0.951	irs
Marciano della Chiana	0.674	0.706	0.955	irs
Marliana	0.594	0.627	0.947	irs
Massa	0.577	0.982	0.588	drs
Massa Marittima	0.424	0.431	0.983	irs
Massarosa	0.535	0.537	0.996	irs
Minucciano	0.279	0.308	0.908	irs
Molazzana	0.339	0.494	0.686	irs
Monte Argentario	0.439	0.442	0.993	irs
Monte San Savino	0.676	0.686	0.985	irs
Montecatini Val di Cecina	0.452	0.492	0.92	irs
Montecatini-Terme	0.487	0.488	0.997	irs
Montemignaio	0.395	0.581	0.68	irs
Monterchi	0.574	0.627	0.915	irs
Montescudaio	0.666	0.702	0.948	irs
Montevarchi	0.585	0.587	0.997	irs
Monteverdi Marittimo	0.629	0.844	0.746	irs
Monticiano	0.46	0.513	0.895	irs
Montieri	0.084	0.094	0.886	irs
Montignoso	0.49	0.496	0.987	irs
Montopoli in Val d'Arno	0.579	0.587	0.986	irs
Mulazzo	0.435	0.466	0.933	irs
Murlo	0.377	0.401	0.94	irs
Orbetello	0.643	0.646	0.995	irs
Orciano Pisano	0.571	0.96	0.595	irs
Ortignano Raggiolo	0.564	0.766	0.736	irs
Palaia	0.75	0.775	0.968	irs
Palazzuolo sul Senio	0.813	0.899	0.904	irs
Peccioli	0.222	0.23	0.968	irs
Pergine Valdarno	0.636	0.671	0.948	irs
Pescaglia	0.56	0.59	0.95	irs
Pescia	0.432	0.434	0.995	irs
Pian di Sco	0.709	0.73	0.972	irs
Piancastagnaio	0.555	0.57	0.973	irs
Piazza al Serchio	0.316	0.348	0.908	irs
Pienza	0.451	0.481	0.938	irs
Pietrasanta	0.39	0.391	0.999	irs
Pieve a Nievole	0.742	0.753	0.985	irs
Pieve Fosciana	0.372	0.4	0.929	irs
Pieve Santo Stefano	0.697	0.731	0.952	irs
Pisa	0.547	1	0.547	drs
Piteglio	0.586	0.645	0.908	irs
Pitigliano	0.64	0.667	0.958	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Podenzana	0.56	0.614	0.911	irs
Pomarance	0.582	0.597	0.976	irs
Poppi	0.575	0.589	0.977	irs
Porto Azzurro	0.424	0.436	0.972	irs
Pratovecchio	0.587	0.618	0.949	irs
Radda in Chianti	0.634	0.679	0.934	irs
Radicofani	0.577	0.637	0.905	irs
Radicondoli	0.305	0.4	0.761	irs
Rapolano Terme	0.601	0.621	0.968	irs
Rio Marina	0.259	0.27	0.957	irs
Rio nell'Elba	0.338	0.38	0.89	irs
Riparbella	0.27	0.298	0.907	irs
Roccalbegna	0.453	0.616	0.736	irs
Roccastrada	0.457	0.464	0.984	irs
Rosignano Marittimo	1	1	1	-
Sambuca Pistoiese	0.678	0.756	0.896	irs
San Casciano dei Bagni	0.476	0.513	0.928	irs
San Giovanni d'Asso	0.526	0.691	0.762	irs
San Giovanni Valdarno	0.562	0.566	0.992	irs
San Godenzo	0.449	0.542	0.829	irs
San Marcello Pistoiese	0.724	0.739	0.98	irs
San Piero a Sieve	0.492	0.51	0.963	irs
San Quirico d'Orcia	0.512	0.539	0.949	irs
San Romano in Garfagnana	0.301	0.367	0.819	irs
Sansepolcro	0.655	0.659	0.994	irs
Santa Croce sull'Arno	0.638	0.644	0.991	irs
Santa Fiora	0.583	0.612	0.953	irs
Santa Luce	0.348	0.386	0.9	irs
Sarteano	0.594	0.614	0.969	irs
Sassetta	0.305	0.423	0.721	irs
Scansano	0.475	0.495	0.958	irs
Scarlino	0.426	0.438	0.974	irs
Seggiano	0.573	0.711	0.806	irs
Semproniano	0.607	0.766	0.793	irs
Seravezza	0.345	0.349	0.988	irs
Sestino	0.458	0.57	0.804	irs
Sillano	0.318	0.571	0.557	irs
Sorano	0.544	0.577	0.943	irs
Stazzema	0.458	0.485	0.945	irs
Stia	0.481	0.514	0.935	irs
Subbiano	0.643	0.66	0.973	irs
Talla	0.433	0.557	0.777	irs
Tavarnelle Val di Pesa	0.698	0.707	0.987	irs
Terricciola	0.769	0.802	0.96	irs
Trequanda	0.608	0.693	0.878	irs
Tresana	0.612	0.672	0.91	irs

Municipality	CRS TE	VRS TE	SCALE	RTS
Uzzano	0.821	0.848	0.969	irs
Vagli Sotto	0.249	0.391	0.638	irs
Vaglia	0.507	0.525	0.966	irs
Vergemoli	0.278	0.942	0.295	irs
Vernio	0.697	0.717	0.973	irs
Vicchio	0.573	0.586	0.979	irs
Villa Basilica	0.103	0.116	0.891	irs
Villa Collemandina	0.375	0.48	0.782	irs
Villafranca in Lunigiana	0.354	0.369	0.959	irs
Volterra	0.802	0.811	0.989	irs
Zeri	0.398	0.455	0.876	irs

Table C.13: DEA2 results: average efficiency results among functions. 2011

Municipality	VRS TE municipal average	VRS TE Tuscan average
Abetone	0.181	0.244
Altopascio	0.696	0.724
Anghiari	0.492	0.597
Arcidosso	0.425	0.435
Aulla	0.316	0.441
Badia Tedalda	0.307	0.517
Bagni di Lucca	0.394	0.418
Bagno a Ripoli	0.632	0.639
Bagnone	0.312	0.364
Barberino di Mugello	0.520	0.526
Barberino Val d'Elsa	0.393	0.439
Barga	0.430	0.497
Bibbiena	0.671	0.679
Bibbona	0.399	0.385
Bucine	0.411	0.645
Buggiano	0.593	0.659
Buonconvento	0.416	0.468
Buti	0.525	0.539
Camaiore	0.647	0.664
Campagnatico	0.368	0.359
Campo nell'Elba	0.298	0.326
Camporgiano	0.398	0.497
Cantagallo	0.460	0.499
Capalbio	0.437	0.447
Capannoli	0.645	0.668
Capoliveri	0.302	0.299
Capolona	0.530	0.565
Capraia Isola	0.457	0.566
Caprese Michelangelo	0.452	0.565
Careggine	0.441	0.445
Carrara	0.666	0.702
Casale Marittimo	0.469	0.498
Casciana Terme	0.502	0.494
Casola in Lunigiana	0.401	0.466
Casole d'Elsa	0.400	0.443
Castel del Piano	0.501	0.520
Castel Focognano	0.433	0.475
Castel San Niccolò	0.355	0.424
Castelfranco di Sopra	0.382	0.483
Castelfranco di Sotto	0.644	0.660
Castell'Azzara	0.355	0.357
Castellina in Chianti	0.380	0.390

Municipality	VRS TE municipal average	VRS TE Tuscan average
Castellina Marittima	0.461	0.452
Castelnuovo di Garfagnana	0.349	0.360
Castelnuovo di Val di Cecina	0.437	0.486
Castiglion Fibocchi	0.476	0.489
Castiglione della Pescaia	0.289	0.268
Castiglione di Garfagnana	0.427	0.459
Castiglione d'Orcia	0.383	0.393
Cavriglia	0.517	0.557
Cetona	0.448	0.457
Chianni	0.383	0.517
Chiesina Uzzanese	0.662	0.690
Chitignano	0.496	0.514
Chiusdino	0.361	0.397
Chiusi	0.540	0.544
Chiusi della Verna	0.382	0.421
Cinigiano	0.389	0.445
Civitella in Val di Chiana	0.506	0.625
Civitella Paganico	0.133	0.183
Comano	0.451	0.463
Coreglia Antelminelli	0.482	0.497
Cortona	0.710	0.734
Cutigliano	0.317	0.431
Dicomano	0.482	0.546
Fabbriche di Vallico	0.376	0.480
Fauglia	0.477	0.494
Filattiera	0.395	0.424
Fivizzano	0.420	0.475
Follonica	0.554	0.580
Forte dei Marmi	0.220	0.213
Fosciandora	0.440	0.485
Fosdinovo	0.531	0.584
Gaiole in Chianti	0.388	0.418
Gallicano	0.301	0.296
Gavorrano	0.541	0.566
Giuncugnano	0.528	0.535
Grosseto	0.860	0.885
Guardistallo	0.462	0.475
Impruneta	0.546	0.543
Isola del Giglio	0.292	0.362
Lajatico	0.444	0.522
Lari	0.449	0.471
Laterina	0.538	0.541
Licciana Nardi	0.407	0.430
Londa	0.380	0.395
Lorenzana	0.486	0.484

Municipality	VRS TE municipal average	VRS TE Tuscan average
Loro Ciuffenna	0.531	0.595
Lucignano	0.374	0.431
Magliano in Toscana	0.353	0.363
Manciano	0.531	0.577
Marciana	0.244	0.231
Marciana Marina	0.238	0.231
Marciano della Chiana	0.569	0.617
Marliana	0.483	0.489
Massa	0.849	0.859
Massa Marittima	0.477	0.466
Massarosa	0.602	0.626
Minucciano	0.320	0.350
Molazzana	0.375	0.377
Monte Argentario	0.425	0.446
Monte San Savino	0.599	0.608
Montecatini Val di Cecina	0.477	0.486
Montecatini-Terme	0.511	0.544
Montemignaio	0.328	0.365
Monterchi	0.443	0.479
Montescudaio	0.429	0.454
Montevarchi	0.719	0.715
Monteverdi Marittimo	0.362	0.492
Monticiano	0.348	0.377
Montieri	0.150	0.196
Montignoso	0.446	0.459
Montopoli in Val d'Arno	0.629	0.652
Mulazzo	0.410	0.455
Murlo	0.399	0.419
Orbetello	0.488	0.501
Orciano Pisano	0.627	0.687
Ortignano Raggiolo	0.404	0.498
Palaia	0.497	0.535
Palazzuolo sul Senio	0.318	0.457
Peccioli	0.236	0.270
Pergine Valdarno	0.576	0.579
Pescaglia	0.396	0.457
Pescia	0.590	0.610
Pian di Sco	0.611	0.624
Piancastagnaio	0.501	0.502
Piazza al Serchio	0.415	0.437
Pienza	0.369	0.377
Pietrasanta	0.482	0.495
Pieve a Nievole	0.607	0.687
Pieve Fosciana	0.479	0.479
Pieve Santo Stefano	0.346	0.494

Municipality	VRS TE municipal average	VRS TE Tuscan average
Pisa	1.000	1.000
Piteglio	0.336	0.395
Pitigliano	0.490	0.554
Podenzana	0.486	0.518
Pomarance	0.383	0.411
Poppi	0.378	0.485
Porto Azzurro	0.393	0.381
Pratovecchio	0.430	0.511
Radda in Chianti	0.424	0.449
Radicofani	0.400	0.404
Radicondoli	0.188	0.221
Rapolano Terme	0.467	0.474
Rio Marina	0.271	0.297
Rio nell'Elba	0.228	0.239
Riparbella	0.368	0.416
Roccalbegna	0.365	0.408
Roccastrada	0.527	0.578
Rosignano Marittimo	0.595	0.667
Sambuca Pistoiese	0.406	0.555
San Casciano dei Bagni	0.354	0.360
San Giovanni d'Asso	0.391	0.436
San Giovanni Valdarno	0.596	0.598
San Godenzo	0.360	0.414
San Marcello Pistoiese	0.522	0.563
San Piero a Sieve	0.467	0.491
San Quirico d'Orcia	0.465	0.463
San Romano in Garfagnana	0.306	0.319
Sansepolcro	0.687	0.700
Santa Croce sull'Arno	0.580	0.605
Santa Fiora	0.440	0.441
Santa Luce	0.370	0.389
Sarteano	0.346	0.451
Sassetta	0.414	0.395
Scansano	0.401	0.412
Scarlino	0.352	0.335
Seggiano	0.387	0.418
Semproniano	0.412	0.462
Seravezza	0.489	0.506
Sestino	0.410	0.455
Sillano	0.358	0.394
Sorano	0.487	0.502
Stazzema	0.357	0.396
Stia	0.438	0.449
Subbiano	0.547	0.593
Talla	0.405	0.425

Municipality	VRS TE municipal average	VRS TE Tuscan average
Tavarnelle Val di Pesa	0.509	0.533
Terricciola	0.492	0.542
Trequanda	0.387	0.418
Tresana	0.505	0.511
Uzzano	0.648	0.687
Vagli Sotto	0.315	0.339
Vaglia	0.381	0.405
Vergemoli	0.478	0.684
Vernio	0.476	0.515
Vicchio	0.516	0.540
Villa Basilica	0.160	0.164
Villa Collemandina	0.450	0.488
Villafranca in Lunigiana	0.391	0.398
Volterra	0.539	0.577
Zeri	0.341	0.390

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