Local or national environmental spending in Italy: a stochastic frontier analysis

Sabrina Auci and Annalisa Castelli and Donatella Vignani

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Sabrina Auci
Department of European Studies and International Integration - University of Palermo

Annalisa Castelli
Economics Department - University of Cassino

Donatella Vignani
Directorate of National Accounts, ISTAT and Sefemeq Department, University of Rome Tor Vergata

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Abstract

The design of environmental spending at the national or local level stands on the concept of subsidiarity and on the theory of fiscal federalism. The main question is, so forth, studying when centralization of a public economic function, such as the protection of the environment, is welfare improving.

Using the stochastic frontier approach (SFA) on a panel of Italian regional data, this paper tries to test this issue, highlighting contrasting results. It seems in fact that, if Italy changes its administrative structure from a centralized to a decentralized government, and gives to local levels more autonomy in choosing how to spend public money, it is not certain if regional economic performance can improve.

JEL classification: H21; H23; H71
Keywords: Fiscal Federalism, Environmental Spending, Stochastic Frontier Approach, Technical Efficiency, Levels of Government.

1. Introduction

The design of environmental spending at the national or local level stands on the concept of subsidiarity and on the theory of fiscal federalism. The main question is, so forth, studying when centralisation of public economic functions is welfare improving. The theoretical foundations could be identified in the seminal work of Musgrave (1959) in which he discusses the optimal level of centralisation of several public economic functions and in the works of Tiebout (1956) and Oates (1981).

The basic economic theory of fiscal federalism explores the trade-off between the internalisation of external effects or economies of scale and their externalisation. The principal motive for decentralisation is to match the variety of preferences that exist in different jurisdictions. In contrast, centralisation may be warranted when the policy of a central government has consequences for another government that are not taken into account in its decision making process (cross-border externalities). In addition, the presence of fixed costs may make decentralised policies suboptimal. In that case centralisation benefits from economies of scale.

More deeply the advantages and disadvantages of fiscal federalism are widely discussed in economics. While some authors argue that federalism favors individual initiatives and serves as a market preserving device, others emphasize the dangers arising from an increasing corruption and local capture due to decentralisation.

In this work, we empirically study the contribution of environmental spending to the efficiency of central vs local units. This should be a contribution to the endless debate on the effective strengthening of the Italian fiscal federalism. In our opinion, the multi-faceted Italian case allows to disentangle the optimal design of fiscal federalism with a focus on the environmental spending. In Italy in fact the existence of different levels of government that coexist and sometimes overlap in their responsibilities, requires a careful design of the taxation structure.

We model efficiency using the Stochastic Frontier Approach (Aigner et al., 1977; Meeusen and van den Broeck 1977). This approach allows to distinguish between production inputs and efficiency/inefficiency factors and to disentangle distances from the efficient frontier between those due to systematic components and those due to noise. The model used in our estimation is based on the Battese and Coelli (1995) specification.

The samples used in this paper have been constructed using data that come from the Istat National Economic and Environmental Accounts. Our data almost cover the 1995 – 2007 period and refer to the Environmental Expenditures of Regions.

The different impact of the environmental spending designed and applied at the national or local level on economic performance, measured by GDP per capita, is analyzed by additionally using controls for physical and human capital investment as well as further controls and indicators of fiscal federalism.

Our empirical results, which still need to be checked for robustness, show how environmental fiscal rules binding on all levels, can help sustain environmental national commitment in countries having coalitions as in Italy. Coordinating institutions help in the use of moral suasion to encourage a coordinated response.

In a decentralized fiscal system in which externalities exist at the local level and in which sub-national governments have the power to provide local public services and to choose tax instruments, theory suggests that it is better to give the control of environmental tax to local governments.

Using a parametric stochastic frontier analysis (SFA), we attempt to test these concepts. Our preliminary results do not confirm that the more a local government is responsible of its environmental policy the more is efficient in term of economic and social performance.

2. Background Literature

According to Tanzi (1995) the term “fiscal decentralization” refers to the devolution of the authority related to public finances and to the delivery of government services from the national to the sub-national levels of the government itself. Federal countries transfer resources from the central government to local jurisdictions in order to alleviate the imbalance between expenditures and revenues.

The topic of fiscal federalism has been introduced into public finance theory during the second half of the twentieth century, opening the door to the systematic analysis of the theme. The main normative question associated with this subject concerns the extent to which fiscal powers and responsibilities should be transferred from higher to lower levels of government.

This concept of federalism, that could have relevant economic consequences, has been studied in a lot of theoretical works and a number of attempts have been made to systematically understand its key economic principles (Bird, 2004; Boadway, 2003; Collins, 2001; McLure, 1998).

Considering horizontal competition among various government units, one branch of the literature, that develops from Hayek (1939), argues that more information on the functioning of government is produced when more than one entity simultaneously try out various solutions. Another branch that goes back to Tiebout (1956), claims that competition by constituent governments for mobile citizens gives constituent governments incentives to provide their populations with a bundle of collective goods that reflects their preferences at a competitive price (Voigt and Blume, 2009).

Looking at vertical competition instead, which means reasoning on the relationship between the federal and the state level, theoretical contributions mainly rely on Olson (1969) and Oates (1972) that find the main advantage of a federalist model in the capacity of a local government to satisfy a greater number of people's preferences with respect to a central one.

In order to lay down a clear path for the development that this research has followed, it is useful to recall the division among first and second generation theories of fiscal decentralization (Oates, 2005). As pointed out by Olson itself, the first generation group of theories was the basic theoretical structure of fiscal federalism as it emerged almost fifty years ago and founds on the works of Samuelson (1954, 1955) on the nature of public goods, Arrow (1970) on the conceptualization of the roles of the private and public sectors and Musgrave (1959) on public finance. These works together considered set a role for the government in correcting various forms of market failures. According to this perspective, considering a multi-level government setting, is it true the presumption that each level of government would seek to maximize the social welfare of its respective constituency.

On the other side, second generation theories starts from strands of literature which are outside the field of public economics such as principal-agent problems, the economics of information, the new theory of the firm, organization theory, and the theory of contracts (Qian and Weingast, 1997).

A policy of fiscal decentralization is directed towards the transfer of fiscal powers and responsibilities from the national to sub-national governments . While fiscal centralization is often a response to the demands of national unity, fiscal decentralization may be seen as a response to the demands for diversity and accountability within the community. On balance, the first

generation theorists investigating fiscal federalism tended to associate the process of fiscal decentralization with an enhancement in the overall degree of public sector responsiveness to a public demand and, ultimately, to an improvement in the economic efficiency of public economic activities by better linking resource allocation with public preferences.

As already said, among many different economic ideas about decentralization of public functions and the associated issue of public finances under decentralized systems, seminal contributions were made by Tiebout (1956), Musgrave (1959) and Oates (1972), all of whom laid the strong foundation for significant discussions of fiscal decentralization. Olson (1969), through his concept of fiscal equivalence, also made an important contribution. These studies, in conjunction with the public choice approach to multi-tier government initially developed by Brennan and Buchanan (1980) represent seminal works in the first generation literature on fiscal decentralization.

In broad terms, it may be concluded that there are two general streams of first generation theory, with Tiebout having a major influence on both. There are (i) studies that draw on Tiebout's impure local public goods concept and integrate it with the Musgravian framework and (ii) studies that draw on Tiebout's notion of inter-jurisdictional mobility and link it with forces that limit the size of the public sector. The work of Oates, for example, would fall under the first category, referred to here as the 'core' first generation theory of fiscal decentralization, while the public choice approach of Brennan and Buchanan would fall under the second, non-core, category. Importantly, though, the non-core public choice approach is a 'complement' to 'core' first generation theory, as it relates to the particular question of fiscal decentralization.

Moving towards the second generations theories we must consider two main concepts that underlie their development. The first concerns the political processes and the behavior of political agents in which participants may have their own objective functions. Government officials may not need to seek the common good as assumed in the first generation theory; rather, they may not act to maximize the welfare of their constituencies. This consideration has obvious links to public choice theory – which was the main 'non-core' stream of the first generation theory of fiscal decentralization. The second concerns the issue of asymmetric information and political agents. Some particular participants have more knowledge of local preferences and tastes and cost structure compared to the others. To analyse these influences, fiscal federalism is examined from the perspective of a framework on industrial organization and microeconomic theory. Much of these works by the second generation theorists concerns the issue of balance between the degree

of fiscal centralization and fiscal decentralization. While the general support for fiscal decentralization in the first generation theory is acknowledged, the dangers of going too far in the fiscally decentralized system are a feature of the second generation theory.

The emerging second generation theory has been characterized in terms of two motivating issues: incentives and knowledge (Vo, 2008). Both motivations have contributed to an increased economic efficiency: incentives are required for sub national governments to do a better job to avoid outward migration of people and firms; and knowledge of local preferences and tastes is crucial to achieve economic efficiency when local public goods and services are provided by sub national governments. The contributions of the second generation theory are mainly drawn from the economics of transaction cost, incomplete contracts and principal–agent perspectives (Vo, 2008). Leading studies, that have been classed as parts in the emerging second generation theory, are associated with Weingast (1995), Seabright (1996), Lockwood (2002) and Besley and Coate (2003).

3. The Italian Federalism

Looking at Italy from a multi level government perspective, the country could be defined as a regional system moving towards a federal one. There exist in fact four levels of sub national government: Regions, Provinces, Municipalities and Metropolitan Cities, with these last three entities forming the "local government"[1].

This structure dates back to 150 years ago, at the time of Italy's Unity and it has been modeled on the French one. For a long time however, the central government enjoyed all the power and decided over most of the resources.

Starting from the end of the 20th century this tendency has been inverted, thanks to some important reforms of the Italian legal system (see box 3.1 for a brief description of the main interventions).

Among them, the main one is the Constitutional Law n. 3 of 2001 which amended the Title V of the Italian Constitution (articles 114, 117 and 119)[2]. In that occasion the legislator introduced deep changes to the relations between state, regions and local authorities with regard to legislative and administrative competencies, in order to increase the functions that fall under the jurisdiction of

[1] Brosio, G. (2010) - Economia Pubblica Moderna. Ed. Giappichelli.

[2] The Constitution is the Supreme Law of the Italian legislation. It sets forth the framework for national and sub-national relationships. All other laws must not contradict the Constitution.

the autonomous entities. It is worth noting in fact, that the "new" article 114 poses the state, the regions, the metropolitan cities, the provinces and the municipalities at the same level, substantially reversing the old approach that saw the state above everything (Frosini, 2009).

Although a huge number of laws and regulations have been designed and mostly enacted, the process is still lagging behind. The main problem is that, in order to be really autonomous, local entities need to have their own financial resources. The funding instead, has remained almost completely in the hands of the central government. This picture becomes clearer considering that even if, according to the law, public spending is equally divided among the central government and the local authorities, the latter raise less than 18% of tax revenues (Frosini, 2009).

Box 3.1: Main laws which are intended to transform Italy in a federal state.

- Law n. 142/1990 (June 8th): "code of local autonomies"
- Law n. 81/1993 (March 25th): "direct election of major, president of the province, municipality council and provincial council". The subsequent Law n.120/1999 extends the mandate of mayor to five years and reviews the electoral system.
- Law n. 59/1997 (March 15th): "delegation to the government to transfer functions and tasks to regions and local authorities for the reform of the Public Administration and for the Administrative simplification (the so called *Bassanini 1*).
- Law n.127/1997 (May 15th): "urgent measures for simplification of administrative" (the so called *Bassanini 2*)
- The Bassanini 1 and 2 were further amended by Laws n. 191/1998 and n. 50/1999 (*Bassanini ter and quater*).
- Constitutional Law n. 1/1999: "provisions concerning the direct election of the regional government and president and the statutory autonomy of Regions".
- Constitutional Law n. 3/2001: "changes to Title V of Part II of the Constitution". In particular art. 119 of the Law modifies financing rules of Regions, Provinces, Municipalities and Metropolitan Cities by reinforcing the principle of the local financial authonomy and introducing the criteria of fiscal capacity in the management of government equalization transfers.
- Law n. 131/2003 (June 5th): "provision for the adjustment of the Republic order to the Constitutional Law n. 3/2001 "
- Constitutional Law n. /2005 (November 18th): additional changes to Title V of Constitution towards an explicitly federal model, however, in June 2006 rejected by referendum of confirmation.
- Law n. 42/2009 (May 5th): delegation to the Government on the matter of fiscal federalism, in accordance with article 119 of the Constitution.

To this end, the financial autonomy of Regions and Local Authorities is guaranteed and regulated by art. 119 of the Constitution which has started to be implemented effectively by the Law n. 42/2009. The most innovative and important principle contained in this delegation is the

introduction of the so called “standard cost” criterion in place of the “historical expense” criteria used so far to determine the costs necessary to the pursuit of the functions entrusted to the territorial bodies (Scuto, 2010)[3].

3.1 A brief quantitative description of Italian Federalism

From a quantitative point of view, the Italian public sector is still quietly centralized. Almost a half of the public spending comes in fact from the state.

Table 3.1 briefly describes the allocation of competencies and resources as it is now.

Table 3.1: Competencies and financing of Italian different levels of government (2011).

Entity	Competencies	Financing
Regions	Legislative and administrative powers on issues such as Social Services (health, education, culture), Planning and Use of natural resources (environmental protection, transportations, forestry etc.) and Economics (tourism, agriculture, trade, etc.)	Own taxes (IRAP, fuel excise duty, IRPEF, road taxes) and grants from the central government.
Provinces	Administrative powers on employment, road maintenance, environmental protection.	Own taxes and grants from both the central government and the regions (almost equally divided).
Municipalities	Administrative powers on almost all aspects of the quality of life of citizens (culture, traffic, water, cemeteries, public gardens, manufacturing, etc)	Own taxes (ICI, IRPEF, TARSU, rates on services) and grants from the central government.

Table 3.2 highlights the evolution of the expenses of regions, provinces and municipalities in absolute values and per capita.

[3] For a critical treating of the Law n. 42/2003 see for example Scuto, F. (2010).

Table 3.2: Current expenditure of Municipalities, Provinces and Regions - year 2008 (absolute values, millions €)

Region	**Municipality exp.**		**Province exp.**		**Regional exp.**		**Pop**
	total	per capita	total	per capita	total	per capita	1000/p
Piemonte	3.738	849	905	206	10.281	2.336	4.401
Valle d'Aosta	198	1.572	0	0	1.063	8.435	126
Lombardia	8.105	841	1.308	136	23.155	2.401	9.642
Trentino Alto Adige	1.242	1.233	0	0	258	256	1.007
Bolzano	604	1.222	0	0	3.237	6.554	494
Trento	638	1.243	0	0	2.616	5.096	513
Veneto	3.536	732	617	128	9.950	2.059	4.832
Friuli Venezia Giulia	1.333	1.091	289	237	4.673	3.824	1.222
Liguria	1.768	1.099	310	192	4.280	2.658	1.610
Emilia -Romagna	3.841	898	668	156	9.823	2.297	4.276
Toscana	3.315	902	781	212	8.301	2.257	3.677
Umbria	755	853	202	229	1.919	2.170	884
Marche	1.276	822	324	209	3.237	2.084	1.553
Lazio	4.435	797	711	128	19.439	3.496	5.561
Abruzzo	974	736	190	144	3.104	2.345	1.324
Molise	276	861	51	158	1.102	3.433	321
Campania	4.795	825	791	136	12.606	2.169	5.811
Puglia	2.741	672	509	125	8.229	2.019	4.077
Basilicata	447	756	167	282	1.304	2.206	591
Calabria	1.489	742	415	207	4.382	2.182	2.008
Sicilia	4.469	889	597	119	17.780	3.535	5.030
Sardegna	38	23	265	159	5.414	3.251	1.666
Italy	**50.455**	**846**	**9.099**	**153**	**156.151**	**2.619**	**59.619**

Source: ISTAT I bilanci consuntivi delle Regioni e delle Province autonome 2007-2008, edition 2010 and ISTAT I bilanci consuntivi delle Province e dei Comuni 2008, edition 2010. Current expenditures, budget commitments

4. The Empirical Model

The neoclassical paradigm in economics assumes that production is always efficient. However, it is quite unrealistic that two regions – even if identical – can produce a similar output with the same costs and profits. In other words, the difference between two regions can be explained through the analysis of efficiency and some unforeseen exogenous shocks, as described by Desli et al. (2002).

A simple OLS regression is not sufficient to estimate the relationship between output and inputs as described in Feld et al. (2004). In fact it has several limits, such as it does not discriminate between rent extraction and productive efficiency and does not simultaneously take into account distances from the efficiency frontier for a given production function.

To test whether local environmental spending and standards inputs affect productive efficiency at the region level, we have estimated regional production functions using the stochastic frontier approach (SFA)[4]. This methodology was developed independently by Aigner et al., (1977) and Meeusen and van den Broeck (1977). This approach allows to distinguish between production inputs and efficiency/inefficiency factors and to disentangle distances from the efficient frontier between those due to systematic components and those due to noise. This parametric approach is preferred to nonparametric ones since it avoids that outliers are considered as very efficient countries (Signorini, 2000).

The main idea is that the SFA, which represents the maximum output level for a given input set, is assumed to be stochastic in order to capture exogenous shocks beyond the control of regions.

Since all regions are not able to produce the same frontier output, an additional error term is introduced to represent technical inefficiency that, in turn, is in the control of regions[5]. After these early studies, the SFA methodology has been extended in many directions using both cross-sectional and panel data. The availability of panel data allows to study the behaviour of technical inefficiency over time. Among others, Pitt and Lee (1981), Schmidt and Sickles (1984) Kumbhakar (1987) and Battese et al. (1989) treated technical inefficiency as time invariant while for example Cornwell et al., (1990), Kumbhakar (1990), Battese and Coelli (1992) and Lee and Schmidt (1993) allowed technical inefficiency to vary over time even if they modelled efficiency as a systematic function of time.

The search for the determinants of efficiency changes has been firstly pursued by adopting a two stage approach in which the efficiencies estimated in the first stage were then regressed against a vector of explanatory variables. Further development of this technique led to the adoption of a single stage approach in which explanatory variables are incorporated directly into the inefficiency error component[6]. In particular, Kumbhakar, Gosh and McGuckin (1991) noted the inconsistency between the i.i.d. assumption on the inefficiency effects at the first stage and the non identical distribution of the predicted inefficiency effects in the second stage, and proposed a

[4] A number of comprehensive reviews of this literature is now available. See for example Forsund et al. (1980), Schmidt (1986), Bauer (1990), Greene (1993) and Coelli et al. (1998).

[5] We follow the Farrel, M.J. (1957) measure of firm's efficiency consisting in two components: technical and allocative. The former reflects the ability of a firm to obtain maximal output from a given set of inputs while the latter reflects the ability of a firm to use the inputs in optimal proportions given their respective prices. These considerations are obviously true also at the country level considering that the aggregate output comes from the sum of national producers.

[6] For a review see Kumbhakar and Knox - Lovell (2000).

model in which the inefficiency effects were explicit functions of a vector of firm-specific factors and the parameters were estimated in a single stage maximum likelihood procedure.

A further development of this first approach has been the Battese and Coelli (1995) model in which the allocative efficiency is imposed, the first-order profit maximising conditions removed, and panel data is permitted. Thus, the Battese and Coelli (1995) model specification may be expressed as:

$$(1) \qquad Y_{it} = x_{it}\beta + (v_{it} - u_{it}) \qquad i=1,...,N,\ t=1,...,T$$

where Y_{it} is (the logarithm of) the production of the *i-th* region in the *t-th* time period; x_{it} is a $k\times1$ vector of (transformations of the) input quantities of the *i-th* region in the *t-th* time period; β is an vector of unknown parameters. The unobserved random noise is divided into a first component v_{it} which are random variables following the assumption of normally distributed error terms [iid N(0, σ_V^2)], and a second independent component defined as u_{it} which are non-negative random variables. These variables are assumed to capture the effects of technical inefficiency in production and are assumed to be independently distributed as truncations at zero of the N(m_{it}, σ_U^2) distribution.

The mean of this truncated normal distribution is a function of systematic variables that can influence the efficiency of a region:

$$(2) \qquad m_{it} = z_{it}\delta + \varepsilon_{it},$$

where z_{it} is a $p\times1$ vector of variables which may have an effect on the production function of a region; and δ is an $1\times p$ vector of parameters to be estimated.

Following Battese and Corra (1977), the simultaneous maximum likelihood estimation of the two equation system is expressed in terms of the variance parameters $\sigma^2=\sigma^2_v+\sigma^2_u$ and $\gamma=\sigma^2_u/(\sigma^2_v+\sigma^2_u)$, to provide asymptotically efficient estimates[7]. Hence, it is clear that the test on the significance of the parameter γ is a test on the significance of the stochastic frontier specification (the acceptance of the null hypothesis that the true value of the parameter equals zero implies that σ^2_u, the non random component of the production function residual, is zero).

The technical efficiency of the *i-th* region in the *t-th* time period is given by:

[7] The log-likelihood function and the derivatives are presented in the appendix of Battese and Coelli (1993).

(3) $$TE_i = e^{(-u_i)} = e^{(-z_{it}\delta - \varepsilon_{it})}$$

5. Our Empirical Model

In this paper we analyze the economic performance of Italian regions. Following the 1995 Battese and Coelli specification, we estimate a production function of Italy based on regional data.

Model results are computed using the program FRONTIER 4.1, which can manage either balanced and unbalanced panel data. This paper is an empirical application of the neoclassical growth model using a different empirical approach with respect to the main work of Mankiw, Romer and Weil (1992).

We perform our estimations using a panel data of 20 Italian regions across 13 years. In our model, the production of each region is measured by gross domestic product Y_{it} and, as usual is assumed to be a function of three inputs: physical capital (K_{it}), labour (L_{it}) and human capital (H_{it}). We divide capital in two types because we want to catch the importance of local authorities in the human capital formation, even if the central government is still responsible for the high level education expenses in Italy.

By assuming that the production function takes the log - linear Cobb-Douglas form, our stochastic frontier production model can be specified as follows:

(4) $$\ln(Y/L)_{it} = \beta_0 + \beta_1 \ln(K/L)_{it} + \beta_2 \ln(H/L)_{it} + \sum_{j=3}^{5}\left(\beta_j \ln(K/L)_{it} * Macroarea\right) + \\ + \sum_{j=6}^{8}\left(\beta_j \ln(H/L)_{it} * Macroarea\right) + v_{it} - u_{it}$$

where the dependent variable is the value of the economic performance of the *i-th* region at time *t* (*i=1,...,N; t=1,...,T*), divided by a scale variable (the labour force) in order to remove potential problems of heteroskedasticity, multicollinearity and output measurement (Hay-Liu, 1997) and the independent variables are: i) physical capital pro-capite (*K/L*) which is the regional capital stock per worker of the *i-th* region at time *t* and ii) human capital (*H/L*) which is the regional education spending per worker of the *i-th* region at time *t*. Moreover, to take into account the differences among Italian regions and the impact of local culture and geography on the local economic performance, we have added the interaction of physical and human capital

with *m*-1 dummies accounting for the four different geographical areas in which Italy can be divided according to economical and cultural characteristics (for more details see Appendix A).

To take into account the technical inefficiencies of Italian regions, we model the second component of the error as a function of several observable explanatory variables as we show in the following equation:

$$(5) \quad u_{it} = \gamma_0 + \gamma_1 DES_{it} + \gamma_2 POP_{it} + \gamma_3 MF_{it} + \gamma_4 PF_{it} + \sum_{k=5}^{7} \gamma_k Macroarea + \varepsilon_{it}$$

where DES_{it} is the decentralization of environmental spending, POP_{it} represents the size of each region, MF_{it} is the fragmentation of the municipalities within a region and PF_{it} is the fragmentation of provinces within a region. Finally to capture the region localization we consider the m-1 geographical dummies.

As we have already underlined, the focus of our analysis is the impact of local environmental spending on local economic performance to somehow try to measure the efficiency of an environmental federalism in Italy. Following Feld et al. (2004), we consider only two of five variables that the authors analyze for their test of the Swiss federalism. The decentralization of the environmental spending is measured by the ratio of local environmental spending on the total regional spending.

Following the traditional Tiebout approach, decentralization is hypothesized to have a positive effect on local economic performance. However, this variable is not sufficient to explain the autonomy of a local government especially in Italy where the federalism is not yet completely implemented, as it has been sketched in paragraph 3. For this reason, our estimations explicitly take into account some fragmentation variables. In particular, municipal fragmentation has been constructed by dividing the number of towns existing in each region by the regional population; provincial fragmentation is instead the ratio between the number of provinces and the regional population.

The possibility of exploiting economies of scale in the reform of fiscal federalism is analyzed by these two variables. In the theoretical debate in fact, it is argued that the number of jurisdictions should be reduced by mergers, in order to exploit economies of scale. Thus, if there are economies of scale, the lack of their exploitation, i.e. a higher number of communities, should have a negative impact on economic performance.

Finally, in order to analyze a recent issue emerged in the New Economic Geography literature, which is that a region belonging to a well developed area can perform better than a region belonging to a less developed area, we have introduced the macro-areas dummies interacted with input factors. A region in the north of Italy in fact should influence positively the regional economic performance and thus the technical inefficiency should be less with respect to others; in other words, the gap from the stochastic frontier of this region should be not so big.

6. Data and Results

The sample used in this paper has been selected by drawing data from ISTAT National Economic Accounting, Regional Economic Accounts and Environmental Economic Accounts. Data are collected yearly from 1995 to 2007 for the twenty Italian regions.

The empirical analysis has been performed using a balanced panel data of 260 observations. Table 6.1 reports descriptive statistics of per-capita output, per-capita physical capital, per-capita human capital and other variables relevant in our model for the overall panel and for subsets of regions divided considering the belonging to the different macro-areas. Since Italy is not a perfect federal country, the local environmental expenditure variable is calculated by the National Institute of Statistics, as we described in more details in Appendix B.

In particular, both the North-West area and the North-East area represent the richest and well developed part of Italy. In fact, focusing on the average product of labor which, generally speaking could be considered as labour productivity, the data show that in mean the regions of the Centre-North of Italy are more productive than the regions of the South of Italy. However, this dualism is not confirmed by the “decentralization of environmental spending” variable, because all Italian regions spend more or less the same percentage of their budget in environment issues with respect to total public expenditures.

Table 6.1: Descriptive Statistics

		Y_L	K_L	H_L	Decentralization of environmental spending	Population	Municipality fragmentation	Province fragmentation
ITALY	**mean**	51.79	11.18	2.52	1.15	2,872,458	0.197	0.0028
	p50	51.70	10.83	2.36	1.17	1,828,748	0.165	0.0024
	sd	6.69	1.86	0.70	0.48	2,275,104	0.135	0.0018
	min	38.78	7.19	1.55	0.19	116,653	0.063	0.0009
	max	66.49	17.84	4.13	2.46	9,545,441	0.634	0.0086
	N	260	260	260	260	260	260	260
NORTH-WEST	**mean**	57.68	11.71	2.05	1.40	3,770,553	0.304	0.003
	p50	56.22	11.95	1.85	1.19	2,927,227	0.225	0.002
	sd	3.55	1.74	0.50	0.74	3,451,777	0.189	0.002
	min	51.23	8.09	1.64	0.19	116,653	0.143	0.001
	max	62.72	15.70	3.58	2.46	9,545,441	0.63	0.008
	N	52	52	52	52	52	52	52
NORTH-EAST	**mean**	56.65	13.01	1.93	1.01	2,671,094	0.188	0.002
	p50	56.77	12.56	1.79	0.97	2,553,808	0.156	0.002
	sd	2.09	2.13	0.39	0.24	1,637,832	0.103	0.0006
	min	51.76	10.27	1.55	0.48	902,177	0.082	0.001
	max	60.31	17.84	3.38	1.41	4,773,554	0.369	0.003
	N	52	52	52	52	52	52	52
CENTRE	**mean**	54.75	10.62	2.26	1.14	2,757,716	0.107	0.002
	p50	52.10	10.62	2.19	1.24	2,513,332	0.093	0.003
	sd	6.21	0.89	0.23	0.28	1,740,286	0.353	0.0009
	min	47.64	8.80	1.92	0.49	813,664	0.069	0.0009
	max	66.49	12.20	2.89	1.64	5,493,308	0.167	0.003
	N	52	52	52	52	52	52	52
SOUTH	**mean**	44.94	10.27	3.18	1.10	2,581,464	0.193	0.003
	p50	45.06	10.16	3.31	1.22	1,828,748	0.21	0.003
	sd	1.99	1.31	0.49	0.44	1,941,246	0.11	0.002
	min	38.78	7.19	2.33	0.23	320,074	0.063	0.0009
	max	48.33	13.07	4.13	1.84	5,790,929	0.425	0.0062
	N	104	104	104	104	104	104	104

Note: Y is GDP in millions at constant 2000 euro; L is labour force in thousand; K is gross fixed capital formation in millions at constant 2000 euro; Decentralization of environmental spending is expressed in percentage and Municipality fragmentation and Province fragmentation are expressed per 1000 inhabitant.

Table 6.2 reports the results of the stochastic frontiers estimations. The efficient frontier has been estimated using the 1995 Battese and Coelli specification. Since, in all specifications, we reject the null hypothesis of the insignificance of the non random component of the production function residual, we can conclude that the stochastic frontier specification is a good model to analyze the effect of local environmental spending on the regional economic performance.

In particular, from the first to the fifth column, we report the results of estimations which include step by step the different variables of fiscal federalism relevant for the environment. In all columns, the results indicate that production function performs relatively well. As usual in this estimations the input factors coefficients show a positive sign. However, the coefficients of the per-capita physical capital become significant only if we introduce in the technical inefficiency

function the main important variables of federalism such as decentralization of environmental spending and fragmentation.

The decentralization shows a positive sign and is very significant especially in the last three columns. This implies that the federalism of the environmental expenditure is not efficient because it increases the specific error component and thus the inefficiency of regions, reducing the regional economic performance. Instead when we introduce municipal and provincial fragmentation separately, the results confirm a negative sign and thus this can have a positive effect on regional efficiency and regional economic performance. These fragmentation variables establish that there are not economies of scales to exploit. So it seems that there is not a high number of municipalities and provinces.

Finally, the localization of Italian regions is relevant, as expected, with respect to labour productivity. In particular, regions belonging to the South area have positive and significant effects on economic efficiency. Instead as regards the North-west and North-east the result is puzzling. It seems that there is a negative impact on economic performance even if the significance is very low.

Table 6.2: Inefficiency models with GDP pro-capite as dependent variable

	(1)	(2)	(3)	(4)	(5)
Const β0	3.52	3.52	3.28	3.28	3.11
t-ratio	62.22	62.58	51.63	51.63	50.95
K/L β1	0.03	0.03	0.35	0.35	0.33
t-ratio	0.76	0.68	4.64	4.64	8.39
H/L β2	0.02	0.05	0.06	0.06	0.08
t-ratio	1.04	2.49	2.98	2.98	4.26
K/L*North West β3	0.23	0.23	0.01	0.01	0.07
t-ratio	7.08	6.25	0.11	0.11	2.14
K/L*North East β4	0.18	0.18	-0.05	-0.05	0.02
t-ratio	5.63	4.97	-0.63	-0.63	0.79
K/L*South β5	0.10	0.09	-0.14	-0.14	-0.07
t-ratio	3.06	2.29	-1.81	-1.81	-2.22
H/L*North West β6	-0.08	-0.11	0.37	0.37	0.30
t-ratio	-2.53	-3.25	6.91	6.91	5.99
H/L*North East β7	-0.04	-0.07	-0.01	-0.01	0.01
t-ratio	-1.27	-2.18	-0.13	-0.13	0.20
H/L*South β8	0.63	0.61	0.35	0.35	0.29
t-ratio	6.86	5.90	5.01	5.01	3.69
const γ0	0.12	0.12	1.45	1.45	1.55
t-ratio	1.68	1.37	8.07	8.07	11.62
Decentralization of environmental spending γ1	-0.22	0.35	0.50	0.50	0.52
t-ratio	-4.86	2.70	6.73	6.73	7.58
Popolation γ2		-0.66	-1.04	-1.04	-0.84
t-ratio		-3.89	-5.65	-5.65	-9.15
Municipality fragmentation γ3			-0.07		-0.09
t-ratio			-12.82		-12.19
Province fragmentation γ4				-0.07	0.0001
t-ratio				-12.82	3.72
North West γ5	0.01	0.003	-0.01	-0.01	0.01
t-ratio	0.48	0.20	-1.43	-1.43	1.32
North East γ6	-0.13	-0.13	-0.05	-0.05	0.05
t-ratio	-3.60	-3.87	-0.28	-0.28	1.00
South γ7	-0.85	-0.84	-0.42	-0.42	-0.18
t-ratio	-2.49	-2.40	-2.43	-2.43	-7.01
Observations	260	260	260	260	260
sigma squared	0.01	0.01	0.002	0.002	0.001
t-ratio	5.42	5.88	7.68	7.68	8.81
gamma	0.95	0.94	0.51	0.51	0.27
t-ratio	59.37	69.87	3.40	3.40	2.25
Log likelihood	445.92	449.90	504.27	504.27	511.95

Note: K/L is the log of gross fixed capital formation/total labour force; H/L is the log of local education spending/ total labour force; North-West, North-East and South are the Macroarea dummies as described in Appendix A; Decentralization of environmental spending is log of local environmental spending/local total public expenditure and Municipality fragmentation and Province fragmentation are the ration between the number of regional Municipalties or Province and regional population.

In order to deepen this analysis, we have estimated technical inefficiencies of each region, using the model described in column (5) on Table 6.2. In Table 6.3 we report the technical inefficiencies in three different years: 1995, 2000 and 2007. Then, we rank Italian regions according to the level of inefficiency reached in 2007.

The results show that Valle d'Aosta, Piemonte and Liguria, all three belonging to the North-West area, are placed more or less at the top of the classification in all years considered, representing the most inefficient regions with respect to the federalist issue. In other words these three regions are the less close to the stochastic frontier. Instead, the last three regions (Puglia, Sardegna and Abruzzo) are the more close to the stochastic frontier, and thus they seems to be the more efficient regions of Italy.

Table6.3: Italian regions ranking of technical inefficiency based on 2007 and compared with previous years

Regions	1995	2000	2007
Valle d'Aosta	1	1	1
Piemonte	3	2	2
Liguria	4	3	3
Umbria	2	4	4
Marche	5	5	5
Lombardia	6	6	6
Toscana	7	7	7
Lazio	8	8	8
Trentino Alto Adige	10	9	9
Friuli Venezia Giulia	12	11	10
Basilicata	9	10	11
Calabria	11	12	12
Molise	13	13	13
Veneto	17	16	14
Campania	15	15	15
Emilia Romagna	18	17	16
Sicilia	14	14	17
Puglia	19	19	18
Sardegna	16	18	19
Abruzzo	20	20	20

7. Concluding Remarks

The results of our estimations confirm that the regions located in Southern Italy are the most efficient. This efficiency is mainly due to the fragmentation of municipalities and provinces, while the decentralization of local environmental spending reduces the efficiency of a region. This

results are dampening the hope for gaining efficiency from the changeover from the centralization to the federalism system. In other words, if Italy changes its administrative structure from a centralized to a decentralized government and gives to local levels more autonomy in choosing how to spend public money, it is not certain if regional economic performances can improve. Moreover, the more advanced regions in terms of productions seems to be the less efficient in terms of federalism.

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Appendix A

The definition of the 4 macro-areas of Italy:

MACRO-AREAS	ITALIAN REGIONS
NORTH - WEST	Piemonte Valle d'Aosta/Vallée d'Aoste Lombardia Liguria
NORTH - EAST	Trentino-Alto Adige/Südtirol Veneto Friuli-Venezia Giulia Emilia-Romagna
CENTRE	Toscana Umbria Marche Lazio
SOUTH	Abruzzo Molise Campania Puglia Basilicata Calabria Sicilia Sardegna

Variables used in the estimations

Source ISTAT - National Economic Accounts - Regional Accounts - Environmental Accounts:

- Output (Y): GDP millions of euros, chain-linked volumes with reference to year 2000
- Physical Capital (K): Gross Fixed Capital, millions of euros, chain-linked volumes with reference to year 2000
- Labour (L): Total Labour Force (thousands of employed)
- Human Capital (H): Educational spending by public administration at the regional level, millions of euros, chain-linked volumes with reference to year 2000
- Physical Capital per capita (K/L): Capital stock per worker
- Physical Capital per capita (H/L): Educational spending per worker
- Decentralization of environmental spending (DES): Environmental protection spending by public administration at the regional level, millions of euros, chain-linked volumes with reference to year 2000.
- Size of a Region (POP): Population within a Region
- Fragmentation of municipalities (MF): number of Municipalities within a Region
- Fragmentation of provinces (PF): number of Provinces within a Region
- Geographical dummies: Macro-areas of Italy as described in the previous table of this appendix

Appendix B

Methodological note regarding the official statistics and the calculus of the Environmental Protection Expenditure of Regions.

In the debate on sustainable development, one of the main topics is the amount of costs that the economic system has to do in order to protect the environment. To answer the growing demand for statistical information to support sustainable development policies, over the past fifteen years the official statisticians have been involved in the definition of integrated systems for the analysis of data and indicators related to economic, social and environmental phenomena.

In this framework, the event of environmental protection spending, with all the breakdowns usually considered necessary (by institutional sector, by sector of economic activity, by sector of environmental intervention, etc..), is generally interpreted as an indicator of the "response" of the socio-economic system to environmental problems, referring to the terminology derived from the DPSIR scheme (Driving Forces - Pressures - State - Impacts - Responses) which is one of the conceptual models most used at the international level to represent the system of relations between anthropogenic and natural environment.

Environmental protection spending particularly supported by the public sector has a strategic interest because it constitutes a crucial element for the analysis and understanding of complex realities. Information about the role and relative weight of public spending compared to that of other subjects of the economy is used to assess the positioning of environmental policies compared to reference models such as the "polluter pays" principle. The growing of the environmental expenditure supported by the government indicates in many cases a situation in which government intervention in the environment tends to replace that of polluters and thus is often indicative of a reality in which this principle does not seem to find enough application. Considering more general analysis of public policy, it is important to identify the financial effort for the protection of the environment relative to that supported by other policies. The information on environmental expenditure in an economic system, and in particular on public sector spending, is the subject of one of the environmental accounts produced within environmental accounting systems developed by Statistics Institutes of international organizations and member states and is part of other statistical information systems including the European System of National Economic Accounts.

Given the purpose of our work, we provide some details on Environmental Protection Expenditure of Italian Regions drawn by National Economic Accounts and in particular by Environmental Economic Accounts.

The time series available have been calculated by ISTAT starting from final balances of Regional administrations reclassified according to the classifications, definitions and schemes of the System of Satellite Account of Environmental Protection Expenditure EPEA (Environmental Protection Expenditure Account) part of the large system SERIEE (Système Européen de Rassemblement de l'Information Economique sur l'Environnement) as developed by Eurostat since 2002.

The financial outlays exposed in the Regional balances are reviewed through an *ad hoc* process of analysis named "*budget analysis methodology*" aimed at identifying and quantifying those expenses finalized to protect the environment, as defined by Eurostat references. This methodology of quantification of public expenditure of environmental protection has been jointly developed by Istat and Italian Ministry of Environment (ISTAT, 2006). The accounts illustrate in more details the Environmental Expenditure of the Regions by environmental sector of intervention and by type of expenditure (current expenditure and capital expenditure). They describe the financial resources used in operations or activities to protect the environment from: i) pollution (air emissions, water discharges, waste, soil pollution, etc..); and ii) degradation (loss of biodiversity, soil erosion, salinization, etc.). Moreover, they describe the costs incurred to use and manage natural resources in a sustainable way (waterways, energy resources, forest resources, wildlife and flora and so on). These expenditures include instrumental activities such as monitoring and control, research and experimental development, administration and regulation, training, information and communication[8] (ISTAT, 2003).

As underlined above, the consistency of definitions and accounting schemes of SERIEE with the European System of Economic Accounts SEC95 ensures comparability of these items with National Accounts aggregates. The official statistics provide a detailed picture of the environmental costs included in the data of Public Administrations Expenditures by function COFOG classification (Classification Of Functions Of Government) developed under the EU Regulation No 2223/96 founding the National Accounts SEC95 and Manual on Government Deficit and Debt, which regulates the processing of transactions related to the general government sector.

[8] Data on environmental expenditure of Italian public administration are brought to the attention of Parliament in the "Report on Environment" periodically prepared by the Ministry of Environment and Protection of the territory. The importance of the information derived from environmental accounts, which support environmental sustainability in development, is stressed in Environmental Action Strategy for Sustainable Development in Italy approved by CIPE in August 2002.