Efficiency of public spending in education: a challenge among Italian Regions

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Abstract**.** The Italian educational system is strictly regulated by the Ministry of Education. However, there are strong differences in educational inputs and outputs among Regions, as can be noticed by analyzing the allocation of public budgets to the Regions and their students' (average) performance in national and international test scores. A general institutional change is ongoing in Italy, that is, the decentralization of competencies from the State to the Regions (federalism). Some insights are necessary about the efficiency of public spending on education in a comparative perspective across Regions. To estimate efficiency scores, a non-parametric technique called DEA (Data Envelopment Analysis) was used. The units of analysis are the 18 Italian Regions, with the focus on the lower-secondary education. Then a second-stage Tobit regression was used to detect the factors affecting efficiency. The results corroborate the difference between the North and South of Italy (the Regions in the North outperform their counterparts in the South). When looking at the Regional socio-economic context, GDP per capita appears as the key determinant of efficiency.

Key words: efficiency of public spending, standard costs in education.

1. Introduction

The intervention of the State in providing social services, including education, is universally agreed upon. Since the 1950-60s the cost of welfare services as a whole has grown increasingly, up to the point where it became hard to sustain in the 1980s (Barr, 1992 and Malinvaud, 1994). The issue of sustainability of the system and the increasing focus on the importance of the results of the system have led to new ideas: the progressive *devolution of powers* from the public sector to the schools (Bottani, 2000; Mitch, 2004 and Maroy, 2008) and stressing the link between *funding* and *performance* (Bartlett and Le Grand, 1993; Hood, 1995).

This paper focuses on the former. Indeed, since a general institutional change is ongoing in Italy, that is, the decentralization of competencies from the State to the Regions (federalism),

some insights are necessary about the efficiency of public spending on education in a comparative perspective across Regions.

"Italy shows marked geographical variation in educational achievement: a key question is whether this is related to exogenous factor or to the characteristics of the education system" (Boarini, 2009 - p. 51). A well known problem in Italy is a wide difference in terms of socio-economics characteristics of its Regions. Our key question is: *in a comparative perspective, does the Regional efficiency on education differ because of their structural differences (i.e. socio-economic factors)? Or is there a different productivity of public expenditure in this sector?*

To estimate efficiency scores, a non-parametric technique called DEA (Data Envelopment Analysis) is used. The units of analysis are the 18 Italian Regions, and the focus is on the lower-secondary education. The teacher:students ratio and the PISA 2009 scores were chosen, respectively, as the input and the output. Then, a second-stage Tobit regression was used to detect the factors affecting efficiency. The candidate factors are: the proportion of disabled and foreign students, the gross domestic product (GDP) per capita, the proportion of adult population with a tertiary degree, and the percentage of students attending private schools.

The results corroborate the difference between North and South of Italy (the Regions in the North outperform their counterparts in the South), even though there are some exceptions. Finally, the Regional socio-economic context appears as a key determinant of efficiency.

The paper is organised as follows: in the next section the Italian context is described. In the third section the contribution of the literature about Italian Regions' difference in education is addressed. Then in the fourth section the data and the methodology are explained. The fifth section shows the results, and includes some concluding remarks.

2. The Italian educational system

Italian Regions are widely different in terms of socio-economic development. As it has been reported in table 1, Northern Italy has higher GDP per capita, a higher graduation rate and higher employment rate. Daniele and Malanima (2007) argue that the gap started between 1861 and 1913, by the unification of the country, and was confirmed after the Second World War (Brugnoli and Fachin 2001), so it is an embedded issue. Italy is considered one of the best-known examples of a persistent and quantitatively important Regional divide (Maffezzoli, 2007). Indeed, Barro and Sala-I-Martin (2004) reported that the Regional inequality in Italy is the highest among all EU countries. Moreover, the economic gap has not shown any tendency to decrease over time (Marrocu *et al.*, 2000; Paci and Saba, 1997). The determinants of this diversity have been hugely investigated, and both differences in total factor productivity and the

quality of institutions seem to be important in explaining the situation (Aiello and Scoppa, 2000; Pigliaru, 2009).

However, even though Italy is so diversified, the education system is very centralised. In figure 1 the number of pupils per class in every Region has been reported. There is no clear distinction between North and South and there is a very small variance: every Region lies between 18 and 22 pupils per class.

Table 1. GDP, graduation rate and employment rate by Regions

Italian Regions		GDP[1]	Graduation rate[2]	Employment rate[3]
North	Piemonte	27,350.7	10.1	64
	Lombardia	31,743.1	11.5	65.7
	Veneto	28,856	9.8	63.4
	Friuli V.G.	28,248.7	9.1	64.6
	Liguria	26,858	13.0	63.4
Center	Emilia-Romagna	30,493	11.2	68.5
	Toscana	27,932.7	10.0	64.8
	Umbria	23,531	9.8	62.9
	Marche	25,640.5	9.8	63.7
	Lazio	29,837.5	14.5	59.4
South	Abruzzo	20,700.4	10.2	55.7
	Molise	20,097.6	9.9	52.2
	Campania	16,322.3	9.3	40.7
	Puglia	16,711.4	8,2	44.9
	Basilicata	18,586.8	7.7	48.4
	Calabria	16,897.9	9.1	43.1
	Sicilia	17,045.2	8.8	43.5
	Sardegna	19,986.1	7.1	50.8

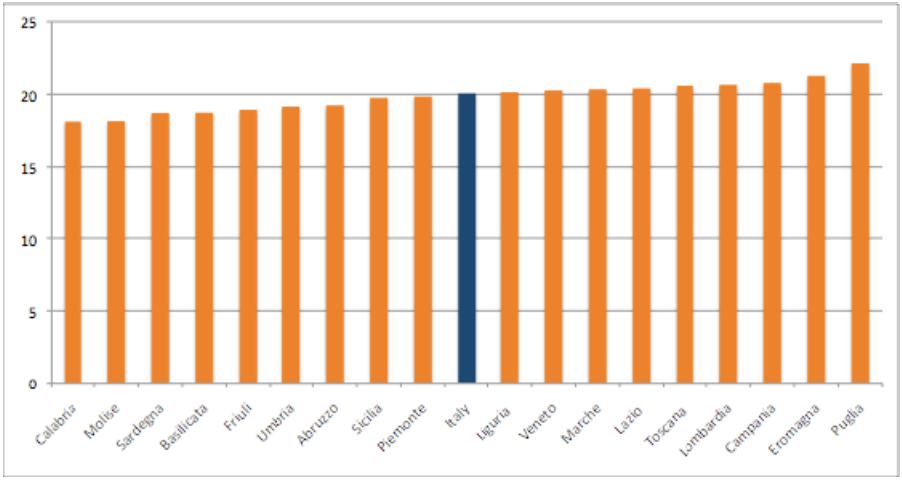
[1] GDP per capita at market prices in 2009.

[2] Percentage of population with academic qualification (undergraduation, master and phd) in 2008.

[3] Percentage o population with an employment in 2009.

Source: elaborations on ISTAT (2010).

Figure 1. The number of pupils per classes and its distribution in Italy (2009)



Source: MIUR (www.pubblica.istruzione.it)

Moreover, there is weak school autonomy in Italy[1]. Schools have low autonomy in comparison to other OECD countries on recruiting, pay-roll and dismissing of teachers, as it has been reported in table 2. The process through which teachers are recruited embodies three different actors: the government (MIUR, which is the employer), *Regional Educational Agency* (USR) and *Provincial Educational Agency* (USP) – which are branches of MIUR, located in the Regions and Provinces – and, only lastly, the schools. The USR determines the number of classes and the USP the allocation between schools, according to their requests (Fontana and Petrina, 2001). It is worthwhile to note that schools request not a specific teacher but just a generic teacher of a given subject. In other words, they do not select their own teachers. Teachers' salaries are determined and paid by the government. Thus, schools just manage facilities and integrative projects.

Table 2. The autonomy of Italian schools: comparison with other OECD countries (2009)

(% of decision's power, for each category)

Selecting teachers for hire	Only principals and/or teachers	Both principals and/or teachers and Regional/national authority	Only Regional/national authority
Germany	29	36	34
Italy	9	10	82
Spain	31	3	66
Sweden	96	4	0
United Kingdom	90	9	0
United States	88	12	0
OECD average	61	14	25
Determining teachers' salary increases	School only	School and government	Government only
Germany	4	15	81
Italy	3	0	96
Spain	3	2	95
Sweden	69	22	9
United Kingdom	67	17	15
United States	18	6	75
OECD average	17	10	73
Formulating the school budget	School only	School and government	Government only
Germany	29	4	67
Italy	7	7	86
Spain	63	4	33
Sweden	64	20	16
United Kingdom	57	29	14
United States	54	29	16
OECD average	46	22	32

Source: elaborations on OECD PISA (2009), Volume IV, Figure IV.3.3a.

[1] Law n. 59/1997, D.P.R. n. 275/1999, D.l. n. 44/2001.

Several public actors deal with spending in education:

- the Ministry of Education, University and Research (MIUR), which awards the resources for teachers, non teachers personnel salaries, and facilities and operations funds;
- the Provinces, which own the schools' buildings; moreover, they have responsibility for buying the teaching equipments, furniture for schools and for paying electricity, light and gas (only for secondary schools);
- the Municipalities, which make sure of any additional service (i.e. transport and meals), and have the same responsibility as the Provinces but only regarding primary and lower-secondary schools.

The Regions also have a role in the educational system, but only about vocational education. Moreover, they have responsibility for students aid, such as either scholarships or vouchers. The different contribution to education by all the actors is reported in table 3. As it is clear, MIUR covers the 86% of the education spending in the country (the most part of which is absorbed by salaries). Interestingly, the Regions which have lower education spending by local authorities, are located in Southern Italy.

Table 3. The expenditure per student by Regions (2008)

Regions*	Total in absolute values		Total in percentage	
	Public expenditure per student	Of which by provincies and municipalities	Public expenditure per student	Expenditure by provincies and municipalities
ITALY	6,810	923	86.45%	13.55%
Piemonte	7,010	1,141	83.72%	16.28%
Lombardia	6,934	1,228	82.29%	17.71%
Veneto	6,812	1,088	84.03%	15.97%
Friuli V.G.	7,655	1,267	83.45%	16.55%
Liguria	6,886	1,014	85.28%	14.72%
E. Romagna	6,722	1,335	80.29%	19.71%
Toscana	6,791	1,043	84.64%	15.36%
Umbria	6,874	788	88.54%	11.46%
Marche	6,613	808	87.78%	12.22%
Lazio	6,772	1,088	83.93%	16.07%
Abruzzo	6,864	761	88.91%	11.09%
Molise	7,646	1,027	86.57%	13.43%
Campania	6,458	569	91.19%	8.81%
Puglia	6,179	566	90.84%	9.16%
Basilicata	7,476	736	90.16%	9.84%
Calabria	7,564	728	90.38%	9.62%
Sicilia	6,496	615	90.53%	9.47%
Sardegna	7,407	689	90.70%	9.30%

* *Valle d'Aosta* and *Trentino Alto Adige* are special status Regions that have complete autonomy on this field, and was excluded.

Source: elaborations on MIUR (2009).

The amount of resources that schools receive for facilities and operations is partly determined through a formula and partly according to national agreements between the government and trade unions (funds devoted to the substitutions personnel). The formula takes into account the number of students, the school type and school size. The amount of these funds in 2009 were 0.896 billions of euro for the funds for facilities and operations and 2.286 billions of euro, for the funds devoted to the substitutions personnel. Finally, there is another fund for the widening of schooling supply and for redistributive interventions, that is distributed according to ministerial priorities, dealing with teacher training, disadvantaged areas and evaluation or innovation projects. Its amount is around 180 million.

Thus, all public funds, apart from the 12% awarded by local authorities, are defined at central level.

3. The literature

The Italian North/South dualism is not a new occurence. A recent report about public services by *Banca d'Italia* argues that territorial differences in Italy do not deal only with education but also with the public services as a whole (Bripi *et al*., 2011). Recently, the issue has been raised because this strong difference occurs despite the fact that the educational system is very centralised (Boarini, 2009; Bratti *et al*., 2007; Brunello and Checchi, 2004).

Italian students' performances are also affected by socio-economic background as well as other individual and schools factors. However, two factors are particularly different from other countries: the choice of secondary school type (Boarini, 2009; Montanaro, 2008; Quintano *et al*., 2009) and the Region in which students live: "the social environment where one was raised matters for the returns to education" (Brunello and Checchi, 2004 - p. 572)

Several studies have tried to shed more light on this diversity between North and South. Bratti *et al.* (2007) investigated in depth this point, finding confirmations about the gap between North and South. They begun by analyzing the context according to three categories: pupils and family factors, schools' resources and environmental factors. Regarding the first category they found a different situation for social status, parental education and material goods possession. Interestingly, they did not find any diversity between North and South for education expenditure, students: teachers and students: class ratios. They found instead a strong diversity according to the environmental factors: very different occupation rates and crime rates. Next, they analysed the variance (ANOVA) of Italian students' achievements (with PISA 2003 data). They found that individuals, schools and territorial (provinces) factors contribute similarly and importantly to explain the variance of students' achievements. Moreover, through an OLS model that included also some contextual variables (occupation rates, schools building status, expenditure for teachers, demographic indicators and social climate). They found that the

expenditure for teachers was not significant, while the occupation rates and local (Province level) literacy matter.

Thus, it appears that the context is a critical determinant of students' performance. Moreover, expenditure per student is not higher in the North than in the South of Italy (see table 3). The issue of efficiency is raised. As outlined by Bratti *et al.* (2007) and Boarini (2009), differences among Regions in students' performances are not explained by the quantity of resources. Boarini (2009) argued also that the low educational attainment and the higher turn-over rate of the teachers in the South are important determinant of the Italian gap. Specifically, her study expounds that: (i) an important driver of PISA 2006 results is the Region in which schools are located (even when contextual variables are included, Regional fixed effects are still significant); (ii) school level factors do not seem to matter for students' performance.

4. Data and methodology

4.1 Methodology

To estimate efficiency scores, Data Envelopment Analysis is used. This is a nonparametric technique that considers each Region as a Decision Making Unit (DMU) using inputs to produce outputs (details in Cooper *et al.*, 2006). In the DEA model, technical efficiency is defined as the relative ability of each DMU (in this case, Regions) in producing outputs, the term "relative" means that each unit is compared with any other homogeneous unit. The choice of a set of weights that combine several outputs and several inputs is the core of DEA analysis. DEA can be represented by a linear programming technique where each DMU tries to maximise the efficiency ratio (output over inputs) choosing the best set of weights. However, in this paper we use just one input and one output, so that the efficiency score coincides with the (size-adjusted) output/input ratio. The efficiency score ranges between [0;1]: the units that obtained a score equal to 1 are efficient, while the inefficiency of the other Regions is calculated through the distance from the efficient frontier.

DEA mathematical formulation can deal with both constant returns to scale (CRS) and variable returns (VRS). In a constant return to scale (CRS) model, the single DMU's dimension has no importance in defining efficiency performance - that is, DMUs face the same efficiency frontier, independently of their relative size. The VRS results can be derived by introducing the dimension factor in DEA modelling: each unit is analysed with respect to another of the same "relative" size. Both CRS and VRS efficiency can be calculated for each unit. In this paper, we used VRS formulation to take into account the different relative size of the Regions. Moreover, there are two different specifications of a DEA model: input-oriented and output-oriented. In the input-oriented model, DMUs minimise inputs while maintaining the same level of output. On

the contrary, in output-oriented models, DMUs maximise their level of outputs while keeping inputs constant. In this paper, an output-oriented approach was preferred.

A well-know shortcoming of DEA is that the method is deterministic; so all the deviance from the frontier is attributed to inefficiency, without considering the possibility of random noise. This is obviously a very strong assumption. Some methodological advancement allowed solving this problem, by defining a procedure to derive statistically robust efficiency scores through DEA. The method consists in bootstrapping DEA results, and was firstly proposed by Simar & Wilson (1998). The bootstrap procedure consists in re-sampling the observational data, to derive confidence intervals for the calculated efficiency scores (more details in Daraio & Simar, 2007). In this paper, we used such a robust approach to derive DEA efficiency scores.

After having derived the efficiency scores, we regressed them against a set of contextual variables, which capture potential explanations for efficiency differentials (sections 1 and 4.2).

Table 4. The descriptive statistics

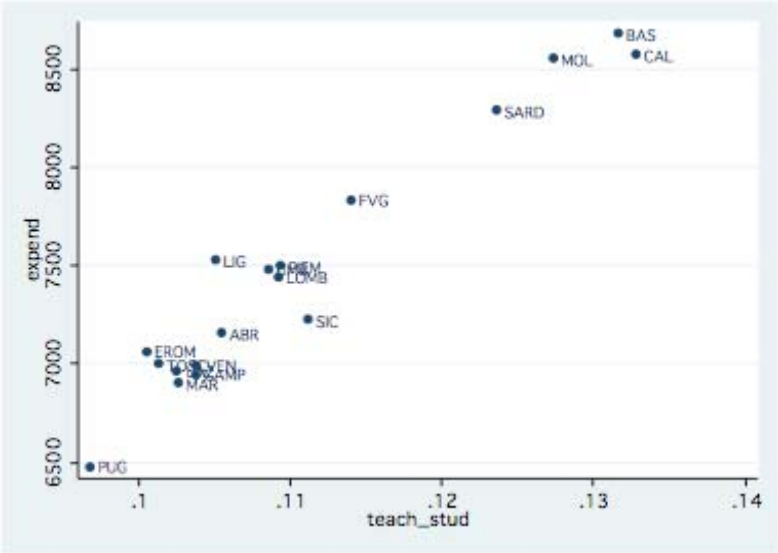
Variable	Obs	Mean	Std. Dev.	Min	Max
teach_stud_avg	18	0.1090556	0.0101023	0.098	0.13
foreign_avg	18	0.0752222	0.0481915	0.015	0.137
disabled_avg	18	0.0313333	0.004284	0.022	0.041
gdp_avg	18	24,219.82	5,657.187	1,6705.8	32,870.1
literacy_avg	18	9.889611	1.688176	7.058	14.519
private_avg	18	0.0355556	0.0272466	0.002	0.1
employ_avg	18	57.61183	9.178417	42.32	69.674
pisa_read	18	484.8583	20.97911	447.96	521.63
pisa_math	18	481.7686	22.50223	442.069	515.839
pisa_science	18	487.6824	25.48184	442.717	525.651

4.2 Data

The data have been collected from different sources: (i) the Ministry of Education, University and Research (MIUR); (ii) OECD and (iii) National Institute of Statistics (ISTAT). They have been accumulated for three years: 2007, 2008 and 2009, apart from the expenditure per student (which is not available for the other years) and the PISA 2009 scores. Since education is a dynamic process, the averages of the three years' values are used. The descriptive statistics of our data set are shown in table 4. A deeper description of the data is necessary in order to get an idea of the relations and the correlations between variables, and then to choose the input variables. Figure 2 shows the evident correlation between the expenditure per student and the teachers:students ratio (0.97). This is an important point, as data of expenditure per student is

not available for all the three years considered, so we used students:teachers ratio as a proxy for the resources invested in education.

Figure 2. The correlation between the expenditure per student and the teachers:students ratio



5. The results

5.1 The results from DEA: the efficiency of public spending

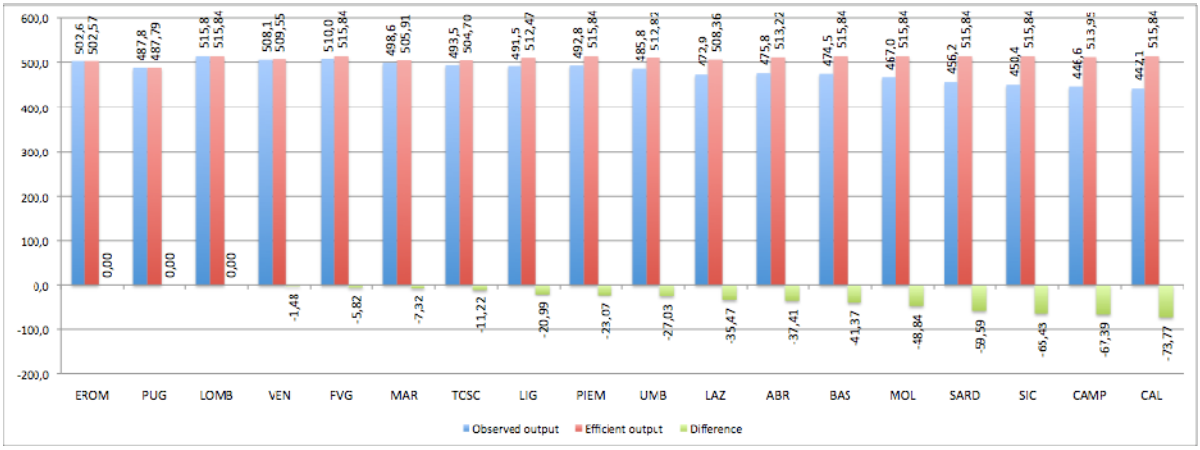
A DEA analysis has been run with teachers:students ratio as input and the PISA 2009 mathematic score as output[2]. The results are shown in table 5. At a first glance, the DEA results corroborate what is already known, that is the North outperforms the South of Italy (INVALSI, 2010). However the focus here is not on "performance" but on "efficiency". Thus, a Region with good performance can be inefficient (due to high level of available inputs); conversely, a low-performer Region can be efficient anyway. Indeed, the *Piemonte* and *Puglia* Regions represent a sort of outlier from the North/South dualism point of view. Indeed, *Piemonte*, which has scored 0.943, is the worst out of the Northern Regions, while *Puglia* has an efficiency score (0.971, more than *Piemonte*) similar to the Northern Regions. In figure 3 the observed and efficient outputs are compared: the former is the OECD-PISA average score for each Region, while the latter is the (average) score that the same Region should obtain if efficient. The Regions have been ranked according to the difference between the two outputs. *Puglia* is the best efficient after *Emilia-Romagna*, while *Piemonte* is the worst out of the Northern Regions.

[2] The appendix in table A1 shows the strong correlation among all of three PISA tests, which are reading, mathematics and science. Thus, anyone of those fit with the analysis.

Table 5. The efficiency scores: DEA results

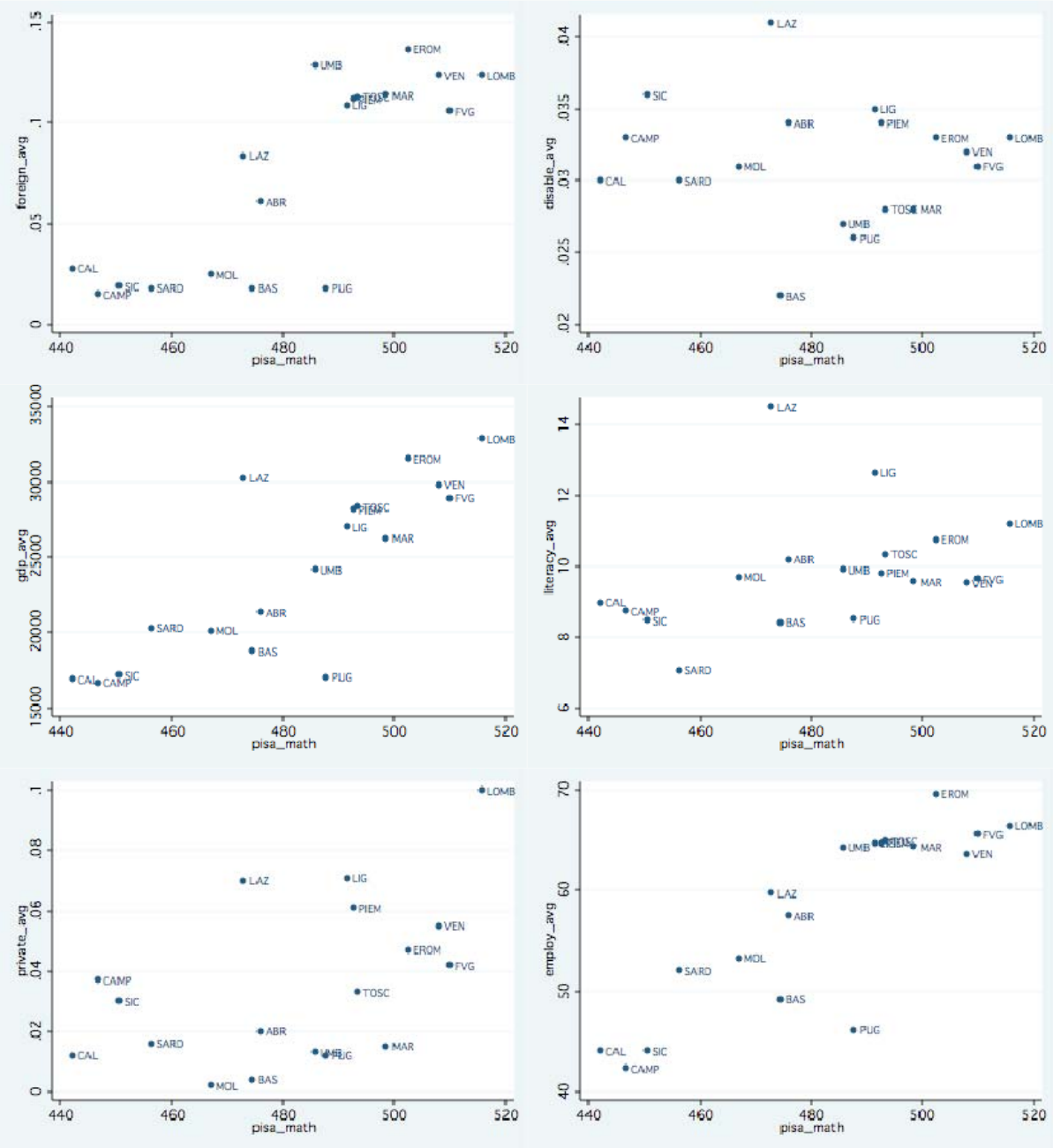
	Efficiency (DEA)	Efficiency (Bootstrap DEA)	Bias	Low.bound	Upp.bound
PIEM	0.955	0.943	0.013	0.928	0.954
LOMB	1.000	0.986	0.014	0.970	0.998
VEN	0.996	0.984	0.013	0.966	0.995
FVG	0.989	0.977	0.012	0.962	0.988
LIG	0.958	0.947	0.011	0.933	0.958
EROM	1.000	0.960	0.040	0.901	0.998
TOSC	0.976	0.958	0.018	0.925	0.975
UMB	0.947	0.936	0.011	0.922	0.947
MAR	0.986	0.968	0.019	0.934	0.985
LAZ	0.930	0.917	0.013	0.898	0.929
ABR	0.928	0.917	0.011	0.903	0.927
MOL	0.905	0.897	0.008	0.883	0.905
CAMP	0.868	0.857	0.011	0.844	0.867
PUG	0.971	0.932	0.038	0.875	0.969
BAS	0.920	0.912	0.008	0.897	0.920
CAL	0.857	0.850	0.007	0.836	0.857
SIC	0.873	0.864	0.009	0.851	0.873
SARD	0.884	0.876	0.008	0.863	0.884

Figure 3. The comparison between observed output and efficient output



What is more interesting now, is to inquiry on the determinant of these (in)efficiencies. Before analyzing this topic by mean of a Tobit regression, some graphical correlations are shown between the efficiency scores estimated and some contextual variables (figure 4), which are: GDP per capita, percentage of students enrolled in privates schools (as an insight of either competition and wealth of the educational context), the percentage of graduated population (as a proxy of the differences of the human capital stock among Regions), the employment rate and, finally, the percentage of disabled and foreign students. These are critical characteristics that potentially affect schools' performances.

Figure 4. The correlation between PISA 2009 math score and contextual variables



Many of them show unexpected scenarios. The GDP graph shows a clear positive correlation with Math score, though *Puglia* and *Lazio* are two significant exceptions. The former, despite of its low GDP per capita, out-performs all the South Regions; the latter, despite of its high GDP per capita, performs as a South Region.

The correlation with the percentage of students enrolled in private schools is less clear. It seems positive, but with high variability. For example, at a relative high level of PISA score (around 500), four Regions are at different levels of students in private schools: *Marche* at 2%, *Toscana* at 3%, *Piemonte* at 6% and *Liguria* at 7%.

The correlation between PISA scores and the percentage of graduated population is positive, though *Lazio* represents an important exception, since it has a high graduation rate with a relatively low PISA score. Similar considerations hold for employment rates.

Surprisingly, the number of foreign students does not appear as negatively correlated with students' performance. In order to give a synthetic panoramic of all these correlations, the annex reports the correlation matrix (table A2).

5.2 The results from the Tobit regression: the determinants of public spending efficiency

The Tobit regression (table 6) suggests the effect of two contextual characteristics (employment rate was not included because of multicollinearity with GDP rate). First, the relationship between students' performance and the percentage of disabled students has a significant and negative coefficient. Thus, these results suggest that the critical characteristic of schools that really affect the performances is the number of disabled students, rather than foreign students. The coefficient of the GDP per capita is positive, as the data suggested. Instead, graduation rate and percentage of students enrolled in private schools do not show any relationship with performances.

Table 6. The second stage analysis: Tobit regression results

Variables	Coefficient	St Error	t	P>t	Beta coefficients
GDP per capita	0,000	0,000	1,900	0,082	0,664
% Private	0,194	0,341	0,570	0,580	0,121
Adult literacy	0,000	0,005	0,030	0,977	0,005
% Disabled students	-4,285	1,765	-2,430	0,032	-0,420
% Foreign students	0,220	0,260	0,850	0,413	0,243
Constant	0,912	0,061	15,000	0,000	.
F (5,12)	13,58				
Adjusted R^2	0,7873				

6. Concluding remarks

The analysis conducted in this paper confirms the Italian contradiction between inputs and outputs in the educational system: despite of uniformity of inputs across the country, the dispersion of the outputs is relevant.

Then the determinants of this diversity have been investigated, following an interest in this topic, which was previously studied by other authors (Boarini, 2009; Bratti *et al.*, 2007). Among several variables that could matter for variance in educational outputs, the economic difference between Regions appeared to be the most important.

The implication of this situation is critical. As it has been reported at the beginning of this paper, the economic difference between North and South of Italy have not decreased since the 60-70s. Thus, it is plausible to argue that the different economic development of the Italian Regions severely influences the educational achievements (Di Liberto, 2006). Since our results corroborate this statement, the risk is a problematic path where the low economic development biases the achievements, which, in turn, biases the economic development.

The crucial point, then, is to answer to the question: "*could it be that growth causes education, rather than education causing growth?"* (Wolf, 2002 - p. 44). Indeed, the consequent implication is: should we implement policies devoted to the economic development (such as fiscal policies) or should we focus on the educational improvements (such as a new teacher recruiting system)? Further research is needed in this field.

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Annex

Table A1. The correlation between PISA scores

	pisa_read	pisa_math	pisa_science
pisa_read	1.0000		
pisa_math	0.9877	1.0000	
pisa_science	0.9907	0.9764	1.0000

Table A2. The correlations between PISA scores and contextual variables

	pisa_math	foreign_avg	disabled_avg	gdp_avg	literacy_avg	private_avg	employ_avg
pisa_math	1.0000						
foreign_avg	0.8236	1.0000					
disable_avg	-0.0774	0.1766	1.0000				
gdp_avg	0.8209	0.9073	0.3392	1.0000			
literacy_avg	0.3549	0.5448	0.6189	0.6500	1.0000		
private_avg	0.5002	0.5753	0.6383	0.7383	0.6539	1.0000	
employ_avg	0.8536	0.9505	0.1555	0.9293	0.5422	0.5279	1.0000