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Regional Economic Disparities as Determinants of Students' Achievement in Italy

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Abstract

We use a statistical (multilevel) approach to study the relationship between Math Scores and individual-level and school-level factors. The sample contains data about 21,336 students sorted into 163 schools. Our results show that students attending schools in Northern Italy outperform their counterparts in the South. Moreover, the between-schools variance is much higher in Southern Italy than in Northern Italy, albeit it is not due to student sorting based on different socio-economic status (SES), as suggested by the traditional literature in this field. Finally, between-schools variance actually masks achievement differentials due to the different economic development of the Regions.

Keywords: *students' achievement; multilevel modelling; regional socio-economic differences*

JEL Code: I21

1. Introduction

In recent years, there is a growing interest in analysing the determinants of Italian students' performances. Such interest can be motivated through a number of reasons. First, the policy relevance of information about students' achievements is very high, for instance in terms of educational reforms or allocation of public budgets. This issue is also emphasised by the poor performance of Italian students with respect to their counterparts around the world (Montanaro, 2008). Such point has been recently stressed, also because of the prominent role assumed by international standardized tests, like OECD-PISA (e.g. Grek, 2009). Second, the public opinion calls for more accountability of schools' performance, both to understand the efficiency of public spending and have information to choose the best schools for their children. Third, the researchers are trying to fill the gap between Italy and other developed countries, where the analysis of students and schools' results has a long tradition. Indeed, while in many countries (especially US) the focus on student achievement has a long history (Urdan & Paris, 1994; Baker et al., 2000; Lamb & Fullarton, 2002; Ertl, 2006; Grodsky et al., 2009), in Italy this is a relatively new tendency. Fourth, as schooling is one of the major means through which young people accumulates human capital, it is important to understand which are the main students' achievement determinants, also because social inequalities tend to reproduce themselves into educational inequalities (Lauer, 2003).

These reasons, taken together, have lead to an improvement of the evaluation procedures of schools' characteristics and results in Italy. At present, the Italian National Evaluation Committee (*Invalsi – Istituto Nazionale per la Valutazione del Sistema di Istruzione e Formazione*) has been established with the specific aim to evaluate the Italian schools. Among other tasks, a recent law prescribed that the Invalsi should carry out an analysis of students' achievement at different levels of education: second and fifth year of the primary school (age 7 and 10, respectively), first and third of the lower-secondary (age 11 and 13), second and fifth of the upper-secondary (age 15 and 18). This is the first time that a law imposes a national evaluation by using standardized tests in Italy. In the year 2008/09, the evaluations covered the primary-education level, and the third year of the lower-secondary; in the next two years, the evaluation system will be fully implemented. These changes represent a positive and radical change with respect to the previous situation; indeed, while in other countries the accountability of the educational system has been guaranteed by several policies (e.g. Andersen et al., 2009 for the case of Denmark, and Lee, 2010 for US), Italy suffered a strong lack of reliable information on students and schools' results.

The present paper employs the new Italian data concerning the national final examination at the end of the lower secondary education (third year of the lower secondary schools, when the regular students are 13 years old) in the year 2008/09 (the first national examination was carried out in 2007/08). This final examination has been conducted through a standardized test identical for all the students involved in the exam. About 560,000 students in 6,000 schools have compiled the test (Invalsi, 2009). Our study analyses a representative sample of students and schools that participated to this test.

Worldwide, there is a huge literature tradition, in the field of educational economics and policy, concerned with the aim to investigate the determinants of students' achievement (Heck & Mayor, 1993). Such studies typically search for empirical support on educational policies to boost students' achievement and learning (Sahlberg, 2007).

Also the specific literature on applied economics contributed to this field of analysis, by asking how different students, schools and institutional characteristics do impact on students' results. The most part of such literature adopts the Education Production Function (EPF) as the paradigm for modelling the relationship between students' achievement (output or outcome measure) and many students and schools' characteristics (inputs) (see Vignoles et al., 2000).

Todd & Wolpin (2007) illustrated the main recent methodological procedures that can be used for the estimation of EFPs. By using OECD-PISA data, Fuchs & Woessman (2007) realised a wide empirical analysis to show the most important determinants of students' achievement in an international setting.

However, the literature in this field has been growing, and now many authors have written extensively, by conducting many empirical studies that employed internationally available datasets. A good summary has been recently provided by Hanushek & Woessman (2010). The authors collected and classified the most relevant contributions, showing the main findings from such empirical research:

- quantitative input measures (i.e. expenditure per student, students:teachers ratios, etc.) have a low statistical association with students' performances;
- the factors that explain more the performances' differences among students (in an international comparison) are (i) the institutional structures (e.g. competition among schools, autonomy, funding procedures, etc.) and (ii) the quality of teachers.

This research effort, as the interested reader can have a fruitful, synthetic glance to the evidence on the determinants of educational achievement – in an international perspective. It is important to point out that all the studies reviewed in that summary adopt such a "macro" perspective (i.e. detecting factors which explain international differences in educational achievement): the typical datasets employed are OECD-PISA, TIMSS, PIRLS, etc. (a list of these acronyms is reported in the annex 4). Their work, on the contrary, did not go into the exploration of within-country determinants of students' achievement.

There are few studies analysing specifically the determinants of Italian students' achievement and performance. The most extensive effort, in the economics field, has been put by researchers at the Milan University, which were collected in a book (Bratti et al. 2007) with the objective to provide a wide-range set of explanations for achievement differentials among Italian students. This research used OECD-PISA2003 data, and the analysis was carried out at student-level. The methodological approach was to estimate an Educational Production Function (EPF), by using student achievement (OECD-PISA scores) as outputs, and several students and schools' characteristics as inputs. Moreover, the analysis controlled also for some major factors affecting student performance, like school location, the type of schools, etc. Given the richness of their results, it is impossible to summarize them in few rows.

However, their main result is that factors affecting students' achievements are related to (i) the socio-economic status (SES), (ii) the macro-area of the country (Northern Italy schools perform much better than their Central, Southern and Isles counterparts), and (ii) the type of school (academic schools – Licei – and technical schools perform better than vocational schools). Another interesting result is that private schools perform worse than public ones (this result is consistent also with the international comparison proposed by Vandenberghe & Robin, 2004, and with previous work of the authors themselves, e.g. Bertola & Checchi, 2004). Nevertheless, Vittadini (2007) challenged this specific result. The author argued that there were methodological problem in the analysis, as he raised doubts on (i) the validity of using OECD-PISA data for a public/private schools comparison in Italy (because of the particular sampling strategy of OECD-PISA) and (ii) on the use of cross-sectional data.

Another study in this field is that of Longobardi et al. (2009). They employ a multilevel modelling to analyse the effects of different covariates on students' performances, by using OECD-PISA2006 data (their study, too, was conducted with students as the units of observation). Their statistical analysis (that is more robust than previous ones as it explicitly accounts for the hierarchical nature of data) pointed out results, which are consistent with Bratti et al. (2007): (i) a gap between Northern and Southern part of Italy, (ii) strong differences among schools' types (namely, with Licei schools outperforming technical and vocational schools), (iii) a major impact of socio-economic background in predicting students' results. Through their results, the authors concluded that even a high-centralized system as the Italian was not actually able to guarantee homogenous students' performances.

Agasisti also contributed to the debate with two papers (Agasisti, 2011; forthcoming). Both contributions rely upon OECD-PISA2006 data, but they differ with regard to the methodological approach: the first specifies an Educational Production Function through multivariate regressions, while the second realises a Data Envelopment Analysis. In both cases, data are aggregated at school-level. The results are pretty similar to those provided by the papers previously cited, and more specifically they evidenced: the role of geographical gaps, the type of school, the socio-economic conditions of students. Moreover, in both articles a measure of competition has been added among the explanatory set of covariates, to investigate whether competition actually fosters schools' performance (the empirical results partially confirm this hypothesis); Ponzo (2011) also confirms this latter finding.

The main objective of this paper is to describe the main determinants of the students' achievement (as measured by the Invalsi test) in Mathematics, with reference to the year 2008/09. While focusing on this objective, the paper also deals with two factors traditionally considered as very important for explaining Italian schools' results: (i) the geographical location and (ii) the average socio-economic status (SES) of students attending the schools. The former factor derives from the evidence that schools in Northern Italy outperform those in Southern Italy; moreover, previous literature about other countries demonstrated the heterogeneity in educational production across different areas within countries (i.e. differences among Regions). The potential role of SES is related to the lower performances associated to schools with higher proportion of students from disadvantaged families.

The paper is organised as follows. The next section contains a detailed presentation of data and methodology. The third section presents the results; the fourth discusses the main implications, illustrates the methodological suggestions derived from the empirical analyses (while providing a potential further agenda), and concludes.

2. Data and methodology

2.1 An overview

In this paper, we model education as a "production process" characterized by some students' characteristics (age, gender, nationality, etc.) as well as schools' characteristics (public/private status, resources, etc.) as inputs, and students' achievement as outputs.

In formal terms:

$$Y_{ij} = f(IND_{ij}, SES_{ij}, SES_j, SCH_j) \quad (1)$$

where Y_{ij} is the achievement of the ith student in the jth school, IND_{ij} is a vector of her personal characteristics, SES_i is a vector of her socio-economic characteristics, SES_j is a vector of the "average" socio-economic conditions of the students attending the jth school (to capture "peer effects"), and SCH_j is a vector of the jth school's characteristics and resources. While the Invalsi dataset contains information about IND_{ij}, there is a lack of adequate data for SES_j and SCH_j (school-level socio-economic conditions of families and schools' resources): to solve this problem, we matched the Invalsi dataset with the TIMSS 2007 one (http://www.iea.nl/TIMSS2007.html; more detailed information about TIMSS 2007 data, with special reference to Italy, can be found in Invalsi 2008b). It is important to point out here that the reference years are different: while the Invalsi data concern the year 2008/09, the TIMSS data refer to 2006/07. However, the latter has been used only for the school-level variables, which can be considered as quite "stable" across years, especially in a very short period (two years).

Nevertheless, we lack information about SES_{ij} (student-level socio-economic status): as a consequence, the empirical models are not able to explain a relevant part of the individual achievements' variations caused by the different socio-economic backgrounds of the individual students. Indeed, as the Invalsi and TIMSS data come from different years, we were not able to match individual students – but only schools.

At the end of the merging procedure, we have data for a sample of 21,336 students, sorted into 163 schools.

2.2 The methodological approach: the advantages of multilevel modelling

In this paper, we used a multilevel approach to analyse the schools and students performances. The choice is justified by the hierarchical nature of data, e.g. students nested within schools. In the context analysed here, the multilevel modelling has many advantages with respect to the traditional linear models. Such advantages are particularly strong when some circumstances occur, and more specifically:

i. the data show highly structured hierarchies because students are nested within schools, and schools are nested within cities and regions. The most common error when not considering the hierarchical structure of data are:

a. Ecological fallacy, that is interpreting at individual level some variables obtained by aggregating data at higher level (this problem is particularly relevant in the educational setting, as pointed out by Connolly, 2006);

b. Atomistic fallacy, that is interpreting groups' effect by using individual-level data.

Both the problems lead to an underestimation of standard errors, which in turn confounds the statistical significance of variables at higher levels (overestimation). Such underestimation of standard errors is especially high when the correlation of individuals within groups is high;

ii. the ability to describe the determinants of students' results is hampered by the potential endogeneity of the students' covariates, as well as by non-considered covariates at school level. Such problems can be partially reduced by properly taking into account both students and schools' characteristics;

iii. there are problems concerning the different numbers of students analysed in the different schools;

iv. techniques for ranking schools' performances (e.g. Data Envelopment Analysis) are often subject to the impact of "extremes" (outlier observations).

In these and other cases the extensive literature about variance and mixed-effects models suggests that hierarchical models (and particularly multilevel models) offer solutions for studying the relationships between outputs (e.g. achievement scores, in our case) and contextual and organizational variables in complex hierarchical structures – considering both individual and aggregate levels of analysis (Goldstein, 1995; Hox, 1995, Morris & Christiansen 1996, Verbeke & Molenberghs, 2000).

In the previous literature about Italian schools, despite the many advantages of multilevel modelling, only Longobardi et al. (2009) adopted it. We follow this methodological approach instead, through the following operating steps (see also Singer, 1998, for more details).

<u>The statistical methodology: a description of the multilevel strategy</u>

The strategy is based upon a two-stage approach: in the first, we estimated an "empty" model, to decompose the variance between student-level and school-level, while in the second we added explanatory variables both at student and school levels.

Phase 1. The "empty" model

We applied an empty model to our dataset, of the following form:

$$Y_{ij} = \gamma_0 + U_{oj} + \varepsilon_{ij} \qquad (2)$$

where Y_{ij} is the dependent variable (test score) for the ith student in the jth school. γ_0 is the

Y mean calculated including all students, and U_{oj} is the distance between the mean of the jth school and the overall mean (second-order error). Finally, ε_{ij} is first-order error, defined as the difference between the mean of the ith student and the mean of the jth school.

The assumption is that both the errors have a normal distribution with mean equal to 0 and a constant variance:

$$\begin{aligned} &\varepsilon_{ij} \approx IID - N(0,\sigma^2), U_{oj} \approx IID - N(0,\tau^2) \\ &Cov(U_{oj}, \varepsilon_{ij}) = 0 \end{aligned} \tag{3}$$

Thus, σ^2 represents the variance within schools, while τ^2 is the variance among schools. As a consequence, we can calculate the "intra-school" coefficient of correlation, by dividing the variance among schools and the total variance:

$$\rho = \frac{\tau^2}{\tau^2 + \sigma^2} \tag{4}$$

The coefficient represents the part of the total variance that could be imputed to the "among schools" variance. If $\rho \neq 0$, a multilevel model will be adopted to account for the hierarchical nature of the data.

Phase 2. The multilevel model with random intercept

In this second step, we added to the empty model some independent variables, which aim is to explain the within-school and among-schools variance.

By means of formal simplicity we assume a two-levels structure of the data, and the availability of one covariate at student-level (x_{1ij}) and one at school-level (z_{1j}), then the equation of the multilevel model with random intercept is:

$$\begin{aligned} Y_{ij} &= \alpha_{0j} + \alpha_1 x_{1ij} + \varepsilon_{ij} \\ \alpha_{0j} &= \gamma_0 + \alpha_2 z_{ij} + U_{oj} \end{aligned} \tag{5}$$

It is important to point out that the random intercept α_{oj} is explained also by considering the effect of z_{ij}. When merging the two equations illustrated in (4), then a single equation can be formulated:

$$Y_{ij} = \gamma_0 + \alpha_1 x_{1ij} + \alpha_2 z_{1j} + U_{oj} + \varepsilon_{ij} \tag{6}$$

In the (5), two components can be identified: (i) a "fixed" part, represented by $\gamma_0 + \alpha_1 x_{1ij} + \alpha_2 z_{1j}$, and (ii) a random" part (the error terms) $U_{oj} + \varepsilon_{ij}$.

The assumptions about the distribution of the error terms (defined for the "empty" model) still hold; but here it is assumed that the observations within schools are correlated indeed:

$$Cov(y_{ij}, y_{i'j'}) = \begin{cases} 0 & \forall i \neq i', \forall j \neq j' \\ \tau^2 & \forall i \neq i', \forall j = j' \end{cases} \tag{7}$$

Lastly, a generalisation of the (5) can be presented assuming m student-level variables and s school-level variables:

$$Y_{ij} = \gamma_0 + \sum_{k=1}^{m} \alpha_k x_{kij} + \sum_{t=1}^{s} \alpha_t z_{tj} + U_{oj} + \varepsilon_{ij} \quad (8)$$

2.3 Data and variables

In the analysis, we employed two levels of variables (to account for the hierarchical structure of data): student-level (level 1) and school-level (level 2).

All the data at the individual level come from the Invalsi dataset, which refer to the final examination at the end of the lower-secondary education (reference year: 2008/09). We used two alternative output indicators: the test scores in reading (Reading_Score) and Math (Math_Score). In the remainder of the paper, all results concern Math Scores, as no interesting alternative patterns emerged for Reading. The scores have been standardized into a range [0;100], that represents the percentage of right answers to the questions of the test. We chose to use data about 2008/09, even though also those for 2007/08 were available, after a previous wave of research on the latter. We found that they were unreliable. Indeed, we found no differences among macro-areas (Northern, Central and Southern Italy), and this fact was very unrealistic given that previous literature unanimously acknowledged the existence of strong differences. This problem has been widely discussed in the descriptive report provided by Invalsi (2008a), that suggests three potential hypotheses:

- Higher motivation for students in the South at the moment of a national (standardized) test, that also is important for their academic career (indeed, it is the final exam at the end of lower secondary education, and not an experimental test – as typically are the international ones);

- The items proposed in the test are more focused on the specific competences provided by Italian schools than others proposed elsewhere (e.g. OECD-PISA, TIMSS, PIRLS), so differences are lower here than in other cases because the specific questions included in the national test are more specifically taught homogenously in the different geographical areas (while competencies as measured by OECD-PISA etc. are more related to socio-economic conditions);

- There was an opportunistic behaviour by teachers in the schools of the South (e.g. cheating).

The analysis proposed by Invalsi for the year 2007/08 does not test these different hypotheses; nevertheless, in the report about the test in 2008/09 they consider the latter as the most credible. Indeed, in the second national examination (2008/09) the final results have been corrected to take "cheating" into account, through a complex procedure based on four factors (statistical details in Invalsi, 2009): (i) the average of achievement scores at class level, (ii) the variance of achievement scores at class level, (iii) an index about missing answers to the test, (iv) an index of uniformity across students within the same class. Such procedure generates a new set of "corrected" scores, namely those that we use in this paper. Table 1a shows an overview of the variables employed in the study, while table 1b contains the descriptive statistics of the dataset.

As covariates at individual level, we employed several students' characteristics: gender (dummy: Female), citizenship (a dummy – Foreign – for students who are not Italian), disabled status (dummy: Disabled). Two variables have been added to control for the age of students. A student who is in time for the final examination should be born in 1994; however, some students were enrolled a year before (Early), and some students were not admitted to the next grade during their past academic career, so they are older than regular ones (Late).

Unfortunately, the dataset does not include information on the individual student's socio-economic status (SES), so we cannot control for this important characteristic. This point is strongly important here, and it must be borne in mind when interpreting the results: much of the variance at individual level is not explained exactly because the lack of this important information.

Table 1: Variables' overview

Variable	Description	
Variables at individual student level		
Female	Gender (Female = 1)	Binary
Disabled	Dummy if the student has a disabled status (=1)	Binary
Foreign	Student's nationality (foreign=1)	Binary
Early	A student who enrolled one year before regular track	Binary
Late	A student who repeated one or more year	Binary
Variables at school level		
Disadvantaged	Average socio-economic status of students at ith school	Categorical
	(Proportion of students whose families have economic difficulties)	Categorical
Short_Instr	Shortage of instructional materials	Categorical
Community	Environment in which the school is located (big city, city, town, rural area)	Categorical
Macroareas	Two dummies (Central Italy and Southern Italy)	Binary

When turning to school-level variables, the source of data is twofold. Part of the variables comes from the same Invalsi dataset (final examination of the lower secondary education, year 2008/09). Another important source was the TIMSS 2007 dataset, which refer to the year 2006/07, as described above.

An indicator was originally included to define if the school is public or private (dummy: Private), but it was dropped in the results because the sample includes just 6 private schools (less than 1% of the sample). However, alternative specifications in which this variable was included did not come to different results.

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Table 1b: Descriptive statistics

Panel A. Descriptive statistics (continuous variables)

Variable	Mean	Std. Dev.	Min	Max	Obs
Math_Score	62.22	21.92	0.00	99.99	21,336

Panel B. Descriptive statistics (binary and categorical variables)

Variable	Proportion (%)	Min	Max	Obs
Female	0.49	0.00	1.00	21,336
Disabled	0.00	0.00	1.00	21,343
Foreign	0.07	0.00	1.00	21,336
Early	0.05	0.00	1.00	21,336
Late	0.09	0.00	1.00	21,336
Northern Italy	0.38	0.00	1.00	21,336
Central Italy	0.21	0.00	1.00	21,336
Southern Italy	0.41	0.00	1.00	21,336
Disadvantaged (0-10%)	0.39	0.00	1.00	19,838
Disadvantaged (11-25%)	0.38	0.00	1.00	19,838
Disadvantaged (26-50%)	0.17	0.00	1.00	19,838
Shortage of instructional material (High)	0.02	0.00	1.00	21,343
Shortage of instructional material (Some)	0.12	0.00	1.00	21,343
Community: big city	0.12	0.00	1.00	21,343
Community: city	0.31	0.00	1.00	21,343

The proportion of students coming from disadvantaged families has been included to control for low socio-economic conditions of the students population (disadvantaged), given that the economic literature showed a positive relationship between socio-economic background and performance (Behrman & Rosenzweig, 2002). Our socio-economic variable takes value 1 if the proportion of students from low socio-economic background is in the range [0;10], 2 if [11;25], 3 if [26;50], and 4 if [>50]. Also, we controlled for the intensity of resource availability, by including the following indicator: "shortage" of instructional materials (short_instr), and it is recorded on a four-tiers scale as follows: (1=none, 2=a little, 3=some, 4=a lot). Moreover, an indicator of the environment in which the school is located was introduced, by including an ordinal variable considering the dimension of the city/town (community): the value is 1 if citizens are [>500,000], 2 if [100,000;500,000], 3 if [50,000;100,000], 4 if [15,000;50,000], 5 if [3,000;15,000], and 6 if [<3,000].

Finally, we considered differences according to the macro-area in which the school is located. Indeed, previous literature on the achievement of Italian students demonstrated that there are relevant differences across the different areas of the country, with schools located in the Central part of Italy performing worse than those in the North and better than those in the South.

3. Results

3.1 Baseline results

The results of the multilevel analysis have been reported in the table 2. We ran six different models:

- An empty model, without and with macroareas dummies (models 1 and 4);
- A model in which individual variables were added, without and with macroareas dummies (models 2 and 5);
- A model in which both individual and school variables are employed, without and with macroareas dummies (models 3 and 6).

The first and fourth columns illustrate the coefficients estimated for the intercept, that is the average math score for all students in all schools. What is interesting here is the analysis of variance, which confirms how both between and within schools differences exist. The between-schools variance is 90.77, and within-schools variance is 387.66; thus, the latter is higher than the former. The most part of the variance is at student-level more than at school-level, even though also the latter plays a significant role – suggesting the existence of some degree of segmentation among schools. Indeed, about 19% of the variance is explained by between-schools variance. Some evidence provided by Invalsi (2010), based on simple statistics, indicates that this percentage is pretty different in the areas of the country, and much higher in the Southern Italy. In our analysis, in all three models, when adding macro-areas dummies the variance between schools diminishes drastically (the between-schools variance "explained" is >21%), suggesting that this is higher in some macro-areas (coherently with the Invalsi findings). Later in this paper, we address specifically this topic.

The columns 2 and 5 show what happens when individual-level characteristics have been added. It is important to note that all the individual variables are statistically significant. Female students perform worse than their male counterparts (-1.8); disabled and foreign students have lower performance (12 and 4 points, respectively). Early students outperform the "regular" (born in 1994) ones (+1, but this effect appears only when macroareas dummies are included), while students who repeated one or more years suffer a strong disadvantage (-8 points).

When adding individual-level characteristics, within-schools variance decreases, coherently with the model. The calculation on the part of the variance explained by such characteristics is as follows (comparing the model without macroareas dummies): (387.6 – 378.2)/387.6 = 2.4%. As expected, these variables are not contributing too much in reducing within-schools variance, as we did not include individual-level socio-economic status. Moreover, such scarce influence raises further questions about the real determinants of achievement at individual level (e.g. cultural capital, previous academic results, etc.).

Table 2: Results of the multilevel analysis (Math Scores)

	Without geographical dummies			With geographical dummies		
Variable	Empty	Individual	Individual & School	Empty	Individual	Individual & School
	1	2	3	4	5	6
female		**-1.874**	**-1.862**		**-1.867**	**-1.859**
		0.000	*0.000*		*0.000*	*0.000*
disabled		**-12.162**	**-12.220**		**-12.300**	**-12.330**
		0.000	*0.000*		*0.000*	*0.000*
foreign		**-4.165**	**-4.354**		**-4.281**	**-4.451**
		0.000	*0.000*		*0.000*	*0.000*
early		0.980	1.144		**1.120**	**1.280**
		0.149	*0.111*		*0.099*	*0.075*
late		**-8.185**	**-8.220**		**-8.200**	**-8.239**
		0.000	*0.000*		*0.000*	*0.000*
Disadvantaged (0-10%)			**7.807**			2.585
			0.010			*0.333*
Disadvantaged (11-25%)			**6.542**			1.181
			0.034			*0.664*
Disadvataged (26-50%)			3.133			0.220
			0.337			*0.938*
High Shortage of Instructional material			-5.827			-3.695
			0.244			*0.391*
Some Shortage of Instructional material			-3.635			-2.625
			0.126			*0.195*
Community_ big city			5.664			5.775
			0.188			*0.120*
Community_city			5.172			**5.926**
			0.162			*0.062*
Community_town			4.854			**6.321**
			0.166			*0.036*
Central Italy				-1.921	-2.394	-1.761
				0.298	*0.190*	*0.381*
Southern Italy				**-10.888**	**-11.889**	**-11.246**
				0.000	*0.000*	*0.000*
Constant	**62.091**	**64.023**	**54.036**	**67.117**	**69.567**	**62.319**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Random effects						
Between-schools variance	90.77603	94.12891	89.3523	65.21201	63.91378	63.34769
Within-school variance	387.6603	378.2766	374.8512	387.6596	378.2754	374.8554
% Between	18.97%	19.93%	19.25%	14.40%	14.45%	14.46%

Notes: in bold, coefficients with statistical relevance
in italics, p-values

Finally, the columns 3 and 6 consider the models where school-level variables are included. All the individual-level variables remains significant and with similar coefficients. There is a positive effect associated to lower proportions of disadvantaged students in the school: this effect is statistically strong for schools where this proportion is <10% (about 8 points), lower (but still significant) where the proportion is between 11% and 25% (about 6.5 points), and finally again lower, still positive but statistically not different from zero where this proportion is between 26% and 50% (the reference group is the school where the proportion is >50%).

When adding school-level variables, the between-schools variance decreases of about 5%, suggesting that the socio-economic composition of the student body matters for achievement. However, this effect is no more statistically significant when dummies about macro-areas are included (sixth column). Here, the explanatory power is captured by Southern Italy (the negative difference with Northern Italy is of about 11 points). The lack of statistical power associated to the school-average SES should be interpreted as follows: school-average SES is not a factor contributing to explain (i) schools' performances and (ii) between-schools variance in Math_Score. The potential explanation is that the school-level SES actually masks a "location" effect, that is schools location in the Southern Italy is responsible for worse performance – for instance, because best teachers are attracted by living in Northern Italy, or other alternative reasons.

3.2 Analyses by macroareas

To further deepen the understanding of socioeconomic variables related to different geographical areas, we applied a multilevel analysis separately for the three macroareas (North, Central and South). The results are presented in the table 3.

The first evidence is that individual-level variables' effects are confirmed: female students perform worse than males, disabled status is strongly negatively associated with performance (around 12 points), as well as being a foreign student (-4 points) or a student who repeated one or more years (around 10 points).

When looking at school-level factors, findings obtained by Invalsi (2010) are confirmed: the between-schools variance is much higher in the South than in the North (21% vs 4%, respectively). Thus, there should be a mechanism that explains student sorting among schools, and/or schools' characteristics, which act in the South but not in Northern Italy. The second evidence is that such mechanism is not the school-average SES: this variable is not statistically related to the Math_score. Other factors seem to play a role instead: (i) the community in which the school is located, and (ii) the shortage of instructional materials. In the former case, it looks like the schools located in cities benefited of a positive advantage in Math_Score (from 4 points in the North to 12.5 points in the South). It could be the case that higher social and cultural development of the cities (in comparison with towns and rural areas) acts both directly (higher educational level of the population) and indirectly (higher cultural stimulus for the school's educational work): such effect appears stronger in the South. In the context of the Southern Italy, also the shortage of instructional materials appears as a critical factor: the coefficient is -7.2 and statistically related to (lower indeed) Math_Scores. Overall, these findings claim for a renewed attention to the school factors affecting performances, as the (traditional) explanation related to the SES is not satisfactory in interpreting our results.

Table 3: Results of the multilevel analysis (Math Scores), by macroarea

	Empty model			Individual level variables			Individual and school level variables		
Variable	Northern Italy	Central Italy	Southern Italy	Northern Italy	Central Italy	Southern Italy	Northern Italy	Central Italy	Southern Italy
female				**-3.464**	**-1.301**	-0.755	**-3.414**	**-1.503**	-0.620
				0.000	*0.024*	*0.102*	*0.000*	*0.014*	*0.195*
disabled				**-12.283**	**-12.817**	-10.692	**-12.462**	**-13.805**	-10.683
				0.000	*0.002*	*0.228*	*0.000*	*0.008*	*0.228*
foreign				**-4.799**	-0.276	**-3.657**	**-4.640**	-1.238	**-3.607**
				0.000	*0.830*	*0.058*	*0.000*	*0.361*	*0.062*
early				0.784	**3.941**	0.834	0.587	**4.072**	1.026
				0.759	*0.026*	*0.322*	*0.821*	*0.029*	*0.252*
late				**-10.432**	**-10.087**	**-3.768**	**-10.318**	**-10.351**	**-3.905**
				0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Disadvantaged (0-10%)							5.489	5.380	1.783
							0.126	*0.457*	*0.684*
Disadvantaged (11-25%)							4.493	7.278	-1.829
							0.211	*0.341*	*0.687*
Disadvataged (26-50%)							1.881	2.175	-1.952
							0.616	*0.768*	*0.671*
High Shortage of Instructional material							1.750	7.972	**-7.243**
							0.247	*0.189*	*0.053*
Some Shortage of Instructional material							3.129	3.279	8.074
							0.199	*0.674*	*0.374*
Community_ big city							**4.202**	-0.829	**12.502**
							0.033	*0.913*	*0.100*
Community_city							**5.180**	-4.259	**11.928**
							0.005	*0.559*	*0.096*
Community_town							-	-4.779	-7.259
							-	*0.403*	*0.379*
Constant	**67.113**	**65.241**	**56.219**	**70.668**	**66.751**	**56.845**	**61.289**	**63.904**	**47.344**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Random effects									
Between-schools variance	13.694	36.154	123.451	12.011	33.734	123.061	9.362	38.707	122.230
Within-school variance	310.135	367.219	468.410	288.668	358.212	467.271	290.957	342.541	466.388
% Between	4.23%	8.96%	20.86%	3.99%	8.61%	20.85%	3.12%	10.15%	20.77%

Another point is about the factors that can explain between-schools variance. The high between-schools variance in the South, indeed, necessitates a serious research of its determinants. A well-known potential interpretation, often adduced in the literature, is that schools perform differently because of different average SES of students (Shea, 2000); thus, the concentration of rich students in certain schools would explain their better performances. Typically, this is the usual justification for the better performances of private schools. Our data only partially support this view: in the Northern Italy, when adding school-level variables the “explained” between-schools variance is around 22%. However, it is not the case for the South: school level variable account for less of 1% the (high) between-schools variance! The available data does not allow investigating deeply this topic, but it is clear that other factors stand behind the phenomenon. Potential explanations could be related to (i) cultural characteristics of the families (and not their SES), or (ii) to specific school-level features not measured in the usual questionnaires (e.g. school climate, collaboration among teachers, educational styles, leadership, etc.).

In addition to these elements, it is important to underline that the model presented in table 3 suffers a major limitation: it does not offer any explanation about the ways through which the geographical factors (location in a macroarea) act on influencing students' performances. In other words, the macroarea dummies are treated like a "black box": they show a correlation with the dependent variable (students' achievement score) but the mechanisms that relate the two variables (in the EPF framework, see equation 1) is not revealed by the model. Nevertheless, such evidence was the stimulus to go deeper into the empirical analysis (see the next section).

3.3 Explaining between-regions variance through socioeconomic variables

The high explanatory power associated to the macro-areas dummies induced a further reflection on the role played by the "geographical" factors, and especially by the different socio-economic characteristics of the Regions. Indeed, Italy is one of the OECD countries with the higher "Gini index of regional disparities in GDP": the value was 0.14, compared with 0.06 for Sweden, 0.10 for Netherlands, 0.12 for Spain and Germany (OECD, 2008). Thus, it is important to verify whether part of the between-schools variance can be attributable to "contextual" characteristics, namely to the structural socio-economic differences between Regions. To investigate this issue, a three-levels multilevel analysis has been carried out, by decomposing the overall variance of students' achievement scores into three components: within-schools variance, between-schools variance, and between-Regions variance. Estimating a three-levels multilevel model is a challenging issue per se, as it assumes that factors associated to the students' performances in the EPF framework (equation 1) can be grouped in three distinct "families". The results are shown in the first column of table 4. Differently to the previous elaborations, the macro-areas dummies have been dropped, because the interest is on the variance between Regions (many Regions compose a macro-area).

The findings are that variance at regional level is statistically significant, as evidenced by the lower part of the table, while around 14% of variance is due to between-schools factors and more than 80% is within-schools. More precisely, 4.6% of the total variance is due to differences between Regions. When adding school-level and individual-level variables (second column), the coefficients are coherent with those deriving from the previous models (e.g. tables 2 and 3), confirming that the inclusion of the third level of variance (the Regional level) did not affect the main results, in terms of coefficients' value, but only the decomposition of variance. The last column of the table 4 shows the effects of including the GDP per capita (GDPpc) at Regional level (1,000€) as a potential variable explaining the variance at Regional level (source: Italian Institute of Statistics: www.istat.it): the coefficient is statistically significant and its value is around 0.9 – that is, the region's economic development is associated with 0.9 points more (on average) in terms of students' performance. Thus, the output of the analysis is very clear, as the variance between-Regions becomes no more statistically significant: that is, GDPpc is able to capture almost all the explanation about the between-Regions differentials in terms of students' achievement; as underlined by the bottom panel of the table, between-Regions variance drops from 5% to less than 0.2%. This is a key result of the paper, as the model with regional socioeconomic characteristics is able to explain at least in part the differences that were "masked" by macroareas fixes effects (as measured through dummies).

Table 4. Results of the three-levels multilevel model (Math Scores)

Variable	Three-levels multilevel model: empty	Three-levels multilevel model: individual and school-level variables	Three-levels multilevel model: individual and school-level variables, plus GDP per capita at Regional level (1,000€)
female		**-1.857**	**-1.857**
		0.000	*0.000*
disabled		**-12.298**	**-12.344**
		0.000	*0.000*
foreign		**-4.421**	**-4.440**
		0.000	*0.000*
early		**1.259**	**1.295**
		0.080	*0.072*
late		**-8.232**	**-8.240**
		0.000	*0.000*
Disadvantaged (0-10%)		3.460	2.427
		0.211	*0.358*
Disadvantaged (11-25%)		2.381	1.178
		0.394	*0.660*
Disadvantaged (26-50%)		0.515	0.035
		0.858	*0.990*
High Shortage of instructional materials		-5.104	-4.199
		0.254	*0.320*
Some Shortage of instructional materials		-2.759	-2.490
		0.186	*0.213*
Community_big city		**6.359**	5.727
		0.097	*0.115*
Community_city		**5.972**	**6.125**
		0.071	*0.051*
Community_town		**6.040**	**6.389**
		0.051	*0.032*
GDPpc (Regional level)			**0.875**
			0.000
Constant	**62.876**	**57.112**	**36.033**
	0.000	*0.000*	*0.000*
Between Regions Variance	**22.085**	**23.490**	0.653
Between Schools Variance	**65.903**	**64.707**	**61.433**
Within Schools Variance	**387.666**	**374.856**	**374.842**
Between Regions Variance (%)	4.64%	5.07%	0.15%
Between Schools Variance (%)	13.86%	13.97%	14.06%
Within Schools Variance (%)	81.50%	80.95%	85.79%

Notes: Statistically significant values are reported in bold
Probabilities are reported in italics (Prob>P)

The story that emerges is that socio-economic structural differences among Regions, as measured by GDP per capita, is a relevant factor that affects students' performances (achievement). Some consequences of this phenomenon are discussed in the next section.

4. Discussion and concluding remarks

In this paper, we analysed the determinants of students' achievement for a sample of 21,336 students in 163 lower-secondary schools in Italy. For the first time, it was possible to use data from a national standardized test (administered by Invalsi), instead of information from OECD-PISA and other international tests. A multilevel approach has been used, to properly account for the hierarchical structure of data.

The results tell that individual characteristics related to performance are, mainly, the disabled status, the foreign nationality and the repetition of one or more years: all these factors are associated to lower scores in the test. When looking at the school-level variables, it turns out that composition of student body (in terms of socio-economic background) matters more than schools' resources. However, this SES effect disappears when considering differences between the macro-areas of the country, with schools located in the Southern Italy experiencing lower results; this suggests a strong correlation between location and socio-economic characteristics of student bodies that should be analysed more cautiously in the future. The findings also underline the existence of school-level factors related to performance, which are not captured by traditional variables.

Thus, the main message that emerged from our findings is to refuse the simplistic view of the socio-economic background as the main factor driving schools' results, and to increase research effort in describing what actually happens into schools. Indeed, the key topic here is about the role of "school factors". This issue is not new, as since the publication of the Coleman Report in the USA (Coleman, et al., 1966), educational researchers face the challenge to investigate which characteristics of schools are associated with higher students' (average) performance. In this paper, the potential school factors were classified in two categories: (i) "externally-determined" factors (namely, the average SES of students who are attending the school) and (ii) "school-manageable" factors (the availability of instructional materials).

The former group seems providing little contribution to explain the between-schools variance, once the geographical dummies are accounted for. Even tough the high variance indicates that some sorting among students (families) is likely to exist, the average socio-economic status (that is the first potential factor along with sorting happens) is not playing a major role, and other families' characteristics should be considered. Some literature suggested that actually the cultural profile of the families is more important in determining their educational choices than socio-economic status per se. This is why the OECD-PISA exercise collects information about (proxies of) families' cultural capital: educational level of parents, number of books, etc. As it is not always the case that high cultural capital goes along with socio-economic status (e.g. teachers, museums' operators, etc.) the analysis of families' characteristics should rely more on cultural capital than on economic factors. The literature on social capital and the role of "functional communities" in education must be considered in future analyses: some studies demonstrated how the families support their children in a number of different ways. Cultural capital approaches showed the relationships between school success and the means available to families that reside on their educational records and in their relationships among people (Coleman & Hoffer, 1987; Dijkstra & Peschar, 2003). Moreover, to the extent that such factors affect previous students' results, sorting along this dimension still reflects different cultural endowments of the families. Thus, the results of this paper describe the inadequate explanatory power of the SES variables alone, and help in putting the educational role of the families (e.g. their culture, values, etc.) at the hearth of the formative processes. At the same time, the differences in the Regional socio-economic development seem to have an effect on the students' achievement: given the wide differences on this respect between Italian Regions, this problem is particularly worrying. Indeed, differences in educational results will lead to increasing differences in economic development, which in turn will reproduce gaps in educational performance. Di Liberto (2008) provided some indirect evidence of this link between education and economic development for Italian Regions, even though she demonstrated that the educational gap between Regions has been reduced in the period 1961-1991.

The second reflection, however, is on school manageable features, as one of the main important roles of schools should be to act as a facilitator for social mobility. The data show that some schools are able to obtain good results on this ground, by obtaining high average achievement despite the students' SES, while others are not. The high level of between-schools variance also suggests that some schools' characteristics are likely to play an effective role in influencing students' results. For instance, it can be possible that teaching styles and programs, evaluating procedures, leadership; practices among teachers, governance structures, etc. actually influence the academic results. The rich literature about school-effectiveness (Creemers, et al., 1989; Scheerens & Bosker, 1997) could help to develop school-level indicators (e.g. specific educational processes) that should be included in future analyses, by extending the present versions of questionnaires administered in national and international testing exercises. Case studies also could be fruitful, in this context, to generate accurate information on this ground, and help in identifying effects of these factors on achievement.

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