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Educational institutions, resources, and students' resiliency: an empirical study about OECD countries

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Abstract

This paper uses the OECD-PISA 2009 data for studying the factors associated with the probability of poor students being resilient, i.e. obtaining good test scores despite their disadvantaged socioeconomic background. The results reveal that not only students' individual characteristics matter, indeed a positive school climate is statistically associated with resiliency; also, educational systems that invest more resources and postpone tracking may help disadvantaged students to overcome their unfavourable background and promote higher equality of opportunities.

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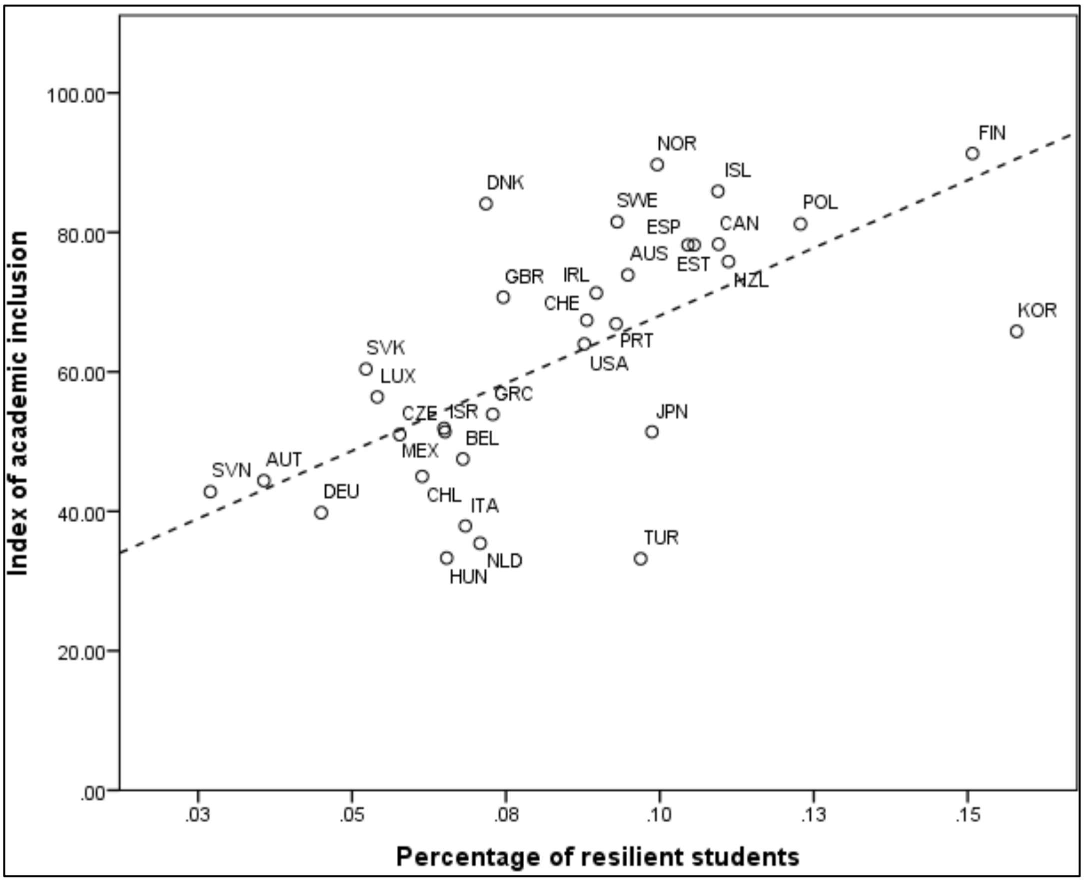
1. Introduction

We define resilient students as those who are able to obtain good academic results despite coming from a disadvantaged socio-economic background. For operational purposes, the OECD (Organisation for Economic Co-operation and Development) classifies a student as resilient if "he or she is in the bottom quartile of the PISA index of economic, social and cultural status (ESCS) in the country of assessment and performs in the top quartile across students from all countries, after accounting for socio-economic background". Such specific focus is important in the light of international economic literature, because, while it uses international datasets such as the OECD Programme for International Student Assessment (PISA) to analyse the determinants of student achievement and identify the positive and negative roles of the variables that make up the characteristics of schools and institutions (see Woessmann, 2003; Hanushek and Woessmann, 2011), in general, the studies do not show a breakdown of the results for students from different backgrounds – i.e. those who are relatively advantaged or disadvantaged.

For both reasons of both efficiency and equity, it is important to focus our attention on these categories of students. With reference to the former group, the relatively advantaged students, empirical evidence shows that there is a close relationship between the percentage of resilient students and the average academic achievement (OECD, 2011) of all students in a given country; in terms of the latter, the relatively disadvantaged students, education is often seen as an instrument for promoting equal opportunity, so the percentage of students who overcome a disadvantaged background can be seen as a direct measure of equality within the educational system. Figure 1 highlights, for each OECD country, the relationship between (i) the percentage of resilient students and (ii) the index of "academic inclusion", calculated as 100*(1-rho), where rho stands for the intra-class correlation of performance, i.e. the variance in student performance between schools, divided by the sum of the variance in student performance between schools and the variance in student performance within schools. What clearly emerges from this figure is that a higher incidence of resilient students is associated with more equality within the educational system.

On the academic side, the existing literature on resilient students focuses more on the individual students' features, such as motivation, engagement and commitment to study, than on school-level or country-level factors (i.e. Finn and Rock, 1994; Sanders, 2000; OECD, 2010;OECD, 2011) and, overall, studies on these particular students are limited in number and scope. The present paper aims at filling this gap, by specifying an international educational production function (EPF) that uses the probability of being a resilient student as the dependent variable, and a set factors at student, school and country level as the covariates; we also develop a new technical/statistical definition of resilient student, which is complementary to the one proposed by the OECD.

Figure 1. The relationship between the percentage of resilient students and "academic inclusion"



Note: (1) The index of academic inclusion is calculated as 100*(1-rho), where rho stands for the intra-class correlation of performance, i.e. the variance in student performance between schools, divided by the sum of the variance in student performance between schools and the variance in student performance within schools. (2) The Pearson correlation index of the relationship is 0.647.

This study cannot infer causality, as it suffers from a typical limitation of international comparisons based on cross-sections of data, like the OECD PISA tests. As students are not randomly allocated across schools, but the families choose the education they wish their children to receive (either directly – by selecting a particular school – or because of where they live), it is likely that a school's features are not exogenous to the students' results. The available information about students and schools does not go into enough detail, with insufficient elements to select the necessary tools for an Instrumental Variable (IV) approach. As a consequence, the empirical analysis proposed here does not explicitly face the challenge posed by any potential endogeneity, and we were forced to assume that all the variables we use are, indeed, exogenous. This assumption can be considered plausible on the basis of the specific procedure of subsample extraction, which selects only low ESCS students in low ESCS schools. Consequently, comparing students from similar families in similar schools leads us to suppose that the size of the endogeneity bias may be small. Despite this limitation, this work still provides an interesting picture of the schools attended by resilient students, as well as the features of educational systems with a higher percentage of these students.
The next section, Section 2, presents the methodological approach and the data in detail, while Section 3 contains the results and discussion.

2. Methodology and data

In this paper, we used OECD PISA 2009 data, which involves a sample of 15 year old students and includes a wide array of aspects at student and school level. We then integrated the dataset with several country-level variables reflecting information about resources (i.e. educational spending, teaching hours per year, etc.), the institutional or educational system (i.e. tracking, or grouping by ability) and additional indirect measures of features belonging to the institutions, such as accountability, choice, competition, etc., which are obtained from the answers given by school principals to the PISA questionnaires.

The main methodological aspect of this paper deals with the selection of the students and schools to be included in the empirical analysis. Firstly, we restricted the sample of students to those who are socially disadvantaged and who attend disadvantaged schools; more specifically, using a composite indicator called ESCS (Economic, Social and Cultural Status) developed by OECD, we selected the schools for which the (average) value of this indicator is particularly low (below the 33th percentile) and the students from these schools in the lower half of the ESCS distribution. It is important to note that this means that the notion of "socially disadvantaged" is relative: the students are disadvantaged when compared to other students in the same country - this choice is important in order to neutralize the structural differences of wealth across countries. The definition of a resilient student is mixed, because it sets an international benchmark for performance and a national benchmark for socio-economic background. Using this mixed definition, it is possible to calculate a measure of resilience at system level that is comparable across countries. An alternative choice is to consider a single country perspective, using a national benchmark for both SES and performance, but, in this way, the successful disadvantaged students in one country may be seen as poorly performing students in other countries and vice versa, and it follows that relative performance within a single system would not be useful for making comparisons across systems.

In addition, looking only at disadvantaged students in disadvantaged schools meant that two results could be achieved. These are, on the one side, to focus the analysis on students who improve their academic performance despite attending the same sort of school as low SES students, and, on the other side, to avoid the confounding effects of positive peer effects, e.g. being positively influenced by higher percentages of wealthier schoolmates. Instead, the study can place an emphasis on the influence of "pure" school and student factors. In a second step, academic performance (Reading score[1]) is compared with the performance predicted by the average relationship between ESCSs and performance across all OECD countries; in this sense, the definition of high performance standards is absolute and not country-specific. Operationally, we estimate the following:

$$y_{ijw} = \alpha_0 + \alpha_1 ESCS_{ijw} + \varepsilon_{ijw} \qquad (1)$$

where y_{ijw} is the Reading score of the i^{th} student, in the j^{th} school of the w^{th} country, and ESCS is the indicator of the student's socio-economic status. Insomuch as the relationship between ESCS and y is similar across all OECD countries, the residuals of (1) can be used to divide the student population into three[2] groups: namely successful, average and low-

[1] The choice of focusing on Reading scores is justified by this being the main focus of PISA 2009; potentially, the same analysis can be carried out using scores in Science and/or Math.

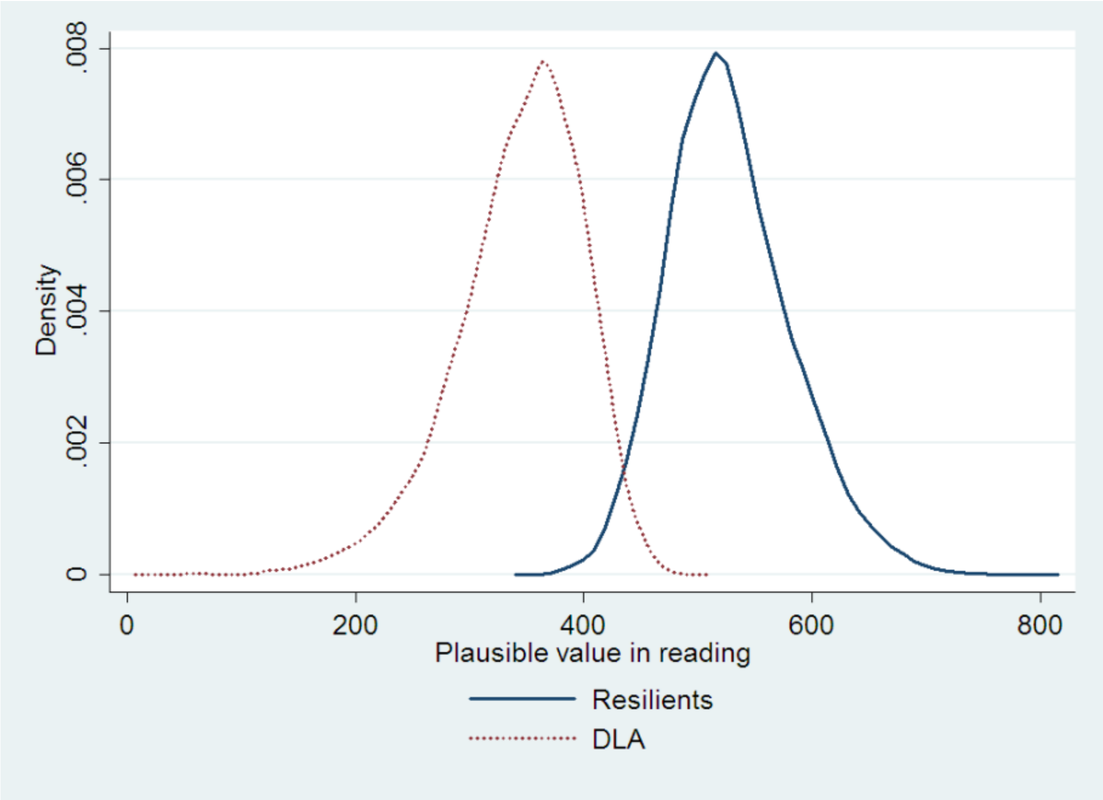
[2] In reality, different cut-points can be used (for instance, at the 25^{th} and 75^{th} percentiles of the residuals); however, the necessity of allocating a sufficient number of students to each group led to the decision of using three equally-sized groups.

performers – after having accounted for their socio-economic status (and also after considering their predicted performance by socio-economic status). We considered the first group as the resilient (RES) students, and the last group as the disadvantaged low achievers (DLA). The students from low SES backgrounds that had been placed in the first or last group (RES and DLA) were then compared, in order to study the determinants of resilience, at both individual and school level. It is important to underline here that the comparison was made between students from low socio-economic backgrounds (in other words, we are not comparing resilient students with well-off students who obtained high scores in the tests). Table 1 gives the number of students and schools included for each country: there are about 48,000 disadvantaged students in 3,600 schools, which represent around 16% and 33% of the entire OECD-PISA 2009 sample, respectively. Differences between countries range between 14.9% of the Chilean students and over 18% of the Korean students. Figure 2 highlights the marked difference between the Reading score distribution of RES and DLA students, showing that the average score of the former is around 340 and that of the latter is more than 527 (it is important to note here that the OECD mean is set at 500). The resulting subsample of students on whom the paper focuses is, therefore, not representative of the entire student population of a country. Instead, to the extent to which the original PISA sample is representative, the subsample used in this paper mirrors the distribution of scores (as well as individual student and school aspects) of the poorest third of the student population (by country). This specific feature of our sample must be kept in mind when reading the results, as these cannot be extended to all students, but are only valid for those who are socio-economically worse-off.

Table 1. Students and schools included in the paper (*disadvantaged* students)

Country	Sample used in the paper		Entire OECD PISA 2009 sample			
	Students	Schools	Students	Schools	% Students in the sample	% Schools in the sample
	(a)	(b)	(c)	(d)	(e) = (a)/(c)	(f)=(b)/(d)
Australia	2,474	118	14,251	353	17.4%	33.4%
Austria	1,089	87	6,590	282	16.5%	30.9%
Belgium	1,465	101	8,501	278	17.2%	36.3%
Canada	3,952	314	23,207	978	17.0%	32.1%
Chile	847	59	5,669	200	14.9%	29.5%
Czech Rep.	980	97	6,064	261	16.2%	37.2%
Denmark	941	94	5,924	285	15.9%	33.0%
Estonia	774	62	4,727	175	16.4%	35.4%
Finland	1,084	61	5,810	203	18.7%	30.0%
Germany	822	78	4,979	226	16.5%	34.5%
Greece	829	67	4,969	184	16.7%	36.4%
Hungary	628	57	4,605	187	13.6%	30.5%
Iceland	628	57	3,646	131	17.2%	43.5%
Ireland	640	51	3,937	144	16.3%	35.4%
Israel	1,020	61	5,761	176	17.7%	34.7%
Italy	4,899	374	30,905	1,097	15.9%	34.1%
Japan	1,051	63	6,088	186	17.3%	33.9%
Korea	901	51	4,989	157	18.1%	32.5%
Luxembourg	751	11	4,622	39	16.2%	28.2%
Mexico	5,581	494	38,250	1,535	14.6%	32.2%
Netherlands	712	63	4,760	186	15.0%	33.9%
New Zealand	822	63	4,643	163	17.7%	38.7%
Norway	803	65	4,660	197	17.2%	33.0%
Poland	835	61	4,917	185	17.0%	33.0%
Portugal	1,018	75	6,298	214	16.2%	35.0%
Slovak Rep.	685	57	4,555	189	15.0%	30.2%
Slovenia	998	109	6,155	341	16.2%	32.0%
Spain	4,443	301	25,887	889	17.2%	33.9%
Sweden	778	59	4,567	189	17.0%	31.2%
Switzerland	1,897	137	11,812	426	16.1%	32.2%
Turkey	765	58	4,996	170	15.3%	34.1%
UK	1,984	164	12,179	482	16.3%	34.0%
USA	867	56	5,233	165	16.6%	33.9%
Total	47,963	3,625	294,156	10,873	16.3%	33.3%

Figure 2. Distribution of RES (resilient) and DLA (disadvantaged low achievers) students' reading scores (OECD plausible value) – Kernel density estimates



With the aim of studying the statistical association between the students' resiliency and aspects relating to individual students and schools and the national educational system, we estimate the following:

$$y_{ijw} = \alpha_1 X_{1jw} + \alpha_2 X_{2jw} + \alpha_3 X_{3w} + \varepsilon_{(i)jw} \qquad (2)$$

where y_{ijw} is the binary output variable (being a RES or a DLA student), X_1 is a vector of student-level feature, X_2 is a vector of school features, and X_3 contains several indicators of (country-level) spending on education and schools. Standard errors are clustered at school level. The indicators composing the three vectors are defined as follows (descriptive statistics in Table 2, panels A-C)[3]:

- Individual student-level features: gender, immigrant status and two indicators measuring the students' attitude towards computers and towards reading;
- School factors: a set of variables classified into the following groups (see Table 2 for details of each variable): size/type, practices regarding grouping by ability, parental

[3] To deal with the problem of missing data, we followed the strategy adopted (among others) by Fuchs and Woessmann (2007). In practice, we did not rely on the simplistic method of imputing missing data with means (or medians) at student or school-level. We also included in the estimation two vectors of dummy variables (D1 and D2, where 1 and 2 are subscripts indicating that they refer to individual students and schools, respectively), with each dummy taking the value of 1 for observations with missing (imputed) data, and 0 otherwise. The inclusion of the D vectors in the model means that observations with missing data on each variable can have their own intercepts. Also, we included the interaction terms between imputation dummies and data vectors, so that these could have their own slopes for their respective variables.

pressure and choice, accountability and autonomy, resources, relationships between students and teachers;

- Country-level educational spending: expenditure on education (%GDP), teaching hours per year, teachers' salaries, teachers' ages, age when students are first tracked.

3. Results and discussion

The results are presented in Table 3 and are organized by variable category for ease of interpretation and discussion[4]. The coefficients are reported as odds ratios, and must be interpreted accordingly, e.g. the proportional change in the odds of the variable associated with the probability of being resilient instead of DLA.

The first evidence is that some known individual features for resilient students are confirmed by our study: these students are more frequently girls (odds ratio >2), and more motivated (i.e. those reporting higher levels of "joy" in reading are more than two times more likely to be RES than DLA students); lastly, immigrant students are more frequently disadvantaged low achievers than resilient students (odds ratio <0.4).

When considering the various school-level variables available for this study, some interesting patterns emerge. Resilient students are more likely to attend private schools (odds ratio: 1.5) and institutions where the school principal indicates that there is some form of selectivity and much pressure from parents for good academic results. This result can be interpreted as a sign that more motivated (but poor) students tend to gravitate towards more challenging and academic schools, which are seen as a way of improving their academic performance. Attending a school where there is significant emphasis on a specific aspect of accountability, namely providing information about the students' achievement compared to national benchmarks, is negatively related to the probability of being resilient. The direction of such effect is not clear *a priori*: a potential explanation is that schools where this accountability is stricter are the ones that are forced to do so because of poor previous performance (and therefore they are expected to report better results over the subsequent years), while another hypothesis is that RES students search for a less competitive environment and are attracted by more collaborative, soft or positive attitudes and relationships (so these students self-select into schools that are known for these aspects).

[4] As a robustness check, we also replicated the analysis using a multilevel logistic regression model. The results (available on request) were consistent across the estimation methods.

Table 2. Descriptive statistics

Panel A. Aspects relating to the students

	Disadvantaged low achievers (DLA)		Resilient (RES) students		Entire sample (OECD Countries)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Reading scores (plausible values)	343.42	56.23	527.34	54.2	493.1	94.45
Gender=female	0.36	0.48	0.61	0.49	0.5	0.5
Immigrant=yes	0.17	0.37	0.1	0.29	0.09	0.29
Socio-economic status (ESCS)	-1	0.87	-0.95	0.89	-0.11	1.08
Joy in/likes reading (JOYREAD)	-0.46	0.8	0.19	0.96	0.02	0.99
Attitude towards computers (ATTCOMP)	-0.12	0.94	-0.03	0.9	0.01	0.99

Panel B. School-level variables

Category	Variables	Mean	S.D.
School features	School community= “Village” or “Small town”	0.33	0.47
	School community=“City” or “Large city”	0.32	0.47
	School governance (0=public,1=private)	0.17	0.37
	Total number of students enrolled in school	670.27	575.54
Selecting /grouping	School selectivity =At least one factor always considered	0.32	0.46
	Students are streamed by ability into different classes=“For some subjects”	0.37	0.48
Parental pressure and choice	Schooling available elsewhere in the school area= “"One other”	0.14	0.34
	Schooling available elsewhere in the school area =“ No others”	0.23	0.42
	Parental expectation towards school in terms of academic results =“Many Parents”	0.17	0.38
Accountability and autonomy	School gives information to parents on child’s academic performance relative to other students in the school (0=no,1=yes)	0.32	0.47
	School gives information to parents on child’s academic performance relative to national or regional benchmarks (0=no,1=yes)	0.41	0.49
	School gives information to parents on child’s academic performance relative to students in the same grade in other schools (0=no,1=yes)	0.21	0.41
	Achievement data made available publicly (0=no,1=yes)		
	School governing board directly influences decisions about budgeting (0=no,1=yes)	0.62	0.49
	School governing board directly influences decisions about assessment practices (0=no,1=yes)	0.28	0.45
Resources	Student-teacher ratio	15.07	15.88
	Index of teacher shortage	-0.02	0.96
	Ratio of computers and school size	0.59	0.44
	Index of quality of the schools’ educational resources (SCMATEDU)	-0.03	1.04
	Extra-curricular activities offered by school (EXCURACT)	0.09	0.99
Relations teachers-students	Students’ learning hindered by teachers’ low expectation of students =“Not at all”	0.34	0.47
	Students’ learning hindered by student absenteeism =“Not at all”	0.12	0.32

Panel C. Country-level variables – spending on education and schools

Country	Expenditure on education and schools, GDP %, (2010)	Teaching hours per year (2009)	Teachers' statutory salaries at mean point in career (2011) $ PPP	Percentage of teachers aged 60 or above (2011)	Age of students when first grouped by ability into tracks (2002)
Australia	4.35	1,004	49,144	8.45	16
Austria	3.64	1,050	46,317	4.42	10
Belgium	4.4	955	58,398	3.83	12
Canada	3.86	920	56,569	4.23	18
Chile	3.39	1,197	25,027	8.16	13
Czech Republic	2.81	790	21,733	9.28	11
Denmark	4.8	930	58,347	8.45	16
Estonia	3.91	770	12,306	18.92	14
Finland	4.15	913	43,302	11.58	16
Germany	4.3	933	69,715	11.75	10
Greece	3.92	773	28,184	8.45	15
Hungary	2.8	1,106	15,515	4.38	11
Iceland	4.92	987	27,159	17.29	16
Ireland	4.77	935	54,954	5.48	15
Israel	4.26	1,102	21,316	11.64	14
Italy	3.23	1,089	36,928	9.27	14
Japan	2.96	944	45,741	3.76	15
Korea	4.24	963	48,146	1.12	14
Luxembourg	3.5	900	100,013	5.94	13
Mexico	3.99	864	41,665	8.45	12
Netherlands	4.1	1,000	63,695	11.95	12
New Zealand	5.08	944	42,726	14.37	16
Norway	5.09	859	40,430	17.88	16
Poland	3.66	832	21,518	6.13	15
Portugal	3.89	950	39,424	2.43	15
Slovak Rep.	3.08	941	12,858	7.64	11
Slovenia	3.91	908	32,193	4.65	15
Spain	3.3	1,050	46,479	4.49	16
Sweden	3.98	741	37,584	17.46	16
Switzerland	4.05	944	41,665	7.88	15
Turkey	2.51	810	25,747	8.45	11
UK	4.78	950	44,269	5.6	16
USA	4.02	944	49,414	8.81	18

Sources: OECD's Education at a Glance, various years; Brunello and Checchi (2007).

This interpretation is corroborated by two further results. On the one side, the positive relationship with the list of extracurricular activities (odds ratio: 1.12) and it can be the case that RES students appreciate a wide range of teaching methods that are not limited to traditional curricular programmes. On the other side, the set of variables that describe the school principal's perceptions about the positive relationships between teachers, and between teachers and students, are all positive and statistically significant; moreover, their coefficients are among the largest for school-level aspects (odds ratios between 1.2 and 1.5, the latter being associated to the fact that teachers have good expectations in terms of their students). In other words, all the variables that measure a positive school climate are positively associated with the probability of a student being resilient. Also in this case, this finding suggests that resilient students specifically search for this kind of the academic experience and self-select into these schools, and that the school itself makes no difference in creating a resilient child. Alternatively, the same result could lead to the hypothesis of a more “causal” effect, that is, certain types of schools (those where the climate is more collaborative) make some schoolchildren more resilient. Given the methodological limits described above (endogeneity), it is difficult to verify which of the two hypotheses is correct, and it can be easily the case that both mechanisms work simultaneously. The last group of variables, those relating to country-level factors, reveal two interesting findings. The variables, which are positively related to the probability of a student being resilient, are (i) attending a school in a country that invests more (% GDP) in education (odds ratio: 1.12) and (ii) being in an educational system where tracking does not happen too early (odds ratio: 1.16). The first relationship challenges the results provided by Hanushek and Woessmann (2011), who report that, in international comparisons, resources do not appear to have a positive effect on the students’ achievement. It can be the case that, while more money invested in the educational system does not benefit the average student, it can have a positive effect on the students in the lower tail of the socio-economic distribution. Should this be the case, the policy implications are significant: if the aim of the educational system is to promote higher average achievement levels, placing more resources in schools is not necessarily the most efficient way, but it could have the (positive) side effect of helping the more disadvantaged students; contextually, this would be beneficial in increasing equal opportunities through education, something claimed to be one of the key present challenges in society (Corak, 2013). The findings about tracking, i.e. its negative effects on disadvantaged students, are coherent with theoretical discussions and empirical evidence from Brunello and Checchi (2007): the authors not only argued that the practice of tracking is likely to be detrimental to academic achievement on average, but also discussed the particularly negative consequences for the worse-off students.

Table 3. Results of the empirical analysis

Category	Variables	Coefficients	
		Odds ratio	S.E.
Student features	Gender (0=male, 1=female)	2.158***	0.080
	Immigration status (0=native, 1=immigrate)	0.386***	0.024
	Attitude towards computers	1.145***	0.019
	Joy in/likes reading	2.291***	0.054
School features	School community= "Village" or "Small town"	1.197**	0.093
	School community="City" or "Large city"	1.126	0.092
	School governance (0=public, 1=private)	1.544***	0.169
	Total school enrolment	1.001***	0.000
Selecting /grouping by ability	School selectivity="Looking at admission tests and feeder school recommendations, at least one factor sometimes but neither always considered"	1.367***	0.096
	Students are grouped by ability into different classes="For some subjects"	0.93	0.061
Parental pressure and choice	Schooling available elsewhere in the school area = "One other"	1.086	0.094
	Schooling available elsewhere in the school areas = "No others"	0.972	0.07
	Parental expectations towards school in terms of academic results ="Many Parents"	1.217*	0.129
Accountability and autonomy	School gives information to parents on child's academic performance relative to other students in the school (0=no,1=yes)	0.932	0.059
	School gives information to parents on child's academic performance relative to national or regional benchmarks (0=no,1=yes)	0.852**	0.054
	School gives information to parents on child's academic performance relative to students in the same grade in other schools (0=no,1=yes)	1.168**	0.089
	Achievement data made available publically (0=no,1=yes)	0.992	0.067
	School governing board directly influences decisions about budgeting (0=no,1=yes)	0.942	0.058
	School governing board directly influences decisions about assessment practices (0=no,1=yes)	0.993	0.063
Resources	Student-Teacher ratio	0.995	0.005
	Index of teacher shortage	1.012	0.034
	Ratio of computers and school size	1.121	0.08
	Index of quality of the schools' educational resources (SCMATEDU)	1.013	0.035
	Extra-curricular activities offered by school (EXCURACT)	1.125***	0.039
Relations teachers-students	Students' learning hindered by student absenteeism ="Not at all"	1.280***	0.088
	Students' learning hindered by teachers' low expectation of students ="Not at all"	1.521***	0.187
	Students feel that teachers treat them fairly ="Agree or Strongly agree"	1.361***	0.059
	Students gets along well with most of their teachers="Agree or Strongly agree"	1.470***	0.056
	Index of disciplinary climate (DISCLIMA)	1.236***	0.022
Country factors (spending and "institutions")	Expenditure on education (%GDP)	1.128**	0.067
	Number of teaching-time hours (per year)	0.999***	0.000
	Teachers' average (statutory) salary after 15 years' experience	1.000**	0.000
	Age distribution of teachers (percentage of those >60)	1.013	0.008
	Age of students when first grouped by ability	1.161***	0.019
Constant		0.094***	0.039
Missing dummies		yes	
Pseudo R-square (McFadden's R2)		0.2414	

Note: *** p<0.01, ** p<0.05, * p<0.1

Summarizing, this empirical study on the aspects of schools and educational systems relating specifically to the important question of student resiliency suggests that the students' own individual characteristics are not the only factors that matter, but that some of the schools' and educational systems' features can play a role in helping economically poor students to overcome a disadvantaged background. It is important to note here that the results are valid specifically for students from a disadvantaged socio-economic background, and cannot be extended in a straightforward way to all the students of a given country; nevertheless, understanding the determinants of resiliency can be helpful for improving the overall efficiency of educational systems in general. Therefore, acquiring deeper knowledge on the mechanisms that encourage students towards a resilient mindset, and not simply the factors statistically associated to resiliency, is an important task for policy-makers and researchers in the near future.

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