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DOES PUBLIC SPENDING IMPROVE EDUCATIONAL RESILIENCE? A LONGITUDINAL ANALYSIS OF OECD-PISA DATA

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Does public spending improve educational resilience? A longitudinal analysis of OECD-PISA data

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Abstract. "Resilient students" are those who, despite their disadvantaged background, are able to obtain good educational results. This paper proposes a statistical procedure for identifying the proportion of resilient students for countries participating to OECD Programme for International Students Assessment (PISA) various years; then, it employs a longitudinal analysis (i.e. a set of fixed-effects [FE] models) to study the determinants of this proportion. While an important stream of the literature pointed at demonstrating that educational funding is not correlated with higher average performances of students, our findings suggest that it can help disadvantaged students in overcoming their penalizing starting conditions, at least when considering the proportion of public expenditure invested in education as a share of total public spending.

Keywords. Resilient students, FE models

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1. Introduction and background

The investigation of those factors that affect educational outputs is an interesting topic since the seminal contribution of Coleman *et al.* (1966), whose Report indicated that the students' own backgrounds were more influent in determining academic results than the role of schools. Economists paid a great attention to this topic, because of the link between education, human capital formation and economic growth. In this perspective, an interesting area is that comparing the performance of educational systems with their "institutional" features and resources (Hanushek, 1986; Clements, 2002), searching for those settings that can contribute more – together with individual and school factors – in "producing" better educational results. In the vast literature about educational production functions (EPFs), the concept of educational efficiency refer to the ability of maximizing achievement, as measured through indicators such as completion rates or, taking advantage of more recent available data, scores in standardizes tests (for a review, see Hanushek & Woessmann, 2011). In other words, an educational system is efficient when – through its rules and institutions – is able to contribute positively to students' achievement, all else (students and schools' characteristics) equal. A well-known stream of the literature suggests that some characteristics of the educational systems do indeed make a difference, while others do not; for instance, accountability, choice and competition are seen as positively related with efficiency (Woessmann, 2007), instead resources are not statistically correlated with higher achievement scores, nor in developed neither in developing countries (Hanushek & Luque, 2003).

When considering educational equity, instead, two different perspectives can be considered: (i) the reduction of disparities in academic achievement between students of the same class, school, region or country, or (ii) the ability of an educational system to reduce the impact of students' background on their academic results. The latter definition seems more in line with that of "equality of educational opportunities" *a là* Roemer (1998), and is also more able to deal with the wider socioeconomic topic of the social mobility (Corak, 2013).

This paper is inserted in the still scarce literature that studies empirically the characteristics of educational systems that are associated with higher levels of equity (instead of efficiency), taking advantage of large administrative or specialized datasets, especially in a cross-country comparison. A first challenge is how to define and measure the concept of "educational equity". An empirical approach is that proposed by Woessmann *et al.* (2009), who measure the correlation between: (i) the interaction of individual students' Socioeconomic Status (SES) and institutional features, on one side, and (ii) academic results in standardized test scores (using OECD-PISA 2003 data) on the other – the higher this relationship, the stronger the adverse effect on equity. Their results generally show that "(…) there is very little evidence that those aspects of accountability, autonomy and choice that are associated with higher levels of student achievement across countries have adverse consequences for the equity (…). To the contrary, the choice created by public funding for privately operated schools in particular is associated with a strong reduction in the dependence of student achievement on SES" (p. 101). A similar approach is proposed by Ammermueller (2012), who however adopts a difference-in-difference strategy by employing OECD-PISA and IEA-PIRLS data; his results indicate that: "streaming and private schools rather benefit the performance of students from a better social background. [while] The time students spend in

schools seems to limit the effect of social origin upon student performance while higher school autonomy is associated with higher parental influence" (p. 207).
The present paper is innovative in that it uses a direct measure of educational equality, which is the proportion of "resilient students", the latter defined as those students who, despite their disadvantaged socioeconomic background, do obtain good results in standardized test scores. In other words, this paper assumes that this indicator can act for improving the way through which an educational system can be judged more/less equitable. Intuitively, the higher the proportion of resilient students in a country's educational system, the higher its ability of pursuing the equality of educational opportunities in that country (all else equal), because a higher proportion of resilient students also means that, for many disadvantaged students, their performance does not reflect the starting unfavourable background.
Following this hypothesis, a general country-level EPF is estimated:

$$P_{jt} = \alpha_0 + \alpha_1 \bar{X}_{1jt} + \varepsilon_{jt} \qquad (1)$$

where P_{jt} is the proportion of resilient students in the country j in the year t, and X_{1jt} is a vector of country's educational and socioeconomic characteristic. The panel component allows the estimation of time-variant factors that are associated with a higher/lower proportion of resilient students, while the aggregation of data at country level neutralises the potential distorting effects due to self-selection of students across schools within countries (a similar approach has been proposed by Brunello & Rocco, 2013 and, in a different fashion, by Hanushek *et al.*, 2013; a complete discussion of the empirical strategy, together with a description of the strategy for identifying resilient students are in the sections §2.2 and §2.3 about Methodology).
The main aim of our analysis is then to identify those country-level factors that are statistically related to a higher proportion of resilient students (again, measured at country level). Previous research work demonstrates that the proportion of resilient students is positively and statistically correlated with the average score in standardized tests (Agasisti & Longobardi, 2014a,b; OECD, 2011); in this sense, studying the determinants of a country educational system that are associated with the presence of more resilient students can be useful not only for equity purposes, but can also contribute positively to efficiency.
To anticipate our results, the empirical analysis shows that resource investments matter for improving the equality of an educational system. More specifically, those countries where there is a higher investment in education as a percentage of total public spending, and that have better indexes about the quality and quantity of educational services, also show higher proportions of resilient students. This finding suggests that the variation in the amount of resources devoted to education can be maybe not related to variations in the absolute levels of achievement (as suggested by Hanushek & Luque, 2003), but can have a beneficial effect on the performances of the worse-off students and can help them to obtain those opportunities and resources that are otherwise missing, given their disadvantaged background. In addition, our results suggest that this effect is likely to be heterogeneous, and particularly important for those countries which economic development (GDP per capita) is lower.

The remainder of the paper is organised as follows: in the section 2, we provide a description of the dataset used for this research, and the methodological approach. Section 3 presents the results, and concluding remarks are in section 4.

2. Data and methods

2.1. Description of dataset

Our empirical analysis's first step relies on the construction of a panel dataset at the country level by merging the five editions of OECD Programme for International Students Assessment (PISA). The panel dataset, covering 58 countries over the period 2000-2012, allows to exploit country and time level variation in the proportion of resilient students accounting for school system difference, furthermore we are able to control for systematic and institutional differences including country and time fixed effects. Thus, the dependent variable is the proportion of resilient students at country level (PERC_RESIL); the following section §2.2 explains how we operationalize this definition – it is important here only to remind the general concept, which is that of a number of students who, despite their socioeconomically disadvantaged background, report good academic results.

The aim of the OECD-PISA project is to collect highly standardized data that can be used to compare competencies of representative samples of 15-year-old students in the three main domains of reading, mathematics and science both within and between countries. Since the first cycle in 2000, PISA has been taking place every three years with a growing number of participating countries and each of these cycles looks in depth at a major domain. The reason to be focused on PISA is that, together with the realization of a standardized test in the domains described above, the PISA procedure collects additional information about students and families' background, school characteristics through a school principal's questionnaire. Also, we integrated the PISA dataset with additional indicators and variables from other sources, such as the datasets compiled by UNESCO Institute for Statistics (UIS) and International Monetary Fund. Nevertheless, our panel dataset uses the rich array of school and student information carried out by PISA but, since the questionnaire is not standardized over the five waves, we select a subset of variables correlated with the resilience and available in all editions of PISA (2000, 2003, 2006, 2009 and 2012); even if this choice reduces the potential explanatory power of our empirical model, it allows improving the reliability of the panel modeling.

The covariates, used as factors for describing and explain the proportion of resilient students at country level, are classified in four categories, which reflect the main groups of variables that the literature showed as statistically correlated with educational achievement and thus can be of interest also for explaining resiliency: a) school system inputs, which are our key variables of interest, b) students' characteristics (socioeconomic background), c) economic development of the country, and d) educational system and schools' characteristics. In table 1, exact definitions of all variables used in this study are provided, while table 2 contains descriptive statistics.

[Table 1] around here

The key variables of interests are those measuring the amount of resources invested in the educational sector: (i) the public expenditure on education as a percentage of GDP (EXP_GDP) and (ii) the public expenditure on education as a percentage of total government expenditure (EXP_GOV). Although it is possible that also the amount of private resources invested in the sector could have an effect on (poor) students' achievement, there are two reasons why we decided to focus on public expenditure. First, public spending is the key policy leverage in the hands of governments (in this sense, understanding its effect on the equality of educational results is the main aim of this study) and, second, private spending is not a major sources of funding for primary and secondary schooling levels in the countries considered here – while its role is definitely more important in Higher Education (HE). Moreover, the choice of having both variables in the empirical analyses relies in that, although they both measure the role of public spending, at the same time they also capture two different attitudes – the "quantity" effect, when considering EXP_GDP, and a more political ("quality") effect when considering EXP_GOV instead, if assuming that those countries that invest more in education, net of GDP effects, are more politically committed to the important role of human capital in modern economies.

As a control for different levels of economic development and performance, we include the GDP per capita (calculated in Purchasing Power Parity – PPP units); data refer to the year in which OECD-PISA has been conducted (for instance, GDP for the year 2000 matched with Oecd-Pisa2000, GDP for the year 2003 matched with Oecd-Pisa2003, and so on).

When considering the socio economic background of students, we include (i) the share of students with migration background (STUD_IMMIG), and (ii) the proportion of students whose father has a full time job (FATHER_FULL). These two variables allow us to control the effect of the average level of students' socioeconomic conditions on the phenomenon of interest (educational resiliency).

Lastly, we included six variables measuring various dimensions of the educational system and schools' characteristics. As indicators of school resources we chose the index SCMATEDU[1], which reflects a principals' perception of the adequateness of educational physical resources such as equipment, laboratories, etc. (it can be considered a proxy of physical inputs of the school). The share of private schools (PRIVATE) measures indirectly the degree of competition in the educational sector, as well as the plurality of offer that can be selected by the students. The proportion of funds coming from the government (GOV_FUNDS) measures the degree of (financial) dependence of the schools from the government, and hence the control exerted by it on schools' activities; its effect on the proportion of resilient students can be negative or positive depending upon how much the government targets policies and actions for disadvantaged students. Two variables are intended to measure the role of school autonomy: (i) the share of schools that report a "high"/"total" degree of autonomy in formulating the budget (BUDGET), and (ii) the share of

[1] The index on the school's educational resources (SCMATEDU) was derived from seven items measuring school head teachers' perceptions of potential factors hindering instruction at their school (SC11). These factors are: i) shortage or inadequacy of science laboratory equipment; ii) shortage or inadequacy of instructional materials; iii) shortage or inadequacy of computers for instruction; iv) lack or inadequacy of Internet connectivity; v) shortage or inadequacy of computer software for instruction; vi) shortage or inadequacy of library materials; and vii) shortage or inadequacy of audio-visual resources. As all items were inverted for scaling, higher values on this index indicate better quality of educational resources.

schools that report a "high"/"total" degree of autonomy in establishing student assessment policies (ASSESS). Lastly, we used an indicator, called "school life expectancy" (SCH_LIFE), defined as "(…) the total number of years of schooling (secondary level) that a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age"; this variable is a proxy of the quantity of education that students are likely to receive after primary level in a given country.
Due to the missing values either on the response variable or in the explanatory variables the original sample of 58 countries decreased to 36 countries. An unbalanced panel dataset was used, where each country entered with a number of observations ranging from three to five. The final dataset included 166 observations of PERC_RESIL.

[Table 2] around here

2.2. The statistical procedure to identify the resilient students

In this paragraph, it is important to underline the approach used to select resilient students in each country. As defined above, in general terms a resilient student is one who, despite his/her disadvantaged socioeconomic background, obtains high academic performance. In the empirical analysis presented here, we adopted a "relative" definition of resilient students applicable across countries. Our attention is on a specific category of resilient students, namely those who derive from a low socio-economic background both at family and school-level; thus, we first selected, in each country, schools in which the average socio-economic condition (as measured through the OECD indicator ESCS: Economic, Social and Cultural Status) is low. ESCS – Economic, Social and Cultural Status – is an indicator calculated and provided by OECD; variable is built to have [mean = 0; st.dev. =1], and it represents a comprehensive measure of socio-economic background, which captures students' family and home characteristics (i.e. goods possession) that describe their socioeconomic background (technical details are in OECD, 2007, Annex A1). The choice of focusing not only on disadvantaged students, but also on the subsample of these students in disadvantaged schools, is motivated on a policy rationale. Students from a disadvantaged background could be helped by attending a school where classmates are more socioeconomically affluent; thus, the consequent benefits would not be the result of resource allocation or instructional policy, but of positive peer effects related to more favourable socioeconomic composition of the schools.
Operationally, the identification process of resilient students is articulated in two steps. In the first step, we selected, in each country, the schools with a socioeconomic level (ESCS) below the 33th percentile of the ESCS within-country distribution. Within the subsample of disadvantaged schools, we dropped students with an ESCS indicator higher than the third quartile of the new, within country, distribution (that of students within disadvantaged schools, broadly defined) to guarantee comparability across students and be sure of considering only disadvantaged students in disadvantaged schools. It is important to underline here that this strategy allows us to eliminate the effect of attending a school populated by affluent students. However, it can be the case that a relatively better-off student is attending a relatively disadvantaged school; this is the case why we intervene by excluding this type of students from the empirical analysis. It is also relevant to note that, this way, the

notion of "socially disadvantaged" is a relative one: the students are disadvantaged when compared with other students in the same country. Such choice must be considered as important for neutralizing the structural differences of wealth across countries, which is further reduced by including also indicators of a country wealth in the subsequent empirical analysis.

In a second step, the academic performance (PISA score[2]) of each disadvantaged student is compared with that predicted by the average relationship among students from similar socio-economic backgrounds across countries (thus, the definition of "high" academic performance is absolute – related to the test score distribution for all students – and not relative to each country's average test score). Mathematically, we estimated the following equation (2):

$$y_{ijw} = \alpha_0 + \alpha_1 ESCS_{ijw} + \varepsilon_i \qquad (2)$$

Where y_{ijw} is the score in the main domain of the PISA edition obtained by the ith student, enrolled in the j_{th} school in the w_{th} country, $ESCS_{ijw}$ is his/her indicator of socioeconomic background, and ε_i is a randomly distributed error. The regression is performed by using student weights, five plausible values for reading score, and Balanced Repeated Replications (through the SPSS macros provided by OECD); we estimated y_{ijw} for each PISA edition separately. The sample of students is restricted to the disadvantaged ones as defined in the first step described above. Student performance levels were then defined by means of the residuals ε_i of the equation (1); the residuals were divided into equal thirds, and students were divided into three groups – namely successful, average, and low-performers – by looking at their performance in comparison to peers of the other countries sharing similar socioeconomic background. Students were defined as "resilient students" (hereafter, RES) if they were disadvantaged students who perform in the top third of performance distribution, after accounting for socio-economic background. Subsequently the proportion of resilient students in each country is computed by dividing the number of resilient students by the total number of students. In this way, this proportion reveals the capacity of each country to provide the disadvantaged students with the chance of overcoming their background. For each country across time the share of resilient students computed by our approach is reported in Table 3. Descriptively, the dependent variable ranges between around 1.9% (Argentina) and almost 18% (Hong Kong), with a mean of 8.8% (data refer to 2012).

[Table 3] around here

2.3. Empirical analysis: the methodological approach

The pooling of the five available PISA waves (2000, 2003, 2006, 2009 and 2012) on a cross-section of countries allows exploiting the potential of panel data in investigating the determinants of the proportion of resilient students. To this end we specified the following panel data regression model with unobserved (fixed) effects (equation 3):

[2] The main domain of each PISA edition is used to assess the student performance, i.e reading for PISA 2000, mathematics for PISA 2003, etc.

$$P_{wt} = \alpha + X'_{wt}\beta + \varepsilon_{wt} \; ; \; w = 1,2, \dots, N \; ; \; t = 1,2, \dots T \qquad (3)$$

Where P_{wt} is the proportion of resilient students in the country w in the year (edition) t, X_{wt} is a $K \times 1$ vector of country's educational and socioeconomic characteristics (as described in section 2), α is a scalar whereas β is a $K \times 1$ vector of coefficients to be estimated. The disturbance term ε_{wt} can be written as a two-way error component (equation 4):

$$\varepsilon_{wt} = \mu_w + \lambda_t + \nu_{wt} \qquad (4)$$

where μ_w is the time-invariant unobservable country specific effect, accounting for any effect at a country level that is not included in the explanatory variables, λ_t represents the country-invariant unobserved time effect allowing for any shocks across waves whereas ν_{wt} is the usual stochastic disturbance term. When focusing on a given set of N countries, as is the case of the present study, the appropriate specification of model (3) leads to the so-called Fixed Effect (FE) model, where both the country effect and the time effect are treated as fixed parameters to be estimated, accounting for unobserved heterogeneity across countries and across time. Moreover the country specific effect μ_w is allowed to be correlated with the explanatory variables. Finally the stochastic component ν_{wt} is assumed independent of the explanatory variables for all w and t (Baltagi, 2008).

For the identification of the parameters, the FE model exploits the within-country and the within-time variation of the observations. For this reason, some restrictions are imposed on the regressors: they can include neither time-invariant nor country-invariant variables. Moreover the coefficient of a regressor with small within variability is not well identified.

In the empirical analysis, we opted for a stepwise (or "incremental") regression approach, which is quite common in this kind of academic research (Dronkers & Robert, 2008): The baseline first model (Model 1) considers only the country's school system inputs (expenditure variables) as explanatory factors of the proportion of resilient students. The Model 2 adds the other variables that are listed above, representing the countries' economic performance, students' characteristics, and educational systems' features. The Model 3 introduces some interaction terms, and more specifically the interactions of variables about (i) educational expenditures and (ii) educational system's characteristics with a dummy GDP2012 that takes value=1 if the country's GDP is higher than the other countries' median (data refer to 2012). The coefficient of the interaction with GDP informs whether the first-order effect of each variable interacted changes when passing from a country below to a country above the GDP median (all else equal). Lastly, the Model 4 includes all the interactions between educational expenditures and educational system's characteristics. The coefficients of these interactions informs whether the first-order effect of a variable about educational expenditure is either reduced or reinforced by the variable with which is interacted; this may have an effect when considering values of the interacting variable (that describing the educational system's characteristics) that are higher/lower its average value in the group of countries considered. The stepwise procedure allows us not only to test how the covariates change their statistical

significance and magnitude, but also to see which groups of variables add more explanatory power to the analysis.

Describing the patterns of the dependent variable (PERC_RESIL)

In this section, before turning to the empirical econometric model, we describe some general patterns of the dependent variable, which can help in preliminarily determining those factors that are likely to be correlated with the phenomenon of interest.

The first dimension that we explored is the dynamic of PERC_RESIL over time, both between and within countries – the main aim is to show that our measure is not dependent on random circumstances, but is able to capture structural differences, as well as time-dependent variations. In the table 4 we report the Pearson correlation coefficients between all yearly resilience measurements (this way, we consider also the consistencies in the measurements for the countries, and the stability over time). Technically, to analyse the statistical dependencies over time, we focus on two types of these correlation coefficients. The first one, Corr(y_{it}, $y_{i,t-1}$), correlates the percentage of resilient students (PERC_RESIL) of each tth year with the value of the variable in the previous year (t-1). These correlation coefficients can be observed directly below the main diagonal of the correlation matrix. For example, the correlation between percentage of resilient students observed in 2003 and the percentage observed in 2000 amounts to 0.822, a fairly high figure – that even increases to values of between 0.845 and 0.894 in the subsequent years. This is a clear indication of the statistical dependencies between the panel measurements, in other words PERC_RESIL (by country) is quite stable over time, albeit there is some time-dependent difference arising that can used for estimating the factors associated to these changes.

The second type of Pearson correlation coefficient, Corr(y_{it}, y_{i1}), correlates PERC_RESIL of each tth year with that of the first year (this correlation's coefficients can be seen in the first column of the correlation matrix). According to this measure, statistical dependencies decrease, as expected, the greater the time interval between t(1) and T. Similar decreasing trends can be found in the other columns of the correlation matrix; the interpretation is that the (although limited) variation of PERC_RESIL over time is cumulative, in the sense that differences in the tth periods grow when they are farer from the initial measurement of PERC_RESIL at the beginning of the period under scrutiny.

[Table 4] around here

Continuing in the attempt of describing the factors association with the dependent variable, we analysed its relationship and correlation with GDP per capita; the idea is to check whether the behaviour of the variable is somehow affected by the country's economic development. As a first step in this direction, we used the dummy GDP2012 defined above (that is equal=1 if GDP in 2012 is above the median), and we observed the distribution of PERC_RESIL in the two groups of countries. As evident from the figure 1, not only the average proportion of resilient students is higher in richer countries (see Panel B), but also the distribution is narrower. To investigate if the variation in the proportion of resilient students is evidently driven by variation between countries' wealth, we plotted the two variables one against the

other (see figure 2), and although there seems to exist a slightly positive correlation between the two, it is very small in magnitude (and the pairwise correlation is <0.38).
Taken together, these patterns suggest that there should some underlying characteristics of a country's wealth that are related to the equality of educational system, but not necessarily there is a direct nexus, as the low statistical correlation between PERC_RESIL and GDPpc highlights – and the searching for the additional evidences is then interesting in this field.

[Figures 1 and 2] around here

Another potentially relevant correlation is the one between the dependent variable and the two indicators that we chose for measuring the expenditure on education: public expenditure as a percentage of GDP (EXP_GDP) and public expenditure as a percentage of public expenditure (EXP_GOV); the figure 3 shows the corresponding graphical plots (panels A and B, respectively), where the distinction between countries with GDP higher or lower than median is maintained. There seems to be a slight negative relationship between EXP_GDP and PERC_RESIL, for the better-off countries, while it is clearly positive for countries with GDP<median. For both groups of countries, instead, the direction of the relationship between PERC_RESIL and EXP_GOV appears as positive. Overall, these correlations seem not that impressive, and as discussed when analysing GDP, they are probably part of a more complex action of institutional and economic variables on educational characteristics and results – that must be investigated through the econometric modelling in section 3. Pairwise correlations corroborate these impressions: coefficient is only .15 for corr(PERC_RESIL ; EXP_GDP) (even not statistically significant) and .28 for corr(PER_RESIL ; EXP_GOV)[3].

[Figure 3] around here

3. Results

The results of our empirical analysis are presented in the table 5. For every model specification the F tests for fixed effects gave the following results: the null hypothesis of no joint significance of both country and time effects has to be rejected, which means that the pooled OLS model with no fixed effects would not appropriate. Similarly a one-way fixed effect model with either only the country effects or only the time effects has to be rejected too. In other words, the factors that affect the proportion of resilient students can be also influenced by structural differences between countries and by a time trend.

[Table 5] around here

In the first column of table 5 (panel A), we report the results of the baseline Model 1, where only the variables of interest are included (i.e. the expenditure on education, EXP_GDP and EXP_GOV). The model explains around 18% of the variation in the percentage of resilient

[3] It is interesting to note, here, that the correlation between EXP_GOV and EXP_GDP is very low too (.152, not statistically significant), confirming that the two economic variables do capture and measure concepts, which are conceptually and substantially different each other.

students across countries (see R^2) and both variables results statistically significant. The indicator that measures the "relative" incidence of expenditure on education (as a % of total public spending) is positively related to resiliency, while the contrary holds for the indicator that measures the absolute level of expenditure on education (as % GDP). In such perspective, the simplest interpretation of these results is that while a higher level of expenditure is not important per se in determining the equality of the educational system, a higher incidence of educational spending compared to other government policies and priorities is instead positive for it. Overall, the negative association between absolute spending and educational equality complements the statistically insignificant role of spending on higher levels of educational achievement (efficiency; see Hanushek & Woessmann, 2011; Woessmann, 2003; Fuchs & Woessmann, 2007).

These basic findings are unchanged when including the other variables about economic performance, schools and educational systems' characteristics and students' socioeconomic background (Model 2; second column of table 5, panel A) - the only relevant impact being a reduction in the magnitude of the effect exerted by EXP_GDP on the percentage of resilient students. The inclusion of the additional variables adds a 16% of additional explanatory power to the model (R^2 is now 34%). GDP per capita is negative, suggesting that the higher the economic development of a country, the lower the equality of its educational system; therefore such relationships between educational spending and overall economic development are complex, and we indeed investigate them in the subsequent models. The percentage of immigrant students (STUD_IMMIG) is negatively associated with the percentage of resilient students, thus confirming findings from previous studies, that showed how these students are less likely to overcome their disadvantaged background than natives (Agasisti & Longobardi, 2014a;b). The index measuring the principals' perceptions about the quality and quantity of educational resources (SCMATEDU) has a positive and statistically significant effect on the proportion of resilient students. This result is particularly important in a policy perspective. Indeed, it identifies a possible factor related to the organization of the educational system that can act positively on its equality; improving the quality and quantity of educational resources is not the same than improving the level of resources *per se*. In other words, this finding highlights how the type of spending matters; when using the resources for educational purposes (and not to other such as supporting services, etc.) these can help disadvantaged students in obtaining good academic results. While the mechanisms behind this positive effect are not investigated here, this evidence constitutes a further step in modelling the relationship between spending, educational activities and results. The other variable, which is positively related to the percentage of resilient students, is the school life expectancy (SCH_LIFE). In this sense, a longer exposition to schooling seems benefitting the equality of the educational systems: in those countries where students are subjected to more expected years of schooling, there is also a higher proportion of resilient students.

The picture that emerges from the two baseline models is quite clear and consistent: a higher policy-related (and economic) attention to education is beneficial for the equality of the educational system. Indeed, those countries characterized by higher proportion of public spending devoted to education, better resources for core educational activities, and more years of education better serve their disadvantaged students; the expenditure (as % of GDP) alone does not produce better equality of opportunities.

Given the articulated relationships between spending, economic development and institutional characteristics, we added interaction terms to the empirical analyses, with the aim of understanding better this complexity. In the Model 3 (first column, table 5 panel B), the variables added are those interacting the various variables with a dummy that takes value=1 if the country's GDP in 2012 is higher than the median observed in the group of countries (in practice, this procedure identifies two groups of countries, labelled as "gdp_low" and "gdp_high", the interaction measuring the impact of the expenditure variables in the richer countries when compared to the poorer ones). The explanatory power of the model increases of another 12%, the R^2 becoming around 45%. The coefficients of the two variables of interest remain unchanged and statistically significant; more precisely, the coefficient of EXP_GOV is still positive, while its interaction with GDP is negative. This latter finding can be interpreted as the effect of devoting more expenditure in percentage of total government spending on education has no effect on influencing resiliency for richer countries (the first-order positive coefficient is counterbalanced by the negative second-order effect); while in poorer countries it has a positive effect, measured by the coefficient of the first-order variable. The interaction of EXP_GDP with GDP, instead, does not gain statistical significance, confirming that more expenditure in percentage of GDP is not associated with higher proportions of resilient students nor in low_gdp neither in high_gdp countries. In this model, other interesting results emerge. The countries where there is a higher proportion of students in private schools also have a higher proportion of resilient students; the data available does not allow investigating whether direct effects (i.e. attending private schools help resiliency) or indirect ones (competition stimulates school-level actions for poorer students) prevail. Nevertheless, the positive effect is only relevant for poorer countries, because the interaction term PRIVATExGDP is negative. Again, the percentage of immigrant students is associated with lower percentages of resilient students. In addition, albeit the index about school life expectancy is no more statistically significant, its interaction with GDP is positive, statistically significant and high in magnitude, suggesting that higher quantities (more years) of schooling are beneficial for equality only in those countries that are already economically developed. The same consideration holds for the index about the quality and quantity of educational resources (SCMATEDU); the first-order variable is not statistically significant, its interaction with GDP instead is, and the coefficient is positive and big in magnitude. Indicators about school are not statistically significant, however the interaction ASSESSxGDP is positive, even if small in magnitude; in this light, school autonomy in assessing students' results help poorer ones in obtaining good results only in the countries that are economically better-off.

In the last Model 4 (second column, table 5 panel B) the variables about the characteristics of the educational system and schools are interacted with the two variables of interest, EXP_GDP and EXP_GOV. The explanatory power of the model increases again (R^2 becomes around 59%; more than half of the variation in the proportion of resilient students across countries is then captured by the variables considered in this empirical specification). Interestingly, the amount of spending in percentage of GDP is no more statistically significant, while EXP_GOV maintains its magnitude, positive sign and statistically significance (also the interaction term EXP_GOVxGDP is unchanged, confirming the positive role of this variable on increasing the proportion of resilient students only for

low_gdp countries). The proportion of immigrant students and that of students enrolled in private schools confirm their negative and positive statistical association with the proportion of resilient students, respectively. The index of quality and quantity of educational resources (SCMATEDU) becomes statistically significant and positively associated with higher proportion of resilient students - and the magnitude of this effect is the highest in the model. This effect is reinforced by the positive interaction SCMATEDUxEXP_GDP, indicating that higher levels of spending are devoted to educational structures, this helps the educational system to reduce the dependence between disadvantaged socioeconomic background and students' results. The effect of school life expectancy seems negatively related to resilience (see the coefficient of the first-order variable) but the interaction SCH_LIFExGDP reveals that its role is positive for countries that have higher GDP, confirming analogous results from Model 3. Lastly, a higher incidence of public resources in schools' incomes are positively related with higher proportion of resilient students, perhaps indicating that the countries in which the government maintains a stronger role in funding can target resources to disadvantaged students helping them in becoming resilient; however, this effect is particularly stronger for high_gdp countries (see the interaction GOV_FUNDSxGDP) but slightly lower for those countries that has a higher educational expenditure in percentage of GDP (see the negative coefficient of GOV_FUNDSxEXP_GDP).

Summarizing, the results show that the proportion of resilient students in a country's educational system in influenced by several factors, among which the variables measuring the expenditures on education play an important role. In general terms, those countries that invest a higher part of (a given) public spending into education obtain more equal educational results (i.e., a higher proportion of resilient students); while the only higher level of public spending (measured as a percentage of GDP) does not serve the same objective. These effects, however, are heterogeneous and dependent upon the economic development of a country; specifically, investing more public money on education (EXP_GOV) creates a beneficial result for the equality of achievement especially for poorer countries. Finally, a way to make the money worth of investment is to spend them for educational services and resources (we measure this attitude with SCMATEDU): in all our models, this leads to an increase in the proportion of resilient students.

4. Concluding remarks

This paper addresses the educational equity of a system through the definition of a measure – the resilience – that accounts for the ability of disadvantaged students to achieve high school performance. More specifically, the disadvantaged condition is defined at both family and school level whereas the performance is derived from PISA score.

The analysis is performed at a country level on a macro panel dataset coming from the pooling of the PISA waves (from 2000 to 2012) on a cross-section of countries. The variable of interest is the percentage of resilient students in each country. The estimation of panel Fixed Effects (FE) models allows to investigate the main determinants of the resilience in a longitudinal framework.

The main result is that the investment in education - in the form of both financial and material resources allocated for educational purposes - does matter for equity. Indeed a higher share of public spending on education over the total government expenditure as well as a better

quality endowment of educational resources turn out to be both associated with a higher percentage of resilient students. In other words, the education systems that can count on both larger share of public expenditure and more adequate equipment seem to be more able to limit the negative impact of the disadvantaged students' background on their schooling performance.

At the same time other variables, related to a country's economic conditions, as well as the characteristics of its educational system, do influence the proportion of resilient students. The higher the GDP per capita, the lower the proportion of resilient students, suggesting that more economically developed country have less equal educational systems. The proportion of immigrant students is negatively correlated with that of resilient students, meaning that immigrants have less opportunities to overcome their disadvantaged background, all else equal – and this finding reinforces the concerns about educational systems' equality: indeed, interpreting this result at country level means that those countries where the proportion of immigrants is higher are less able to pursue those conditions that help students to become resilient. The analysis of interaction terms reveals, however, that the characteristics of the educational system and the level/type of educational resources are jointly important in affecting the proportion of resilient students at country level.

A further discussion about the effects of the expenditure variables is worth of attention, therefore. The positive sign (and statistical significance) associated with the variable that measures the proportion of public funds devoted to education on the total public funds (EXP_GOV) has been interpreted throughout the paper as one indicator of the "intensity" of (financial) investment on education. Actually, this interpretation holds only when considering countries with similar levels of public spending; if it is not the case (as in this paper, that considers a wide and diversified group of countries) the indicator EXP_GOV can capture not only the amount of financial resources, but also the cultural orientation towards education. In other words, those countries where EXP_GOV is higher are not only (or not necessarily) those where education receive more money, but those where education is funded more than other public policies. In this sense, it can be that the positive effect on the proportion of resilient students is not driven by a direct financial effect, but instead by an indirect action of the cultural preferences of citizens towards a more equal (or inclusive) educational system. If, for instance, the governments of these countries are stimulated to invest more in education as a key driver for promoting the equality of opportunities, the direct nexus between expenditure and proportion of resilient students is mediated by different policy orientations and activities in the educational system that go beyond expenditures alone.

The discussions about the potential different channels of this effect do not change the central message of the paper: investing public money on education, and specifically on educational core resources for the quality of teaching, can help disadvantaged students to beating the odds, and can support the final goal of making the educational systems positive agents in promoting the equality of opportunities.

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Table 1. Variables used in the study.

Category	Variable	Label	Description	Source
School system input	Education expenditure (%Gdp)	EXP_GDP	Education (public) expenditure as a % of GDP	UNESCO Institute of Statistics
	Education expenditure (%Gov)	EXP_GOV	Education (public) expenditure as a % of the total government expenditure	UNESCO Institute of Statistics
Students' characteristics	% immigrants	STUD_IMMIG	Percentage of students born in a foreign country	OECD (Pisa)
	% fathers employed	FATHER_FULL	Percentage of students whose father works with a full time job	OECD (Pisa)
Economic performance	GDP per capita	GDP	GDP per capita, calculated as purchasing power parity (PPP)	International Monetary Fund (IMF)
Educational system's characteristics	Index of school educational resources	SCMATEDU	OECD's indicator combining different indicators reflecting school principals' perception of the resources adequateness for teaching,	OECD (Pisa)
	Private schools	PRIVATE	Proportion of private schools	OECD (Pisa)
	Funds from government	GOV_FUNDS	Self-answered questions from the schools' principals, who report how many funds (in %) come from government	OECD (Pisa)
	Autonomy in budget	BUDGET	Proportion of school principals who report the school having a major responsibility in budget formulation	OECD (Pisa)
	Autonomy in assessment	ASSESS	Proportion of school principals who report the school having a major responsibility in establishing student assessment policy and practice	OECD (Pisa)
	School life expectancy	SCH_LIFE	Total number of years of schooling (primary to tertiary) that a child can expect to receive	UNESCO Institute of Statistics

Table 2. Descriptive statistics

Variable	source	mean	Std. Dev.	Min	Max	Obs.
PERC_RESIL	overall	8.98	3.59	1.42	18.48	N=166
	between		3.37	2.35	17.49	n=36
	within		1.48	3.32	12.08	
EXP_GDP	overall	5.24	1.2	2.46	8.74	N=160
	between		1.12	3.16	8.33	n=36
	within		0.46	4.13	7.72	
EXP_GOV	overall	14.15	4.02	7.16	31.5	N=160
	between		3.75	8.1	23.5	n=36
	within		1.38	7.85	22.15	
GDP	overall	25,253	11,642	2,433	54,343	N=166
	between		11,048	3,529	47,540	n=36
	within		3,980	13,870	38,009	
STUD_IMMIG	overall	5.69	5.65	0	30.14	N=164
	between		5.07	0.11	22.75	n=36
	within		2.42	-1.01	28.41	
FATHER_FULL	overall	73.17	10.88	37.7	90.89	N=166
	between		10.67	45.07	87.85	n=36
	within		2.78	61.76	81.39	
SCMATEDU	overall	-0.06	0.45	-1.63	0.96	N=166
	between		0.32	-1.22	0.35	n=36
	within		0.34	-1.03	1.56	
PRIVATE	overall	20.41	23.17	0.44	93.26	N=163
	between		21.46	0.75	69.86	n=36
	within		8.3	-32.69	55.66	
GOV_FUNDS	overall	84.75	16.21	33	100	N=166
	between		16.06	42.36	99.92	n=36
	within		3.32	69.08	95.31	
BUDGET	overall	72.97	20.73	8.61	99.79	N=165
	between		17.79	30.99	96.4	n=36
	within		11.54	23.88	119.34	
ASSESS	overall	86.65	15.33	0	100	N=165
	between		12.32	37.35	99.62	n=36
	within		8.93	47.08	141.76	
SCH_LIFE	overall	6.63	1.23	3.35	9.42	N=166
	between		1.15	4.09	8.84	n=36
	within		0.45	5.34	8.61	

Table 3. Proportion of resilient students by country and PISA edition

Country	2000	2003	2006	2009	2012
Argentina	4.69	m	2.70	3.52	1.95
Belgium	8.35	8.98	7.65	7.89	7.86
Bulgaria	1.42	m	2.51	2.82	2.65
Chile	3.23	m	6.17	8.57	5.38
Colombia	m	m	5.34	7.57	4.38
Czech Republic	5.83	8.12	9.34	6.96	8.52
Denmark	9.16	10.38	8.19	8.58	7.71
Estonia	m	m	14.66	12.02	14.06
Finland	18.26	15.23	17.90	15.63	11.89
Germany	4.51	6.72	6.13	5.36	6.60
Greece	7.23	4.21	6.81	8.67	7.14
Hong Kong SAR, China	17.43	17.13	16.90	18.48	17.52
Hungary	5.07	3.92	8.40	8.40	7.40
Iceland	11.48	9.82	8.97	11.60	7.98
Indonesia	2.19	2.82	4.13	7.69	7.06
Ireland	13.21	9.95	10.88	9.98	12.54
Israel	3.49	m	4.10	7.55	7.60
Italy	7.34	8.16	6.91	8.38	8.25
Japan	m	11.51	10.87	11.14	12.63
Korea, Rep.	15.23	13.43	11.79	17.18	15.02
Latvia	5.93	7.07	10.30	10.55	10.15
Lithuania	m	m	8.96	7.55	7.51
Mexico	6.13	5.66	6.83	9.79	7.27
Netherlands	9.11	9.94	7.92	8.38	6.41
New Zealand	12.35	10.82	11.67	12.15	10.11
Norway	10.18	6.30	7.86	10.79	10.33
Poland	5.34	8.99	12.76	13.95	13.96
Portugal	7.52	10.18	12.06	11.31	9.94
Serbia	m	m	2.98	4.20	4.44
Slovak Republic	m	7.36	7.65	6.81	3.66
Spain	13.47	11.53	13.29	12.15	11.49
Sweden	11.41	9.58	10.04	10.42	9.06
Switzerland	8.23	11.46	10.20	10.29	10.43
Thailand	13.15	8.12	8.93	10.04	9.98
United Kingdom	10.17	8.68	9.25	8.47	9.45
United States	6.76	5.21	7.40	9.92	10.10
Total	8.60	8.97	8.85	9.58	8.85

Source: authors' calculations based on the methodology described in the section §3.1.

Table 4. Serial correlations coefficients for the dependent variable (PERC_RESIL)

	2000	2003	2006	2009	2012
2000	1				
2003	0.825	1			
2006	0.805	0.846	1		
2009	0.769	0.734	0.869	1	
2012	0.715	0.678	0.852	0.892	1

Table 5. Results of the empirical analysis
Panel A. Baseline models, without interactions

Category	Variable	Model 1	Model 2
School system input	Education expenditure (%Gdp)	-1.265***	-0.812***
		(0.345)	(0.360)
	Education expenditure (%Gov)	0.354*	0.280***
		(0.130)	(0.131)
Students' characteristics	% immigrants		-0.154***
			(0.040)
	% fathers employed		0.080
			(0.049)
Economic performance	GDP		-0.190*
			(0.102)
Educational system's characteristics	Index of school educational resources		1.112***
			(0.374)
	Private schools		0.004
			(0.016)
	Funds from government		0.002
			(0.034)
	Autonomy in budget		-0.013
			(0.009)
	Autonomy in assessment		-0.006
			(0.012)
	School life expectancy		0.488**
			(0.247)
Constant		8.281***	0.074**
		(0.393)	(3.187)
Time dummies		yes	yes
Country fixed effects		yes	yes
Adjusted R2		0.182	0.338

Notes: *,** and *** denotes variables that are statistically significant at 10%, 5% and 1% levels respectively. Standard errors (SE) among brackets;

Panel B. Models with interactions

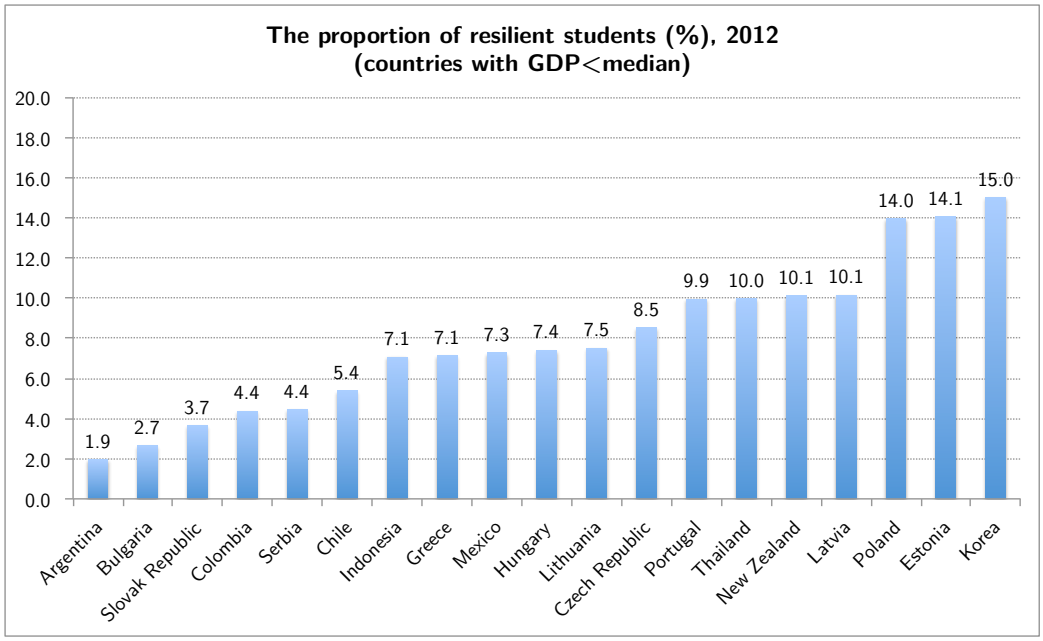
Category	Variable	Model 3	Model 4
School system input	Education expenditure (%Gdp) [EXP_GDP]	-0.932*	-0.831
		(0.492)	(0.527)
	Education expenditure (%Gov) [EXP_GOV]	0.410***	0.377***
		(0.135)	(0.143)
Students' characteristics	% immigrants [STUD_IMMIG]	-0.129***	-0.189***
		(0.042)	(0.053)
	% fathers employed [FATHER_FULL]	0.077	-0.016
		(0.053)	(0.053)
Economic performance	GDP per capita [GDP]	-0.189*	-0.215**
		(0.112)	(0.110)
Educational system's characteristics	Index of school educational resources [SCMATEDU]	0.423	1.692***
		(0.486)	(0.512)
	Private schools [PRIVATE]	0.148***	0.190***
		0.049	(0.036)
	Funds from government [GOV_FUNDS]	0.017	-0.043
		(0.031)	(0.039)
	Autonomy in budget [BUDGET]	-0.007	0.002
		(0.017)	(0.022)
	Autonomy in assessment [ASSESS]	-0.023	-0.041**
		(0.019)	(0.020)
	School life expectancy [SCH_LIFE]	-0.544	-0.779*
		(0.395)	(0.430)
Interactions with GDP	EXP_GDP x GDP2012	0.455	0.398
	EXP_GOV x GDP2012	-0.531**	-0.587**
	BUDGET x GDP2012	-0.020	-0.032
	ASSESS x GDP2012	0.055*	0.103***
	SCH_LIFE x GDP2012	1.131***	1.885***
	SCMATEDU x GDP2012	1.240*	-0.263
	PRIVATE x GDP2012	-0.150***	-0.171***
	GOV_FUNDS x GDP2012	0.119	0.259*
Interactions with EXP_GOV	ASSESS x EXP_GOV		0.007**
	BUDGET x EXP_GOV		-0.005*
	SCH_LIFE x EXP_GOV		0.103
	PRIVATE x EXP_GOV		0.000
	SCMATEDU x EXP_GOV		-0.032
	GOV_FUNDS x EXP_GOV		0.003
Interactions with EXP_GDP	BUDGET x EXP_GDP		0.010
	ASSESS x EXP_GDP		-0.040**
	PRIVATE x EXP_GDP		0.009
	GOV_FUNDS x EXP_GDP		-0.053**
	SCMATEDU x EXP_GDP		0.621**
	SCH_LIFE x EXP_GDP		-0.387

Category	Variable	Model 3	Model 4
Constant		0.021	8.065
		(2.091)	(4.141)
Time dummies		yes	yes
Country fixed effects		yes	yes
Adjusted R2		0.454	0.590

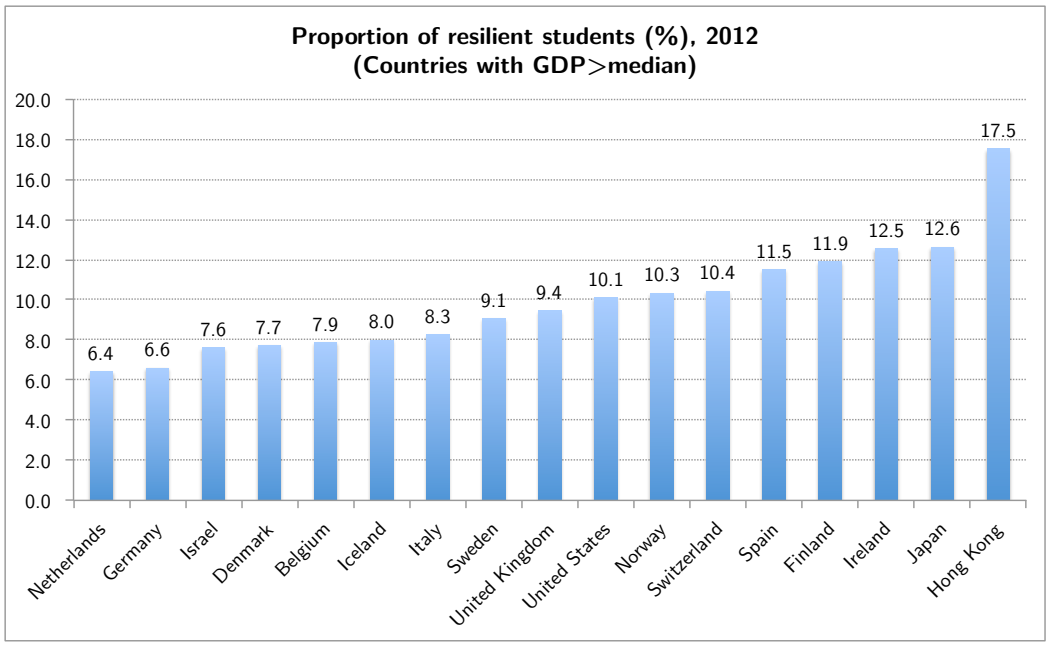
Notes: *,** and *** denotes variables that are statistically significant at 10%, 5% and 1% levels respectively. Standard errors (SE) among brackets; SE of interactions are not reported, but available on request from the authors.

Figure 1. Values of the dependent variables (PERC_RESIL), 2012

Panel A. Countries with GDPpc<median

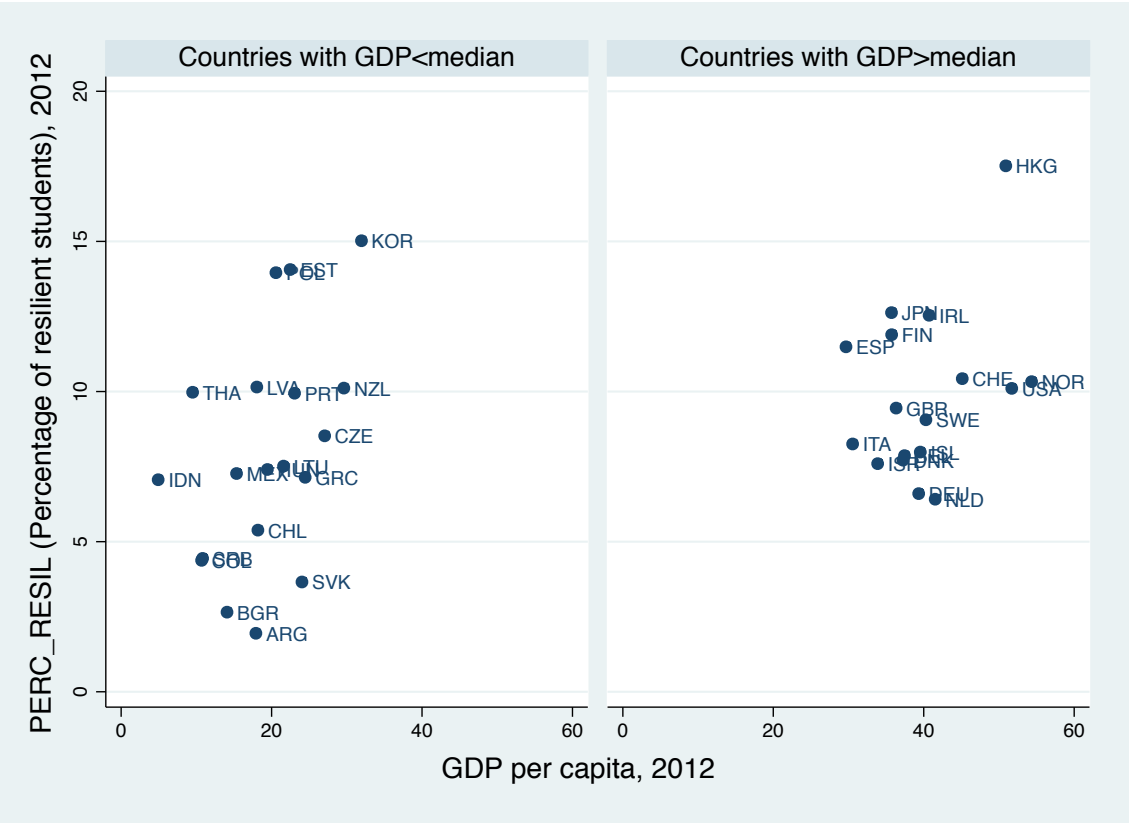


Panel B. Countries with GDPpc>median



Notes. The classification of GDP higher/lower than median is based on values for 2012; analogously, the proportion of resilient students is calculated for the PISA edition of the corresponding year (OECD-PISA 2012).
Sources: authors' elaborations on IMF data, following the methodology illustrated in section 2.

Figure 2. The relationship between PERC_RESIL and GDP, 2012

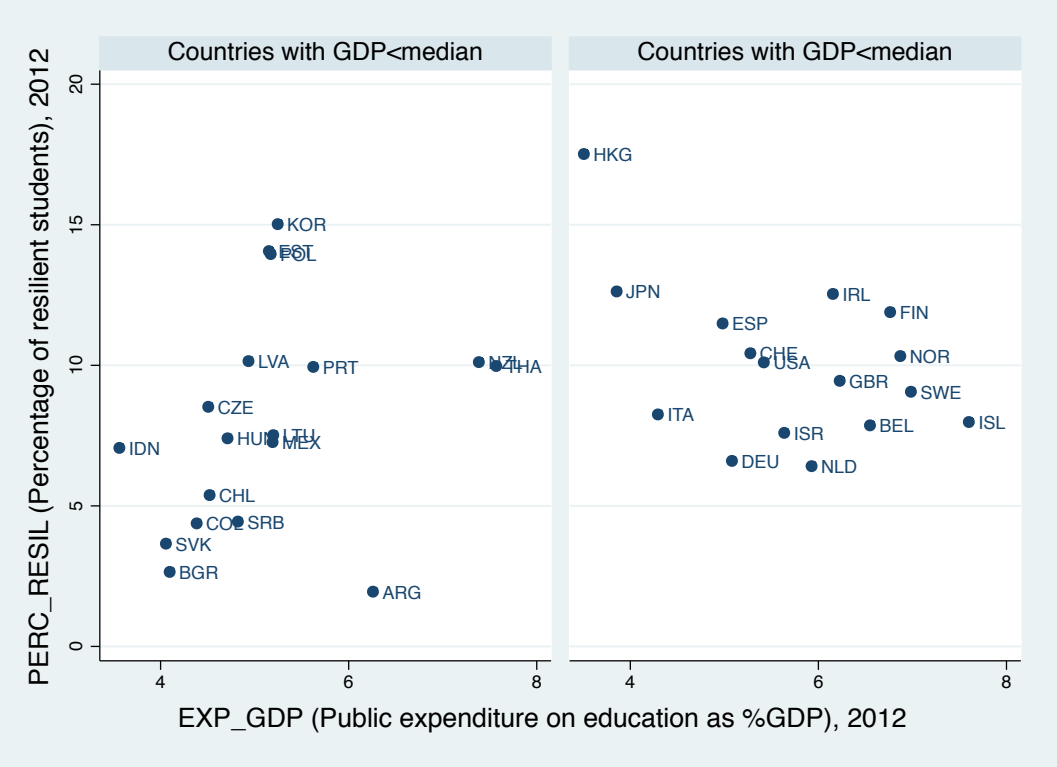


Notes. The classification of GDP higher/lower than median is based on values for 2012; analogously, the proportion of resilient students is calculated for the PISA edition of the corresponding year (OECD-PISA 2012). GDP per capita is expressed in dollars ($), Purchasing Power Parity (PPP).

Sources: authors' elaborations on IMF data, following the methodology illustrated in section 2.

Figure 3. The relationship between PERC_RESIL and economic investments (public expenditures) on education, 2012

Panel A. PERC_RESIL and EXP_GDP (public expenditure as %GDP), 2012



Panel B. PERC_RESIL and EXP_GOV (public expenditure as % public expenditure), 2012