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SOCIO-ECONOMIC FACTORS FOR READING PERFORMANCE IN PIRLS: INCOME INEQUALITY AND SEGREGATION BY ACHIEVEMENTS

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SOCIO-ECONOMIC FACTORS FOR READING PERFORMANCE IN PIRLS: INCOME INEQUALITY AND SEGREGATION BY ACHIEVEMENTS[3]

This study examines the relationship between family and school characteristics, and student reading performance; and how these vary across countries with different levels of economic inequality and stratification. Economic inequality is measured with the Gini index and stratification by the distribution of students by reading achievements. Reading tests and questionnaire responses of 190,456 fourth-graders, their parents and 6,987 school administrators in 41 countries were analysed using multilevel analyses. Students with lack of early home literacy activities have better test scores in schools with higher average socioeconomic status (SES), and reading scores in countries with a high level of economic inequality. The higher the stratification level, the better student reading achievements, despite the stratification measure indicating the inequality of their distribution among schools.

JEL Classification: I24.

Keywords: educational achievements, inequality, peer effects, PIRLS, school resources, segregation, socio-economic status.

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Introduction

Researchers outline different factors for the inequality of educational achievement at individual, school and country levels. The influence of socioeconomic status (SES) on children's success at school is widely accepted: children whose parents have a higher SES and provide them with necessary educational resources perform better at school [Chudgar and Luschei, 2009]. A supportive home environment positively affects educational achievements [Trong and Kennedy, 2006; Lam and Cheung, 2009]. On the school level, average SES and average academic performance appear to be significantly linked [Hanushek, Kain, Markman, Rivkin, 2003; Zimmer and Toma, 2000]. On the country level, a positive effect of economic well-being is usually revealed [Baye, Monseur, 2006; Woesmann, 2003].

Many studies show that stratification in education on the school and class level [Loveless, 1998] and education system level [Horn, 2009; Hanushek and Woessmann, 2006] significantly affects educational achievements. However, there are no studies dedicated to the relationship between family and school characteristics, and achievements in educational systems with different levels of stratification. This work studies the influence of family, school, and country level inequality on educational achievements.

I. Literature review

Inequality on the family level

Family SES influences children's achievements at all stages of education [Lucas, 2001]. The higher the SES, the better the results at school. However, a high SES is not sufficient for high educational achievement, since the home educational environment is also important. Lam and Cheung [2009] reveal a positive link between fourth-graders' reading achievements and their early involvement in activities developing literacy, for instance, reading books, telling stories, singing songs, playing with alphabet toys, or reading signs and notes aloud. Educational resources available at home such as a computer or a special room for studying also affect children's reading achievements [ibid]. Another key element of the home environment is parental attitude to reading, i.e. whether they read books in their free time, why they read them, and whether they consider reading an important home activity [Lam et al., 2009]. Favourable attitudes towards reading positively correlate with children's reading performance [Trong et al., 2006].

Inequality on the school level

Educational systems display differences both between and within schools, which also affect inequality in educational achievements. Coleman [1968] conducted the Equality of Educational Opportunity Study in the USA from 1962 to 1964[4]. It demonstrates that students from the same school but of different background differ much more in performance than an "average student" in different schools. Some interpreted this to mean school resources do not impact children's performance [Sorensen, 2012; Hanushek, 1997, 1998]. Here school resources stand mainly for classroom resources (teacher's education and experience, and the pupil-teacher ratio), financial resources (expenses per student and teacher salaries). A meta-analysis of 400 studies of American pupils' performance showed that "there is no strong or consistent relationship between school resources and student performance" [Hanushek, 1997: 148].

Peer performance and SES influence academic progress. For instance, Hanushek et al. analysed data on primary schools in Texas, USA, revealing that better average peer performance leads to better performance of other students [Hanushek et al., 2003]. Zimmer and Toma used data on Belgium, USA, Canada, New Zealand, and France to show that the effect of average performance is greater in relation to children with low skills [Zimmer and Toma, 2000]. Moreover, according to their research results, the higher the peer SES, the better student's performance [ibid].

From our point of view, the most plausible explanation of the peer effect on achievement is that peers communicate with each other throughout the learning process and are an important source of motivation for each other [Hanushek et al., 2003]. They influence the learning process and the pace of instruction by asking and answering questions or by impeding learning through destructive behaviour [ibid].

Inequality at the country level

One of the important characteristics of education systems relevant to achievements is their level of stratification. It implies the number of school types between which a pupil may choose at the moment of transferring from one educational stage to another and the age of this transition. For instance, the German education system is highly stratified: pupils must choose one of five school types at the age of ten. The Swedish system maintains a low level of stratification: all children attend school of same type up to the age of sixteen [Pfeffer, 2008].

[4] Known as Coleman Report.

A high level of stratification extends achievement inequality according to several studies. Horn [2009] demonstrates that early distribution of pupils among different types of schools increases the correlation between children's SES and achievements. Hanushek and Woessmann, [2006: 75] using PISA[5] and PIRLS data, show that "early tracking increases inequality in achievement".

Apart from stratification**,** macroeconomic indicators can be used as factors predicting educational achievements: GDP [Baye et al., 2006] or GDP per capita [Woessman, 2003]. Studies demonstrate that a country's higher economic well-being reduces the level of achievement inequality [Baye et al., 2006]. According to Woessmann [2003], GDP per capita is positively related to TIMSS average scores[6]. He also points out that greater financial expenditure per pupil at the country level and smaller class size increase progress in mathematics [Woessmann, 2003].

Interaction between family, school, and country effects, and inequality

A large number of studies are dedicated to the mutual influence of factors at different levels on inequality in educational achievement.

Family effects on child performance in various subjects appear to be different depending on school characteristics. According to Coleman [1987], regardless of quality, education in an American school is more effective for students with a higher family SES because of the interactive effect between school and family educational resources. In other words, parents that are mostly focused on a better career and higher income are ready to support schools by paying taxes or tuition fees [Coleman, 1987]. On the other hand, schools that possess equally distributed resources[7] are able to decrease the advantages of pupils with high SES [Chiu and Khoo, 2005]. Such a trend can be observed in countries with unequal income distribution. And vice versa, if school resources are biased towards wealthier students in a country with unequal income distribution, then schools will further disadvantage children with a low SES [ibid]. Chiu and Khoo [2005] describe it as the "privileged student bias".

[5] PISA (Program for International Student Assessment) is an international programme for evaluation of school performance used to assess 15-year-old pupils' literacy and ability to apply their knowledge in mathematics, reading, and natural sciences. It is carried out by the Organisation for Economic Cooperation and Development (OECD).

[6] TIMSS (Trends in Mathematics and Science Study) is an international comparative study of fourth-graders' and eighth-graders' achievements in mathematics and natural sciences. It is conducted every four years by the International Association for the Evaluation of Educational Achievement.

[7] Here school resources stand for the number of hours per week spent on mathematics, native language, or natural sciences; the share of certified teachers in a school; the share of teachers of mathematics, native language, or natural sciences who have a university degree in a school; and the level of scarcity of teachers and teaching materials.

The country level of economic well-being affects the interrelation between family characteristics and pupils' achievements. Research by Park [2008] shows that the effect produced by early home literacy activities on reading achievements is the strongest in countries with a high level of economic development. Chiu [2007] achieved similar results explaining them by the "complementary intangibles hypothesis": "the widespread availability of physical resources (such as public libraries and museums) might increase the value of less tangible resources (such as parent time and attention). For example, a child benefits from reading an extra book, but that benefit can be substantially magnified by discussing the book with a parent. Thus, parental involvement and other intangible family resources might be more strongly linked to academic outcomes in richer countries" [Chiu, 2007: 511]. Students from countries with more equal income distribution achieve better results in natural sciences. Chiu explains this effect by arguing that children from poor families have more resources in countries with equal income distribution. As a result, their achievements increase. Another explanation implies homophily, that is, a more equal income distribution contributes to closer interactions between schoolchildren. These interactions, in turn, result in greater educational achievements [ibid].

II. Our research

Family characteristics affect achievements in different ways depending on schools and countries. Little attention has been given to the effect of interrelation between education system, family and school characteristics. Education system characteristics means the level of stratification. The goal of this work is to analyse the relations between family and school characteristics and student reading performance and how these relations differ across countries with different levels of economic inequality and stratification. This research answers two questions. First, what is the mediating role of schools in the relationship between family characteristics and reading performance? The following hypotheses will be therefore tested:

1.1. the higher the level of school resources, the higher the students' achievements, regardless of family resources;

1.2. the better the school environment based on peers' characteristics (average test score and SES), the higher the students' achievements, regardless of family resources. In other words, it is assumed that a school is capable of compensating for the lack of family resources.

The second question is whether schools' capacity to influence relations between family characteristics and reading achievements varies depending on the level of economic inequality in

a country and the level of stratification in the educational system. The following hypotheses will be therefore tested:

2.1. the higher the level of economic inequality in the country, the more school and family characteristics increase students' reading progress;

2.2. the higher the level of stratification in an educational system, the more school and family characteristics increase students' reading progress.

Data and methods

We use PIRLS 2006 data in our research. PIRLS is a comparative study conducted on a regular basis by the International Association for the Evaluation of Educational Achievement in more than 40 countries and regions[8]. PIRLS involves reading tests and questionnaires for fourth-graders: students answer questions regarding their situation at school and at home, while parents and teachers provide information about the child's development, their own role in the child's education and upbringing and the school environment. School executives answer the questions regarding school organisation and enrolment. PIRLS data have the following structure: one fourth grade was selected from every school. Students are grouped by schools which are grouped by countries. Hence, there are variables on the individual, school, and country levels. Data on 190,456 fourth-graders in 6,987 schools in 41 countries are used in current study.

Variables

Reading scores. The most important variable extracted from the PIRLS database is reading scores, the dependent variable in the analysis. There are five estimates for each pupil's reading score (plausible values[9]), which were taken into account during data analysis. Using HLM software, each model was estimated separately for each plausible value and a model with averaged effect and correctly estimated standard errors was automatically measured. The reading score values vary between 5 and 813.

Early home literacy activities. Early home literacy activities (such as reading books, telling stories, singing songs, etc.) are measured with an ordinal variable in PIRLS: low (3); medium (2); high (1). For the sake of convenience, this was recoded into three binary variables:

[8] Data on England, Scotland, and the USA are not analysed in thus study since they have more than 50% missing data on the variables reflecting child's socioeconomic status. Data on Luxembourg are not analyzed since they have 100% missing data on the variables representing school resources.

[9] The test completed by each student contains only a part of the whole international set of tasks. Therefore, assigning an individual reading score is complicated. That is why reading scores are measured as "plausible values". A special psychometric scaling technique is used, i.e. scaling based on the item response theory with preconditioning and multiple imputation enabling to measure scores that students could receive if they completed all of the tasks.

"few parent-child activities", "medium parent-child activities" and "many parent-child activities".

SES. There is a whole range of methods of measuring SES [Baye et al., 2006; Park, 2008; Myrberg and Rosen, 2008]. We apply an internationally accepted SES measure which reflects the child's socioeconomic position, i.e. an index designed according to Van Damme and co-authors [Van Damme, Vanhee, and Pustjens, 2008]. The first benefit of this method is that the index allows us to make valid comparisons between countries. The second benefit is that it allows us to work with the minimum number of different variables measuring various aspects of SES without losing relevant information.

The variable measuring SES was constructed as an index using the principal component analysis. The following variables from PIRLS database compose the index: the number of books at home[10], home educational aids[11], parental occupation level (for a parent with the higher level)[12], and parental education level (for a parent with the higher level)[13]. The values of the standardised SES variable vary between -2.99 and 1.7.

Due to the fact that all student-level independent variables are measured with different scales, SES is centred around the school mean to enable the interpretation of results and the comparison of variable effects.

School resources. Based on studies covering the effect of school resources, two variables have been introduced: "Factor 1: material resources and teaching staff", "Factor 2: equipment". Although many studies underline that school resources play a minor role in student achievements [Coleman 1968; Hanushek 1997, 1998; Sorensen 2012], this variable is included in the analysis as other works show that resources produce an effect on performance in combination with country-level variables [Chiu et al., 2005].

We conducted a factor analysis of fourteen variables from the PIRLS base measuring the level of each of the resources. Two factors were extracted via principal component analysis. Variables related to material resources and teaching staff load mostly on Factor 1. All the other variables load on the second factor, for example computers for instructional purposes and special equipment for physically disabled students. The "Library books" component was excluded at the

[10] Coded 1: 0-10, 2: 11-25, 3: 26-100, 4: 101-200; 5: more than 200.
[11] This variable is the sum of four binary variables: availability of a pc at home, own study desk, own books, and daily newspaper at home. It ranges from 1 to 4.
[12] Coded 1: never worked outside home for pay; 2: general worker 3: skilled worker; 4: clerical, 5: small business owner; 6: professional.
[13] Coded 1: some primary, lower-secondary or no schooling; 2: finished lower-secondary education; 3: finished upper-secondary education; 4: finished post-secondary but not university; 5: finished university or higher.

final stage of analysis because it loaded on both factors equally. The final rotated component matrix is shown in Table 1. The values of the extracted variables vary from -2 to 3.

Average SES and reading score. The last group of school-level variables enables us to measure the influence of the school environment on pupils' achievements based on peer characteristics. It includes the "Average SES" (in each school) and "Average reading score" (in each school). Both variables are interval.

As all school-level independent variables are measured with different scales, they are all centred around the country mean to enable the interpretation of results and the comparison of variable effects.

The Gini index. The economic aspect of inequality is represented by the interval variable "the Gini index", which shows the country's equality in income distribution. The Gini index is equal to zero in case of totally equal income distribution, up to100.

Segregation index. The inequality in terms of educational system structure is measured as the level of segregation within an education system, that is "the measure of inequality in distribution of individual characteristics among organisational units" [Gorard and Taylor, 2002: 876]. It allows us to assess how disproportionately pupils with higher or lower achievements are distributed among schools. In a broader sense, this term is a synonym of stratification and social mobility [Gorard et al., 2002].

The segregation index is used as a measure of inequality in an educational system [Gorard and Smith, 2004]. One of the benefits of this measure is that it can be constructed independently for each PIRLS-rated country, including Canadian provinces. The higher the value of this index, the higher the level of segregation in a country or a region.

$$S = 0.5 \times \sum \left| \left(\frac{A_i}{X}\right) - \left(\frac{C_i}{Z}\right) \right| \quad (1)$$

Formula 1 is for the segregation index of an individual country [Gorard et al., 2004: 20], where A_i is the number of fourth-graders in a specific school who scored less than 400 points in the reading test, which is below the Low International Benchmark[14]. X is the nation's total number of fourth-graders who scored less than 400 points; C_i is the total number of fourth-graders in the school; Z is the number of surveyed children in the country. The segregation index

[14] The Low International Benchmark is 400, the Intermediate International Benchmark is 475, the High International Benchmark is 550, and the Advanced International Benchmark is 625.

is an interval variable which varies between 0,09 in Qatar and Kuwait and 0,95 in the Netherlands[15].

Analysis

A three-level linear regression analysis was used in this study because of the three-level structure of the data (student, school, and country levels).

Each three-level linear regression is defined as follows with pupil's reading score as the dependent variable in each model:

$$\begin{aligned}\text{reading score}_{ijk} &= \gamma_{000} + \gamma_{001}*W_k + \gamma_{010}*Z_{jk} + \gamma_{011}*Z_{jk}*W_k + \\ &\gamma_{100}*X_{ijk} + \gamma_{101}*X_{ijk}*W_k + \gamma_{110}*X_{ijk}*Z_{jk} + \gamma_{111}*X_{ijk}*Z_{jk}*W_k + r_{0jk} + r_{1jk}*X_{ijk} + u_{00k} + \\ &+u_{01k}*Z_{jk} + u_{10k}*X_{ijk} + u_{11k}*X_{ijk}*Z_{jk} + e_{ijk,}\end{aligned} \quad (2)$$

where γ_{000} is the average student's reading score; γ_{001} is the coefficient for the country level variable *W*; γ_{010} is the coefficient for the school level variable *Z*; γ_{011} is the coefficient for the interaction effect between country and school level variables; γ_{100} is coefficient for the individual level variable *X;* γ_{101} is the coefficient for the interaction effect between individual and country level variables; γ_{110} is the coefficient for the interaction effect between individual and school level variables; γ_{111} is the coefficient for the interaction effect between individual, school and country level variables; r_{0jk} is the deviation of school *j* from average score in country *k;* u_{00k} is the deviation from the country average; e_{ijk} is the deviation of student *i* from school *j* from average score in country *k.*

The relationship between explanatory variables and achievements are considered to be different for different students, schools and countries. Therefore, slopes were modelled as multiplications of the explanatory variables by the residuals of the corresponding level. For instance, the individual level slope is modelled as the multiplication of the explanatory variable *X* and school level residual r_{1jk}. Moreover, intercepts are allowed to vary between schools and countries. That is, models are fit as random coefficient models. There are several reasons for that. Firstly, it is assumed that the complete school and country structures cannot be represented by the explanatory variables. "Additional effects of the nesting structure can be represented by letting the regression coefficients vary from group to group" [Snijders and Bosker, 2012, p. 44].

[15] Data necessary for index calculation were weighed by TOTWGT (ensures that the various subgroups that constitute the sample are properly and proportionally represented in the computation of population estimates, and that the sample size will be inflated to approximate the size of the population).

Secondly, schools are regarded as samples from country populations and the general research goal is to draw conclusions referring to these populations. According to Snijders et al. [2012], random coefficient models are appropriate in such case.

Since PIRLS has a complicated sampling design, data were weighted during the analysis. Following Rutkowski et al. [2010] school level weights were calculated by formula 3:

$$wgtfac1^{*}\ wgtadj1 \tag{3}$$

where *wgtfac1* is the school weight factor, and *wgtadj1* is the school weight adjustment.
Student level weights were calculated by formula 4:

$$(wgtfac2^{*}\ wgtadj2)^{*}(wgtfac3^{*}wgtadj3) \tag{4}$$

where *wgtfac2* is the class weight factor, *wgtadj2* is the class weight adjustment, *wgtfac3* is the student weight factor, and *wgtadj3* is the student weight adjustment.

The weight factor is defined as "the inverse of the probability of selection for the relevant unit (school, class, or student) [Rutkowski et al., 2010: 145]. Weight adjustment is "nonresponse adjustment for units that were sampled but did not participate" [ibid].

In cases when the Gini index is applied as an independent variable at the third level, the data on countries and regions for which the Gini index is not measured are not analysed. That is, four Canadian provinces (Alberta, British Columbia, Nova Scotia, and Toronto), French-speaking part of Belgium, Taipei (China), Qatar, Kuwait, and Trinidad and Tobago.

Results

In order to test the hypothesis that school resources increase a child's achievement regardless of family resources, a range of models with variables measuring school-level resources were estimated. The effects of both the "Factor 1: material resources and teaching staff" and "Factor 2: equipment" were examined. Model 1 allows us to conclude that the availability of computers and special equipment does not affect student reading performance, either separately or when controlled for by family's SES centred around the school mean (see Table 1). The effect of "Factor 2: equipment" and its interactive effect with student's SES in

Model 2 were not significant. These effects refute the thesis that school resources do not influence student performance (see Table 1).

To test the hypothesis that the school environment based on peer characteristics positively affects student performance regardless of family resources, the “Average SES” at the second level and variables measuring early home literacy activities were included in the models. Model 3 shows that there is a positive effect of Average SES at school on individual achievements when controlled for by the variable “few parent-child activities” (see Table 1). This confirms the hypothesis: high average peer SES compensates for a lack of parent-child activities.

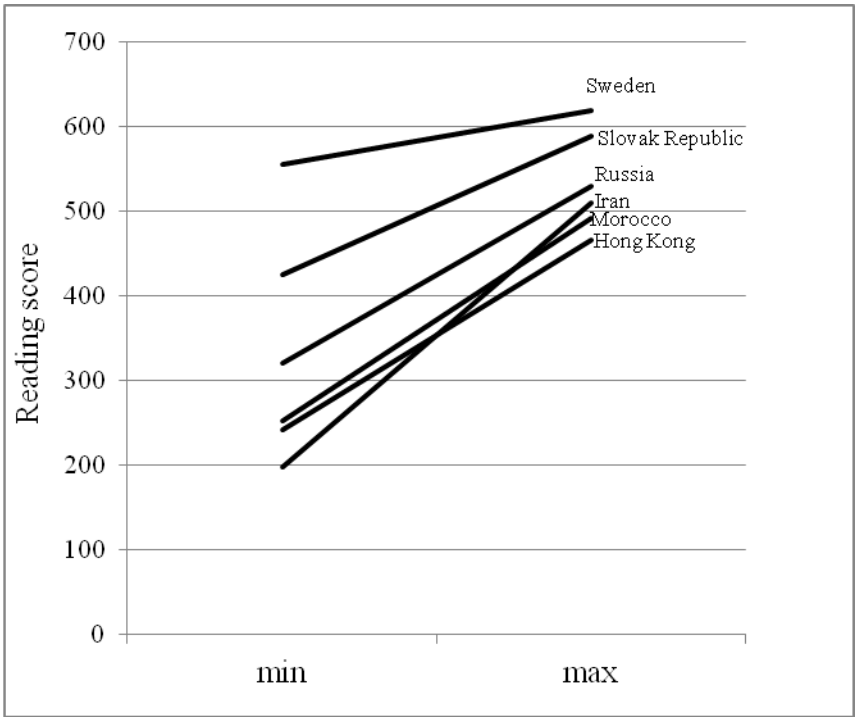
Model 4 (see Table 2) was set up to test the hypothesis regarding the relationship between family and school characteristics, and the level of income distribution inequality in a country. The "few parent-child activities" variable was applied as an independent individual-level variable. Children who were engaged in few activities with their parents before entering school receive 28,6 points less than other students on average. Moreover, there is a negative effect produced by the Gini index on educational achievements (coefficient -6.7) which is partly compensated for by the positive interactive effect of the average school SES and the Gini index (coefficient 2.06). This means that a student in a school with a higher average SES will show better test results on average even in a country with a high Gini index. The graph (see Fig. 1) shows that in countries with a high Gini index (such as Hong Kong, Iran, or Morocco) the average SES in a school produces a much greater effect on reading performance than in countries with a low Gini index (such as Slovakia or Sweden).

To further test the hypothesis about the relationship between family and school characteristics, and the level of income distribution inequality in a country, we developed models with another indicator of the school environment quality, i.e. average reading score. Model 5 (see Table 2) demonstrates that the Gini index effect is negative: the greater inequality of income distribution in a country, the worse student test results (if the index were to increase by 1, children would get 6.8 points less in the test on average). However, schools are able to improve these results: a positive interactive effect tells us that a student in a school with a higher average reading score has better test results even if there is high income inequality. Moreover, we observed a positive interactive effect between the average school score and the "few parent-child activities" variable: if the school score is one point above the national average, a child who was engaged in few reading activities with their parents will get a 0.34-point higher score on average. Thus it can be argued that average score is a component of the school environment, which is able to compensate for a lack of family resources, but to a lesser extent than average SES.

The effect of the Gini index in Model 6 (see Table 2) is also negative. The interactive effects of the Gini index with student's SES and school average reading score are significant. The first is negative (in a country with a high Gini index SES decreases student's reading score), while the second is positive, but rather small. There is a negative interactive effect of the average reading score at school and student's SES, which means that in schools with a low average reading score children with a high SES handle the test better.

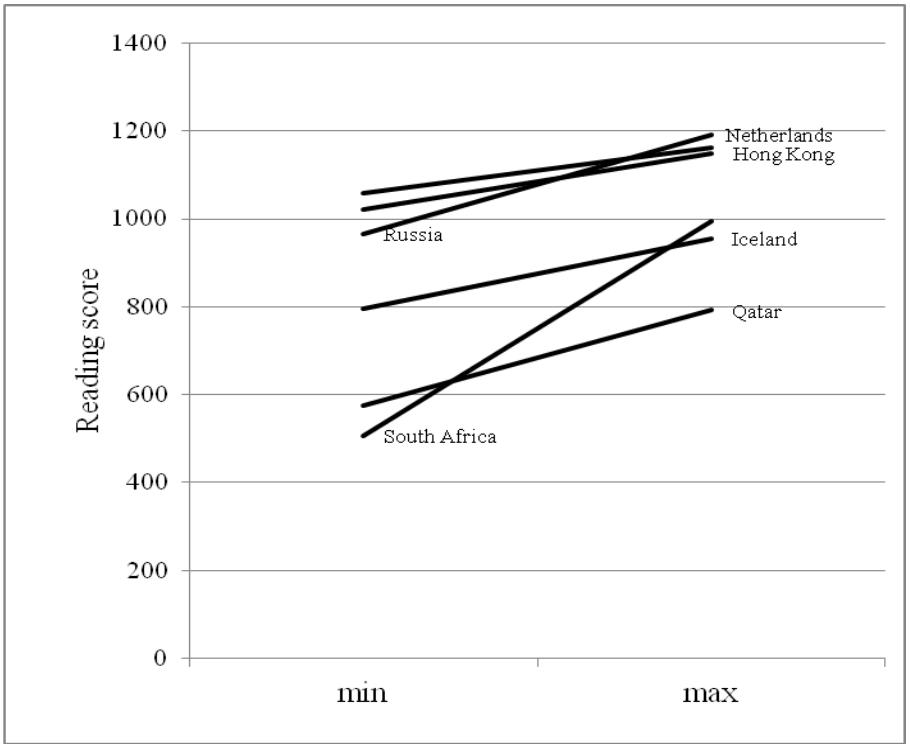
The segregation index increases student reading achievements although it indicates the inequality of children's distribution among schools by their achievements. Interactive effects with the segregation index were significant in very few cases. Model 7 (see Table 3) shows that in countries with a high segregation level a student with higher SES scores 15,8 higher on average. According to Model 8 (see Table 3), the average reading score at a school exerts a negative effect on achievements in countries with a higher level of segregation as demonstrated in Fig.2. A lack of home literacy activities also lowers the reading test scores of children in countries with a higher segregation level (a student will score 11,7 points less on average if the segregation level increases by 1).

Fig. 1. The association between SES on school level and individual achievement adjusted for the Gini coefficient on country level



The graph shows that in countries with a high Gini index (such as Hong Kong, Iran, or Morocco) the average SES in a school produces a much greater effect on individual reading performance than in countries with a low Gini index (such as Slovak Republic or Sweden).

Fig. 2. The association between average reading score on school level and individual achievement adjusted for few parent-child activities and the segregation index on country level



The graph shows that countries with a high segregation index (such as Netherlands, Hong Kong, Russia) are also high achievers. The average reading score in a school produces the greatest effect on individual reading performance in South Africa, a country with very low achievement level.

Tab. 1. Interrelation between school- and individual level variables

	Model 1				Model 2				Model 3			
Fixed effects	*B*	*p*	*SE*	*t*	*B*	*p*	*SE*	*t*	*B*	*p*	*SE*	*t*
Intercept	454,8	<0,001	23,7	19,2	454,6	<0,001	24	19	463	<0,001	25,1	18,4
Country level												
School level												
Factor 1: material resources and teaching staff					0,9	0,85	4,6	0,2				
Factor 2: equipment	1,4	0,7	4,2	0,3								
Average SES									**59,9**	<0,001	4,2	14,6
Individual level												
SES	**18,3**	<0,001	2,6	7	**18,2**	<0,001	2,6	6,9				
Few parent-child activities									**-17,8**	<0,001	1,3	-13,7
Interactive effect (Factor 1*SES)					1,7	0,1	1	1,7				
Interactive effect (Factor 2*SES)	-0,6	0,4	0,6	-0,9								
Interactive effect (Average SES * Few parent-child activities)									-2,2	0,31	2,1	-1
Deviance	1808862				1808677				1912197			
Number of estimated parameters	18				18				18			

$N_1 = 161247$; $N_2 = 5882$; $N_3 = 40$

Tab. 2. Three-level models with Gini index

	Model 4				Model 5				Model 6			
Fixed effects	*B*	*p*	*SE*	*t*	*B*	*p*	*SE*	*t*	*B*	*p*	*SE*	*t*
Intercept	719,5	<0,001	43,2	16,65	722,27	<0,001	44,16	16,36	721,8	<0,001	46	15,7
Country level												
Gini index	**-6,7**	<0,001	1,45	-4,55	**-6,8**	<0,001	1,49	-4,55	**-6,8**	<0,001	0,02	-4,4
School level												
Average SES	-21,64	0,317	21,26	-1,018								
Average reading score					**0,87**	<0,001	0,02	50,64	**0,93**	<0,001	0,02	52,3
Individual level												
SES									**45,2**	<0,001	5,25	8,6
Few parent-child activities	**-28,6**	<0,001	6,8	-4,2	**-27,52**	<0,001	6,92	-3,98				
Interactive effect (school*student)	18,1	0,22	14,5	1,25	**0,34**	<0,001	0,08	4,1	**-0,2**	0,05	0,09	-2
Interactive effect (school *country)	**2,06**	0,001	0,6	3,6	**0,002**	<0,001	0	6,09	**0,001**	0,001	0,1	3,5
Interactive effect (country*student)	0,3	0,13	0,19	1,57	0,33	0,104	0,19	1,68	**-0,7**	<0,001	0,1	-4,6
Interactive effect (country*school*student)	-0,49	0,13	0,39	-1,26	**-0,008**	<0,001	0,002	-4,21	**0,004**	0,05	0,002	2
Deviance	1106002,08				1092977				10921695			
Number of estimated parameters	22				22				22			

$N_1 = 98643$; $N_2 = 4447$; $N_3 = 32$

Tab. 3. Three-level models with segregation index

Fixed effects	Model 7				Model 8			
	B	*p*	*SE*	*t*	*B*	*p*	*SE*	*t*
Intercept	334	<0,001	11,4	29,2	344,7	<0,001	12	28,6
Country level								
Segregation index	**276,3**	<0,001	26,8	10,3	**275**	<0,001	24,8	11,1
School level								
Average reading score					**1**	<0,001	0,008	119,7
Individual level								
SES	**11,5**	0,004	3,8	3				
Few parent-child activities					**-9,9**	<0,001	2,1	-4,6
Interactive effect (school*student)					-0,04	0,26	0,04	-1,2
Interactive effect (school *country)					**-0,04**	0,02	0,02	-2,5
Interactive effect (country*student)	**15,8**	0,046	7,7	2,1	**-11,7**	0,004	3,9	-3
Interactive effect (country*school*student)					0,12	0,09	0,07	1,7
Deviance	2137694				1837018			
Number of estimated parameters	11				22			

$N_1 = 190456$; $N_2 = 6987$; $N_3 = 41$

III. Discussion

We find that such components of school environment as average SES and average reading score influence student reading achievements. A higher average peer SES compensates for a lack of home literacy activities with parents. A higher average school reading score is also capable of making up for this shortcoming, but to a lesser extent. The effect of the school environment might be explained by the fact that peers communicate with each other during the learning process and motivate each other. They are also able to affect the learning process and instruction pace by asking and answering questions [Hanushek et al., 2003].

The ability of schools to compensate for a lack of family resources varies depending on the level of inequality in income distribution in a country. A student from a school with a high average SES or a high average reading score will perform better in a reading test taking place in a country with a high Gini index. Chudgar et al. [2009] drew similar conclusions from their research on fourth-grader achievements in mathematics. According to them, school effects on fourth-grader performance in mathematics are stronger than family effects in countries with a high Gini index. Chiu [2007] explains this effect by arguing that a high level of income inequality might increase the poverty level of children from low-SES families. As a result, the availability of school resources might have a significant positive impact on poor children's achievements.

School resources do not affect fourth-grader reading achievements. The availability of qualified staff and material resources do not influence the achievements when controlled for by student SES. These findings support the research conducted by Coleman [1968], Hanushek [1997, 1998], Sorensen [2012]. The availability of computers for instructional purposes and special equipment for physically disabled students is also insignificant. This result is in line with Fuchs and Woessmann [2004] on the basis of PISA data: the availability and usage of computers at school do not have a significant impact on success in reading. The authors suggest that the availability of computers might distract students from effective learning. Computer usage might raise the corresponding skills, but only at the expense of other skills [ibid].

Country level effects merit special attention. The higher the Gini index, the lower the student reading scores. A similar finding was pointed out by Chiu [2007]: children from countries with more equally distributed income achieve higher results in natural sciences. Chiu explains this effect by arguing that children from poor families have more resources in countries with more equal income distribution. As a result, their achievements increase. Another explanation implies homophily, that is, a more equal income distribution contributes to closer

interactions between schoolchildren. These interactions, in turn, result in greater educational achievements [ibid].

As for segregation, it increases student reading achievements despite indicating the inequality of the distribution of children among schools by their achievements. Interactive effects with the segregation index were significant in very few cases: in countries with a high segregation level a student with higher SES performs better in the reading test on average. A lack of home literacy activities, on the contrary, lowers reading test scores of children in countries with a higher segregation level. The average reading score at school negatively affects achievements in countries with a higher level of segregation.

Most probably, this result is connected with the fact that the segregation index's value depends directly on the share of students who scored below 400 points in the reading test. For example, 69% pupils in 100% schools of Qatar received scores below 400 comparing to 0,4% pupils in 4% schools of the Netherlands. In other words, the fewer the schools with low-scoring pupils in a country, the higher the segregation level. In such countries as Qatar the majority performed poorly in the test and are more evenly spread across the schools. Accordingly, the segregation level is lower.

The findings could be interpreted as follows: the better a country performs in the reading test, the more important the role played by home literacy activities with parents and student SES.

Endogeneity might be a limitation of the research. That is, explanatory variables applied in the analysis and the dependent variable "Reading score" might correlate with other undefined variables. As a result, the effects of predictors on achievements might become inflated. One of the possible solutions could be the introduction of a randomized instrumental variable which affects predictors, but has no impact on reading scores. However, this approach is inapplicable in current study due to application of secondary data.

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Appendix

Tab. 1. Factor loadings of school resources (rotated component matrix)

	Factor 1. Material resources and teaching staff	**Factor 2. Computers and special equipment**
Instructional space (e.g., classrooms)	**0,808**	
Instructional materials (e.g., textbooks)	**0,802**	
Qualified teaching staff	**0,801**	
School buildings and grounds	**0,765**	
Supplies (e.g., papers, pencils)	**0,753**	
Heating/cooling and lighting systems	**0,732**	0,341
Teachers with a specialization in reading	**0,607**	
Second language teachers	**0,521**	
Computer software for instructional purposes		**0,888**
Computers for instructional purposes		**0,834**
Computer support staff		**0,806**
Audio-visual resources	0,362	**0,759**
Special equipment for physically disabled students		**0,511**

Tab. 2. Country list

Country	Gini index	Segregation index
Alberta (Canada)	32,1	0,84
Austria	25	0,67
Belgium (Flemish)	28	0,47
Belgium (French)	28	0,88
British Columbia (Canada)	32,1	0,78
Bulgaria	29,8	0,65
Chinese Taipei	41,5	0,53
Denmark	29	0,58
France	32,7	0,56
Georgia	40,8	0,41
Germany	27	0,87
Hong Kong	53,3	0,82
Hungary	28	0,75
Iceland	28	0,18
Indonesia	39,4	0,25
Iran	44,5	0,27
Israel	39,2	0,57
Italy	32	0,77
Kuwait	-	0,09
Latvia	36	0,8
Lithuania	36	0,81
Macedonia	39	0,39
Moldova	33,2	0,45
Morocco	40,9	0,14
Netherlands	30,9	0,95
New Zealand	36,2	0,52
Norway	25	0,41
Nova Scotia (Canada)	32,1	0,52
Ontario (Canada)	32,1	0,71
Poland	34,9	0,44
Qatar	-	0,09
Quebec (Canada)	32,1	0,72
Romania	32	0,44
Russian Federation	42,2	0,89
Singapore	48,1	0,6
Slovak Republic	26	0,63
Slovenia	28,4	0,44
South Africa	65	0,15
Spain	32	0,55
Sweden	23	0,67
Trinidad and Tobago	-	0,31

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