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Born With a Silver Spoon

Inequality in Educational Achievement across the World

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Abstract

This paper assesses inequality of opportunity in educational achievement using the Human Opportunity Index methodology on data from the Programme for International Student Assessment. The findings suggest that there are large inequalities in learning outcomes as measured by demonstrated proficiency in Programme for International Student Assessment test scores in math, reading, and science. Differences in wealth, parental education, and area of residence explain a bulk of this inequality in most of the countries in the sample. Consistent with what has been documented previously in the literature, the paper also finds a strong and stable correlation between inequality of opportunity and public spending on school education. An exploration of the changes in inequality of opportunity between the 2009 and 2012 rounds of the Programme for International Student Assessment, using parametric and nonparametric techniques, suggests that there has been little progress.

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Born With a Silver Spoon:
Inequality in Educational Achievement across the World

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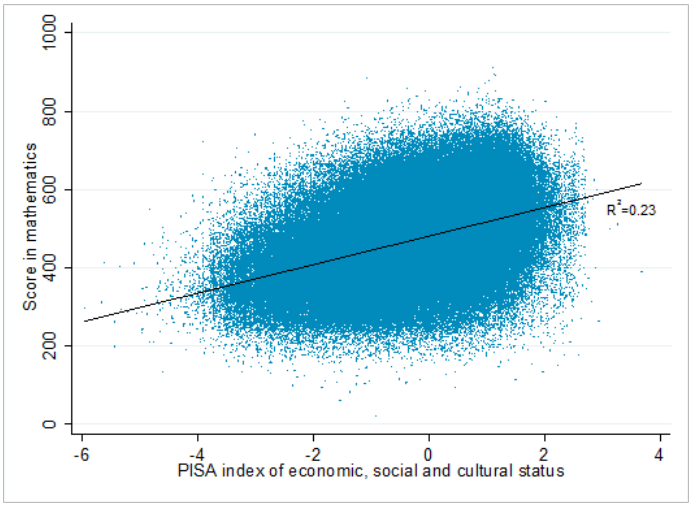
JEL Codes: D63, H52, I29, O50

Key words: Educational inequality, educational achievement, inequality of opportunity

1. Introduction

In this study we assess *inequality of opportunity* in educational achievement in countries that participated in the Programme for International Student Assessment (PISA) in 2012. Following Roemer's conceptual framework (Roemer, 1998), our fundamental premise is that educational outcomes should not depend on socially-inherited factors, such as gender, parents' education, wealth, and so on; and instead only depend on factors under the control of the individual, like the time or intensity of effort devoted to the pursuit of education. Inequalities derived from circumstances beyond the control of children are morally objectionable; individuals should be held responsible only for the level of effort they exert in comparison to those exerted by other individuals (Cohen, 1989; Dworkin, 1981; Roemer, 1998; Fleurbaey, 2008). Nonetheless, socioeconomic and cultural endowments do matter (Figure 1) and the extent to which they do is in some ways a measure of how unfair any given society is.

Figure 1. Students' socio-economic status and performance in mathematics



Note: The index of economic, social and cultural status was constructed on a basket of 13 household items: a dishwasher; a DVD player; number of cellular phones, televisions, computers, cars, rooms with a bath or shower; a room of their own (student); a computer that can be used for schoolwork; educational software; Internet; a desk; a quiet place to study; books to help with school work, technical reference books, dictionary, classic literature, books of poetry, works of art, and three country specific items. The index was computed by the OECD using weighted likelihood estimation; it has a mean of zero and a standard deviation of one for OECD countries as a whole.
Source: Authors' calculations based on data from the OECD, PISA 2012

There is increasing evidence that inequality in education during school years has lasting impacts into adulthood. Bedard and Ferrall (2003) and Blau and Kahn (2005) find suggestive evidence of a positive relationship between test scores and wage dispersion: high dispersion in test scores is followed by higher dispersion in wages later in the labor market. In the same vein, OECD (2013) shows that individuals scoring at the highest levels in literacy are almost three times as likely to enjoy higher wages and twice more likely to be employed than those scoring at the lowest levels. Furthermore, "individuals with lower proficiency in literacy are more likely than those with better

literacy skills to report poor health, to believe that they have little impact on political processes, and not to participate in associative or volunteer activities." (OECD, 2013)

Most studies on inequality of educational outcomes focus on assessing inequality in educational attainment by measuring the dispersion in years of schooling.[1] However, years of schooling is an imperfect measure for educational outcomes: what someone learns in any given country in grade 6, for example, is not comparable to what they would have learned at the same grade in another country. This is more problematic at higher levels of education, as enrollment into tertiary programs is highly endogenous to learning achievements.

To avoid the problems associated with using years of schooling, we use data from PISA to assess inequality of opportunity in educational achievement. PISA is an international student assessment that measures learning rather than mastery of specific school curricula for students roughly 15 years old. This allows us to compare students' academic achievement with a common benchmark. PISA also provides information on several socio-demographic characteristics of students, many of which are socially-inherited factors: gender, parent's education, economic, social and cultural status, etc.

Unlike others who have used the raw scores in the analysis for similar purposes (Ferreira and Gignoux, 2013), we construct a binary variable of proficiency using the cutoffs defined by the OECD. We choose *Level 2 proficiency* as our cutoff, which, according to the OECD is a baseline proficiency level at which students are able to demonstrate the skills that will enable them to *participate effectively and productively in life* (OECD, 2010a). Scoring at or above level 2 can be defined as an "opportunity", not only because it is a socially desirable minimum standard, but also because it is low enough to be either affordable by most societies already or in the near future given the available technology.[2]

How do we measure inequality of opportunity? We start from Roemer's (1998) distinction between "circumstances" and "effort". Circumstances are socially-inherited factors, thus exogenous to the individual. Effort is endogenous but may also depend on circumstances and other factors (parents who push their children to strive at school, for example). Hence, outcomes can be generally modeled in the following way:

$$y = f[X, E(X, v), u],$$

where y denotes the outcome variable, X denotes a vector of circumstances, E is a vector of effort variables that depends on circumstances and other unobservables (innate ability and motivation, for example), and u is a vector of other purely random factors. To measure inequality of opportunity would imply measuring the extent to which $F(y|X) \neq F(y)$.

Ferreira and Gignoux (2014) present a simple measure of inequality of opportunity, given by the ratio of the conditional and unconditional variances of scores. They apply this methodology to the context of inequality of educational opportunities using data from PISA 2006.

[1] For example: Thomas et al. (2001); Caestello y Domenech (2002), or Morrison and Murtin (2007).

[2] In the Republic of Korea 91% of the students score at/above the level 2 of proficiency in math, while in countries like Colombia, Peru and Indonesia, less than 30% of students do so. Similar results emerge for reading and science.

De Carvalho et al. (2012) use a methodology attributed to Checchi-Peragine (2005, 2010), which involves identifying subgroups of people (also called "types") defined by the socially-inherited factors and some partition of the distribution of test scores (tranches) such that inequality of opportunity arises whenever two individuals of different types belonging to the same tranche achieve different outcomes. A tranche is a given partition of the distribution of test scores –say the bottom (or top) $p\%$ or a certain range in the middle (e.g. $p\%$ to $(p + 10\%)$) – corresponding to each type. A key assumption behind this characterization is that individuals belonging to any type, who belong to a given tranche, have exerted the same effort conditional on the individual's type.[3]

The concept above can be illustrated with a simple example. Consider a world with two types, males and females, where the outcome (test scores) is partitioned into two tranches: top and bottom 50%, for each type. The assumption would be that a male who has a test score in the top 50% among males has exerted the same effort as a female whose test score is in the top 50% among females. In such case, inequality of opportunity arises if the average male score in the top 50% of male scores differs from the average female score in the top 50% of female scores.

The previous approaches have two main limitations. First, since they consider the entire distribution of the dependent variable, they do not directly capture the idea of *basic* opportunities in educational achievement. Second, and related to the first point, is the extent to which effort can be considered truly exogenous. The assumption that individuals in each tranche (or partition of the data) exert the same degree of effort implies that the level of effort is uncorrelated with individual circumstances.

The assumption of effort being uncorrelated with circumstances is arguably more problematic when we consider the entire score distribution rather than the attainment of basic proficiency. Thus by regarding test performance above a certain minimum level of proficiency (regardless of type) as the outcome of interest, our approach mitigates this concern to some degree. At the same time, a measure of inequality of opportunity based on the attainment of an absolute standard essentially ignores any inequality occurring among individuals who have met (or have fallen short of) this standard. In our case, if "opportunity" is defined by a dichotomous variable that takes the value of one if an individual achieves Level 2 proficiency (and zero if not), a measure of inequality of opportunity would necessarily ignore any inequality among individuals whose scores are above (or below) Level 2 proficiency. Having an absolute standard defining the opportunity is thus likely to understate the extent of inequality of opportunity, but focus attention on the inequality that exists in the attainment of that standard.

The Human Opportunity Index (HOI) methodology provides us with the appropriate framework to analyze inequality of opportunity with a dichotomous variable (attainment of Level 2 proficiency in PISA scores) defining the "opportunity". It corresponds to an appropriately normalized average deviation of average outcomes from the mean outcome across groups with the same combination of circumstances (Barros et al., 2009, 2010). Therefore, it allows us to analyze the extent to which a child's chance to access a given opportunity, defined as a dichotomous result, depends on the

[3] De Carvalho et al. (2012) also note that the larger number of tranches, the closer one would be to Roemer's theoretical conception of within-type percentile of the distribution of outcomes. The empirical researcher, however, will almost always be limited to work with a relatively small number of tranches due to limitations of sample size or information needed to construct types.

characteristics that she is born into and has no control over. This methodology has been widely used to measure inequality in access to a broad range of basic services for children, such as water, sanitation, electricity, health services, and educational services (using enrollment as an indicator).[4] In its most intuitive interpretation, the HOI is the coverage rate (average attainment) of an opportunity in a population, discounted by a measure of inequality between circumstance groups (or types). It is this measure of inequality between types that we focus on for our analysis.

We report four main findings. *First*, our measure of inequality is strongly correlated with the level of human development and a broader measure of inequality: the *Human Development Index overall loss*. *Second*, by decomposing our measure of inequality into its component parts, we find that wealth, city size, and parental education explain bulk of the inequality in opportunities in educational achievement in math and science. An interesting contrast is the opportunity related to reading proficiency for which we find the role of gender to be dominant, with girls consistently outperforming boys. *Third*, we find a negative correlation between public spending in primary education and our measure of inequality. This correlation is robust to controlling for other possible confounding factors such as the level of economic development of the countries and the size of the overall government budget. *Fourth*, by analyzing the changes in inequality of opportunity between 2009 and 2012, we find that there has been little progress in reducing inequality of opportunity. The changes that have occurred are by and large associated with overall improvements for all groups rather than a change in the distribution of underlying circumstances of the students over time.

The rest of the paper proceeds as follows: in the next section we present the data and the Human Opportunity Index methodology. In section 3 we present our general results and discuss the relationship between public spending and inequality. In section 4 we explore the changes in inequality of opportunity between 2009 and 2012. Section 5 concludes the paper.

2. Data and Methodology

The Programme for International Student Assessment (PISA) is a standardized test for students with roughly 15 years of age at the time of the assessment. The 2012 version of PISA covers 65 countries and economies. PISA evaluates students' knowledge and skills in math, reading and science. Eligible students should have completed at least 6 years of formal schooling by the time of the test –but they can be enrolled in any type of institution (public or private), participate in full-time or part-time education, and in academic or vocational programs.

In this paper we restrict attention to countries, which means that cities or economies such as Hong Kong SAR, China; Chinese Taipei; Macao SAR, China; and Shanghai are left out. This leaves us with 98.2% of the full sample. We drop another 9.5% of the sub-sample due to missing values. Table A1 in the Appendix shows the number of observations and weighted observations.

We define each opportunity as a discrete [0,1] variable, where 1 denotes the student demonstrating at least the level of academic performance necessary to participate effectively and productively in life (level 2 proficiency), 0 otherwise. The opportunity is defined for all three tested subjects:

[4] See Molina et al. (2013) for a recent literature review.

science, math and reading. For circumstances, we use gender, whether the child has attended preschool or not, presence of parents at home, education level of the most educated parent/guardian, immigration status, quintile in the distribution of economic, social and cultural status, and city size, as these are all characteristics over which 15-year olds have no control.

Gender is a dummy that takes the value of 1 if the student is a boy. Preschool attendance is a dummy that takes the value of 1 if the student attended at least one year of preschool. Presence of parents is coded into two categories: i) the student lives with any of his/her parents, and ii) the student does not live with any of his/her parents for any reason whatsoever. Maximum level of education of the parents or guardians (in case that he/she does not live with his/her parents) is coded into four categories: a) primary education or less, b) secondary education, c) technical or technician, d) tertiary education (undergrad or postgrad). We compute the quintiles of the distribution of socioeconomic status on the basis of the country level distribution of social, economic and cultural status.[5] City size has the following categories: village (less than 3,000 habitants), small town (3,000 to 15,000 habitants), town (15,000 to 100,000 habitants), city (100,000 to 1 million habitants) and large city (more than 1 million habitants).

2.1. Human Opportunity Index

In a discrete population of size n, let p_i denote the probability of student i of scoring at or above level 2 proficiency. The share of students having access to the opportunity would be given by $\bar{C} = \frac{1}{n}\sum_i p_i$. In practice, probabilities can be estimated econometrically from binary data on access using a discrete choice model. Let this population be partitioned into M types, so that for any type k defined by a set of circumstances: $X = (X_1, X_2, \dots, X_M)$, $k \in X_1 \times X_2 \times \dots \times X_m$ and $C_k = \frac{1}{n_k}\sum_{i \in k} p_i$. Denoting the share of type k in the entire sample by w_k, the Human Opportunity Index can be defined as:

$$HOI = \bar{C}(1 - D),$$

$$\text{where } D = \frac{1}{2\bar{C}}\sum_{k=1}^{M} w_k \, |\bar{C} - C_k|.$$

D is a version of the dissimilarity index commonly used in sociology to measure segregation. In this case D might be seen as a measure of inequality of opportunity, more precisely as the share of total opportunities that are misallocated in favor of (or against) types that have coverage rates higher (or lower) than $\bar{C}$. Note also that for any $A, B \in X$, and $A \cap B = \emptyset$, $D(A, B) \geq D(A)$, which implies

[5] The index of economic, social and cultural status was constructed by the OECD on a basket of 13 household items: a dishwasher; a DVD player; number of cellular phones, televisions, computers, cars, rooms with a bath or shower; a room of their own (student); a computer that can be used for schoolwork; educational software; Internet; a desk; a quiet place to study; books to help with school work, technical reference books, dictionary, classic literature, books of poetry, works of art, and three country specific items. The index was computed using weighted likelihood estimation, and it has a mean of zero and a standard deviation of one for OECD countries as a whole.

that D serves as a lower bound to the "real" level of inequality of opportunity that could be measured if *all* relevant circumstances were observable from the data and included in the analysis.[6]

The HOI can be considered as a welfare function à la Sen, where mean outcomes are adjusted by one minus a measure of inequality (Brunori et al., 2013). However, given that D is a direct measure of inequality, we focus on D to assess inequality of opportunity in educational achievement.

2.1.1. Decomposition of the D-index

Given that D is sensitive to the set of circumstances chosen for the analysis, we identify the impact of each circumstance on it using Shapley Decompositions. We do so by considering all the changes that occur when we add a circumstance to all possible subsets of pre-existing variables, and then taking the average of all these possible changes. Thus, if we have two sets of circumstances $A, B \in X$, the impact (on D) of adding the set of circumstances A is given by:

$$D_A = \sum_{S \subseteq N \setminus \{A\}} \frac{|s|!(n-|s|-1)!}{n!} \left[D(S \cup \{A\}) - D(S)\right],$$

where N is the set of all circumstances, which includes n circumstances in total; S is a subset of N (containing s circumstances) that does not contain A; $D(S)$ is the dissimilarity index estimated with the set of circumstances S; and $D(S \cup \{A\})$ is the dissimilarity index calculated with set of circumstances S and A. Hence, we can define the contribution of the set of circumstances A to the inequality index as $M_A = \frac{D_A}{D(N)}$, where $\sum_{i \in N} M_i = 1$.[7]

3. Results

The D-index or *inequality of opportunity index* and the results of the Shapley Decompositions by country can be found in the Appendix (Table A2). In this section we analyze these results.

First, we ask ourselves whether the level of inequality of opportunity is related to development. In a recent study, Brunori et al. (2013) find that inequality of opportunity is highly correlated to Gross National Income per-capita. In the same spirit, we compare the D-index to a popular measure of the level of development: the Human Development Index (HDI) published by United Nations Development Programme (UNDP). The HDI is a national average of human development achievements in the three basic dimensions of health, education and standard of living, measured by the geometric mean of indicators of life expectancy, Gross National Income, and the mean and expected years of schooling.[8]

We expect the HDI to be negatively correlated to our inequality of opportunity (or D) index for educational achievement since countries with high HDI have highly educated populations and

[6] For further methodological details see Barros et al. (2009, 2010).

[7] For further methodological details see Hoyos and Narayan (2011).

[8] The HDI is the geometric mean of normalized (using minimum and maximum value for each) indices for each of the three dimensions: (i) the health dimension measured by life expectancy at birth; (ii) the education dimension measured by (the arithmetic mean of) mean of years of schooling for adults aged 25 years and expected years of schooling for children of school entering age; and (iii) the standard of living dimension measured by (the logarithm of) gross national income per capita. (UNDP, 2014)

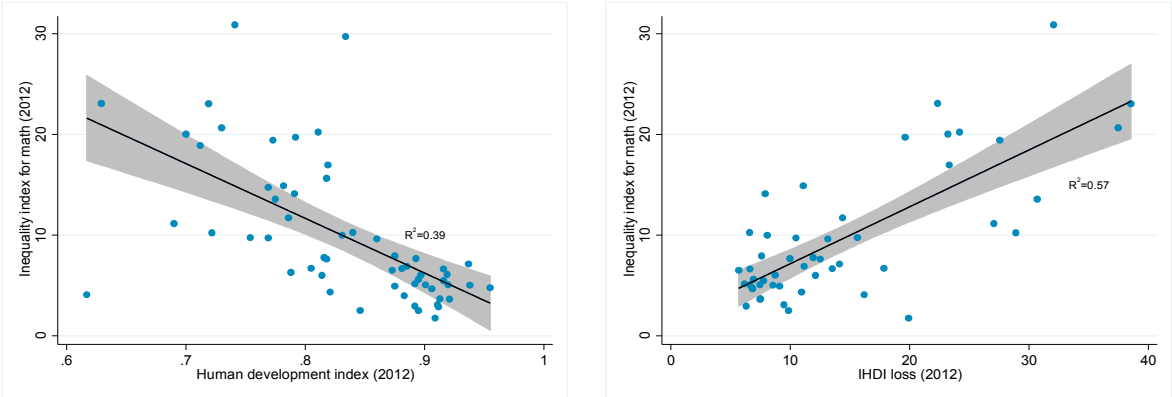
higher income per-capita (by construction). Indeed, Figure 2, panels a, c and e, show a non-trivial correlation between the level of human development and inequality of opportunity in educational achievement.[9] This can be a result of intergenerational transmission of human capital and higher investments by more developed societies on education (Brunori et al., 2013).

Like all averages, the HDI conceals within-country disparities in human development. A relevant question to ask would be whether more unequal societies tend to have more unequal access to basic opportunities (Brunori et al., 2013). We proceed explore the relationship between inequality in human opportunity and inequality in human development. The latter is proxied by the percentage difference between the HDI and the Inequality adjusted HDI (IHDI), which is called *overall loss* and is the HDI-equivalent of the inequality of opportunity (or D) index.[10]

Panels b, d and f of Figure 2 show a significant positive association between inequality of opportunity in educational achievement (D-indices for reading, mathematics and science) and HDI overall loss.[11] Several mechanisms might drive these correlations. One that appears plausible is the notion that today's outcomes shape tomorrow's opportunities: for example, large income gaps and schooling gaps between today's parents are likely to imply bigger gaps in the quality of education among tomorrow's children (Ferreira, 2001). The reverse mechanism probably holds as well: if opportunity sets differ a great deal among people, then individual outcomes are also likely to be unequal. In section 3.2 we explore this further by addressing the relationship between lagged indicators of welfare and our measure of inequality of opportunity.

Figure 2. Human development index vs. inequality index

a. HDI vs. inequality in math **b. Overall loss vs. inequality in math**

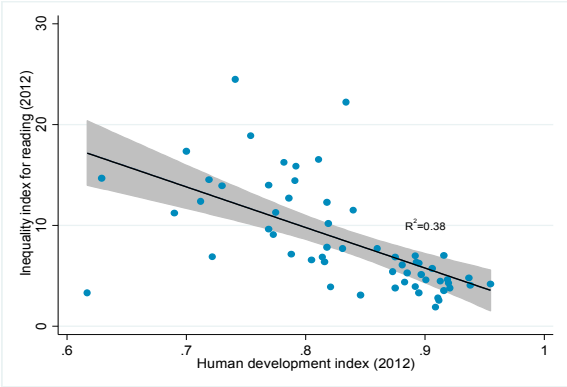


[9] Looking at each component of the HDI independently, we find that average years of education is the variable with the highest correlation with our inequality index: -0.62; for expected average years of education is: -0.51; for life expectancy the correlation is: -0.47; for GNI is: -0.26. For science, these numbers are -0.53, -0.48, -0.46, and -0.17 respectively. For reading, the correlations are -0.50, -0.50, -0.60, and -0.3 respectively.

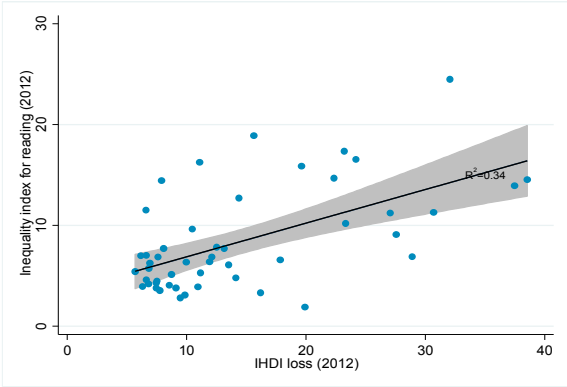
[10] The IHDI is based on a distribution-sensitive class of composite indices proposed by Foster, Lopez-Calva and Szekely (2005), which draws on the Atkinson family of inequality measures. More specifically, the IHDI corresponds to the HDI discounted by inequality estimated by the Atkinson inequality measure.

[11] Looking at the correlations between the "loss" in each component and our inequality index, we find that correlations lie between 0.56 and 0.77, with no component showing a consistently higher correlation compared to the other components.

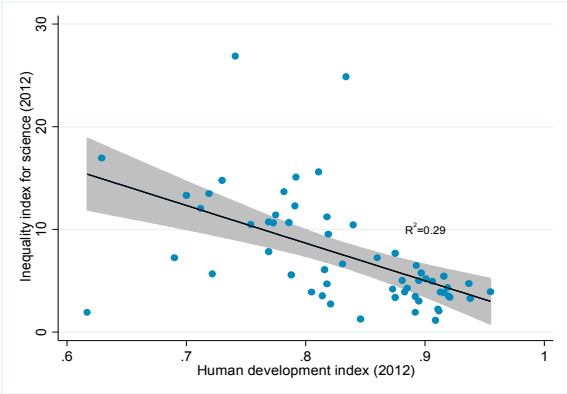
c. HDI vs. inequality in reading



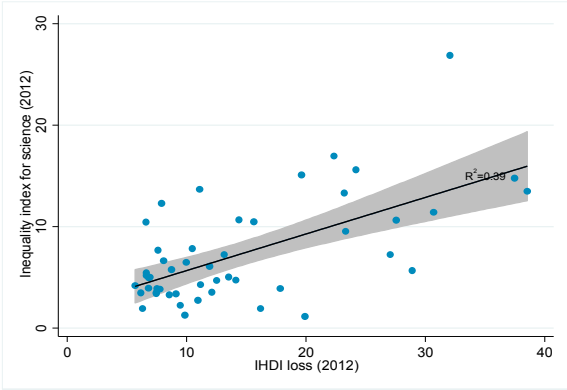
d. IHDI loss vs. inequality in reading



e. HDI vs. inequality in science



f. IHDI loss vs. inequality in science



Note: 95% confidence intervals added (shaded area).
Source: Authors' calculations based on data from the OECD, PISA 2012, and UNDP, HDI 2013.

3.1 Decomposition of inequality of opportunity

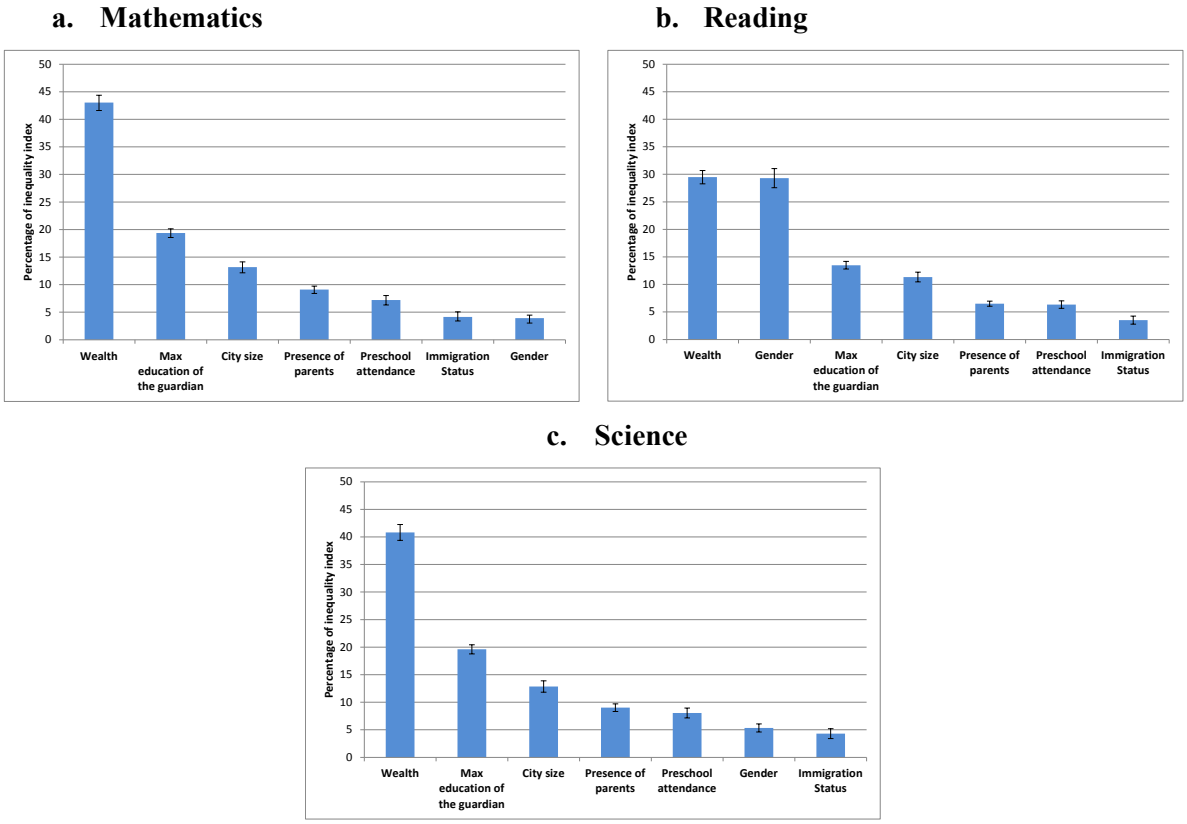
From our decomposition exercise we find that socioeconomic status is the single most important circumstance contributing to inequality of opportunity in educational achievement (Figure 3). This is consistent with previous findings by the OECD (OECD, 2010b) and points out to a "silver spoon" type phenomenon; having a prosperous background vastly improves your chances of succeeding in life. We also find that, on average, education of the parents/guardians contribute to inequality of opportunity in education to a considerable extent. This is also consistent with previous findings – parental education can affect children's academic outcomes through parents' educational expectations of their children and the kind of educational stimulation they provide at home (Eccles, 2005; Davis-Kean, 2005). City size, on the other hand, reflects the often observed urban-rural divide, which favors urban areas over rural ones.

The decomposition results for reading proficiency reveal a large share of inequality of opportunity being explained by gender for most countries, which favors girls.[12] Although this phenomenon has

[12] The share of women in or above level 2 of proficiency is 76% in reading; the corresponding share for men is 64%. Looking at individual countries, in every country, women outperform men on average.

been previously documented (Stoet and Geary, 2013), economists have not adequately assessed the implications of gender differences for reading on social outcomes. Some research has provided evidence that reading skills relate to subsequent academic achievement, employment and wages for males (Currie and Thomas, 2001). While it is hard to discern what (if any) implications our results might have for the considerable gender gaps favoring men in the labor markets and mathematics/science related careers, the causes and economic implications of girls' advantage in reading appear to be worthy topics for future research.

Figure 3. Average contribution of each circumstance to inequality of opportunity (simple averages across all countries)



Note: 95% confidence intervals added. Each bar shows the simple average (across all counties) of contribution of a circumstance to D-Index for each type of education achievement, where the contributions are computed using Shapley decompositions of the D-Index for every country.
Source: Authors' calculations based on data from the OECD, PISA 2012.

3.2 Public spending on education and inequality of opportunity

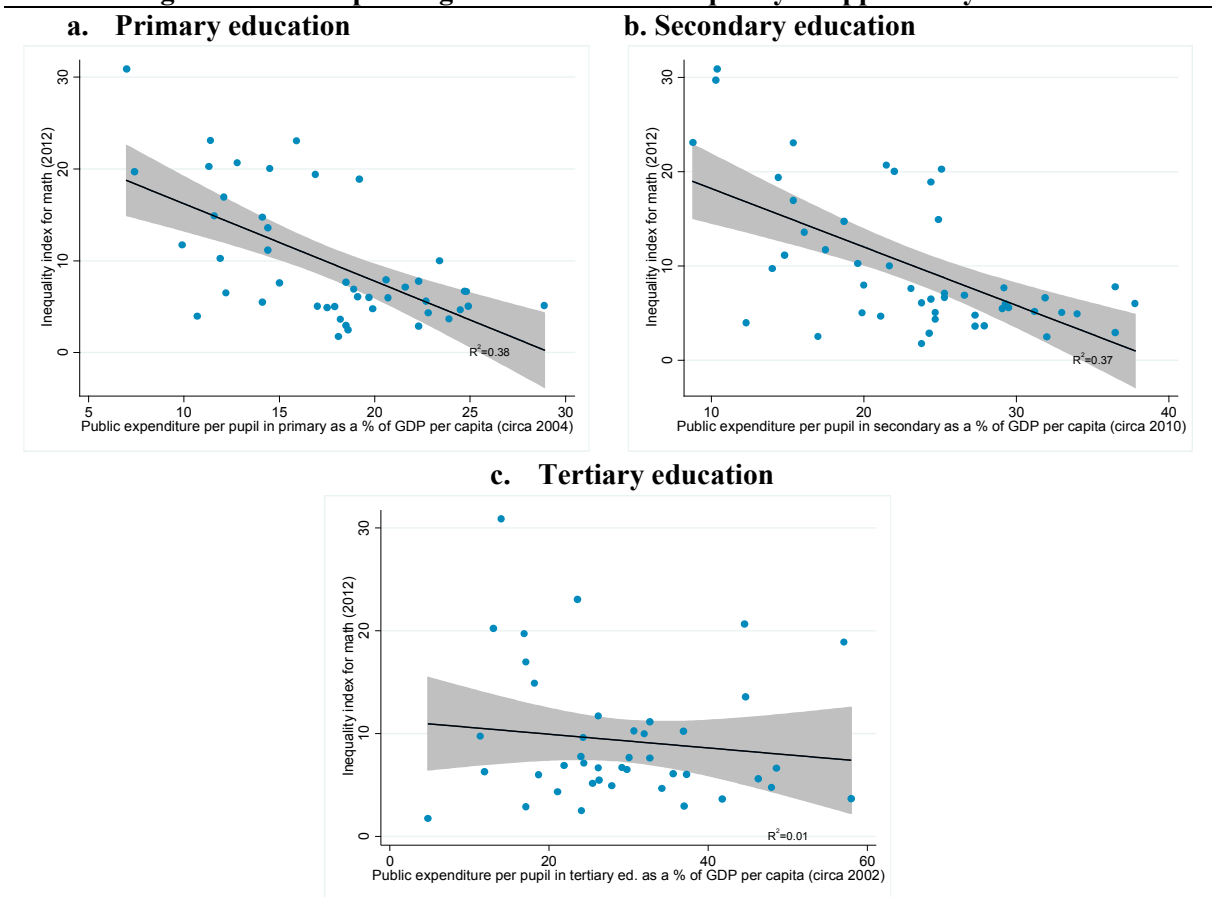
In the interest of exploring the links between public policy and inequality of opportunity, we conduct a modest analysis of the relationship between our inequality index and public spending in education, which is generally thought to be progressive (Sahn & Younger, 2000; Ferreira and Gignoux, 2014). We examine the correlation between public spending per children in school education as percentage of GDP per-capita and our indices of inequality. For this, we consider the level of public spending in primary school circa 2004 –when the cohort of students taking the PISA

in 2012 would likely be starting primary school – and the level of public spending in secondary school circa 2010 –when the same students are likely to be in secondary school. We also explore the correlation between inequality of opportunities in educational achievement and public spending in tertiary education to provide contrast.

From this point on we will show the results for mathematics only, given that the results for reading and science are very similar –which is expected since the correlations between our measures of inequality of opportunity for math, reading and science are above 0.9. The results for both reading and science can be found in the Appendix.

The bivariate plots for public spending in education and inequality of opportunity are shown in Figure 4. Countries with higher public spending in primary school per children as percentage of GDP per-capita have lower inequality of opportunities in educational achievement (panel a). The same is true for public spending in secondary school (panel b). Spending in tertiary education appears uncorrelated with these inequalities (panel c).[13] These results hold for reading and science.

Figure 4. Public spending in education vs. inequality of opportunity in math



Note: 95% confidence intervals added (shaded area).

[13] If there is a correlation between spending in tertiary education and educational attainment, it is likely to be explained by the mechanism of intergenerational transmission of human capital. However, available information does not allow us to explore such long lags (e.g., 20-year lags).

Source: Authors' calculations based on data from the OECD, PISA 2012, and UNESCO Institute for Statistics.

There could be several reasons why we observe these bivariate relationships. For example, countries with higher spending in primary and secondary education may be wealthier countries that have more egalitarian and well-functioning institutions which could limit inequality. We check the robustness of these relationships by regressing our inequality index on spending in education and controlling for a few other potential confounding factors, namely average years of schooling for people 25 years or older, Gini index of income, and GDP per-capita (US$, PPP) for 2002.[14] While one can think of many other potentially confounding factors to control for, including this parsimonious list of variables seems intuitively appealing – they are reasonable proxies for average level of development, and the quality and egalitarianism of institutions. Our results (Table 1) show that the negative relationship between public spending on school education and inequality prevails for every subject and combination of control variables.

We find a stronger correlation between public spending in primary education and our inequality index than between public spending in secondary education and the index, which is consistent with theories of early childhood development: the earlier the intervention the more effective it is (Heckman, 2011). [15] In contrast, we do not find evidence of a relationship between public spending in tertiary education and inequality of opportunity. We find very similar results (with opposite signs) when considering the percentage of students at or above Level 2 of proficiency as the dependent variable (Table A3 in the Appendix), which is consistent with the high correlation between this percentage and the D-index. All in all, this shows that public spending in education, particularly in primary school education, is positively related to the percentage of individuals that show the skills necessary to participate effectively and productively in life and negatively related to the disparity in such basic skills among children of different circumstances.

At least in the limited framework in which we examine these correlations, the relationship between public spending on schooling and inequality of opportunity in achieving basic proficiency in reading, mathematics and science seems to be highly robust. One cannot infer a causal relationship between spending and learning outcomes from these findings, namely that increased public spending by itself is likely to reduce inequality of opportunity in achieving basic proficiency. But the robust association suggests a strong possibility that increased public spending on schooling contributes to reducing inequality of opportunity in combination with other factors that are unobserved in our analysis.

[14] We draw average educational attainment from Barro and Lee (2013), who provide information on average years of education for people 25 years or older, but not older than 65. Data on Gini is obtained from Milanovic's *all ginis* data set. Data on GDP per-capita is drawn from IMF's World Economic Outlook.

[15] Our results are in line with other studies analyzing these relationships: Salehi-Isfahani et al. (2013) and Ferreira and Gignoux (2014).

Table 1. Ordinary least squares estimates for the effect of public spending on education on inequality of opportunity

a. Mathematics

Estimated effect of public spending on education on inequality of opportunity: $D_c = \alpha + \beta spending_c + \boldsymbol{X}_c\boldsymbol{\theta} + \varepsilon_c$

Variable	Dependent variable: Inequality index in mathematics											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	-0.8432***	-0.6705***	-0.4740***	-0.3909**								
	(0.1717)	(0.1437)	(0.1191)	(0.1447)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					-0.6192***	-0.4713***	-0.3132***	-0.2371**				
					(0.1375)	(0.1065)	(0.0909)	(0.1080)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0186	-0.0513	0.0171	0.0440*
									(0.0646)	(0.0538)	(0.0306)	(0.0245)
Constant	24.6519***	38.6425***	20.8994***	20.0128***	24.4104***	36.9827***	17.4341***	17.2508***	9.9473***	29.7394***	0.4341	1.6762
	(3.4942)	(4.0257)	(5.5058)	(5.7559)	(3.7515)	(4.3523)	(5.5692)	(5.7443)	(2.4799)	(5.5725)	(5.7542)	(5.2406)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.3817	0.6734	0.7539	0.7667	0.3676	0.6051	0.6666	0.7221	0.0025	0.3633	0.6395	0.6969
Observations	46	45	45	45	48	47	46	46	44	44	44	44

b. Reading

Estimated effect of public spending on education on inequality of opportunity: $D_c = \alpha + \beta spending_c + \boldsymbol{X}_c\boldsymbol{\theta} + \varepsilon_c$

Variable	Dependent variable: Inequality index in reading											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	-0.6263***	-0.5325***	-0.4624***	-0.3654**								
	(0.1362)	(0.1300)	(0.1246)	(0.1370)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					-0.4136***	-0.3237***	-0.2381***	-0.1616*				
					(0.0966)	(0.0859)	(0.0763)	(0.0854)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0265	-0.0471	-0.0070	0.0302
									(0.0579)	(0.0539)	(0.0428)	(0.0238)
Constant	19.1909***	27.5892***	21.2582***	20.2228***	17.9500***	25.8624***	16.4369***	16.2523***	9.1167***	21.5879***	4.3771	6.0928
	(2.6691)	(2.9027)	(3.7469)	(3.8526)	(2.6359)	(3.0998)	(3.6031)	(3.6088)	(2.1759)	(4.0119)	(5.5615)	(4.4515)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.4078	0.6198	0.6396	0.6733	0.3220	0.5087	0.5016	0.6111	0.0084	0.2411	0.3959	0.5739
Observations	46	45	45	45	48	47	46	46	44	44	44	44

c. Science

Estimated effect of public spending on education on inequality of opportunity: $D_c = \alpha + \beta spending_c + \boldsymbol{X_c\theta} + \varepsilon_c$

Variable	Dependent variable: Inequality index in science											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	-0.6571***	-0.5530***	-0.4555***	-0.4342***								
	(0.1497)	(0.1391)	(0.1172)	(0.1389)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					-0.4642***	-0.3663***	-0.2523***	-0.2085**				
					(0.1193)	(0.1045)	(0.0883)	(0.0980)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0166	-0.0377	0.0104	0.0323
									(0.0487)	(0.0442)	(0.0270)	(0.0219)
Constant	18.8734***	27.7268***	18.9268***	18.6990***	18.3396***	26.7638***	14.5209***	14.4152***	7.6102***	20.3795***	-0.2346	0.7754
	(2.9899)	(3.2987)	(4.3168)	(4.5122)	(3.2020)	(3.7592)	(4.5735)	(4.6944)	(1.9999)	(4.6286)	(5.3334)	(4.9362)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.4132	0.6260	0.6611	0.6626	0.3514	0.5341	0.5505	0.5836	0.0033	0.2483	0.4711	0.5331
Observations	46	45	45	45	48	47	46	46	44	44	44	44

Robust standard errors in parentheses. * Significant at ten percent; ** significant at five percent; *** significant at one percent.
Note: Data on average years of schooling comes from Barro and Lee (2013), we restrict to individuals above 25 years of age; data un public expenditure and GDP per-capita comes from UNESCO's Institute for Statistics to guarantee homogeneity; the data on Gine comes from Milanovic's compilation of Gini indexes.
Source: Authors' calculations based on data from the OECD, PISA 2012, UNESCO, Barro and Lee (2013), and Milanovic:
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22301380~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html

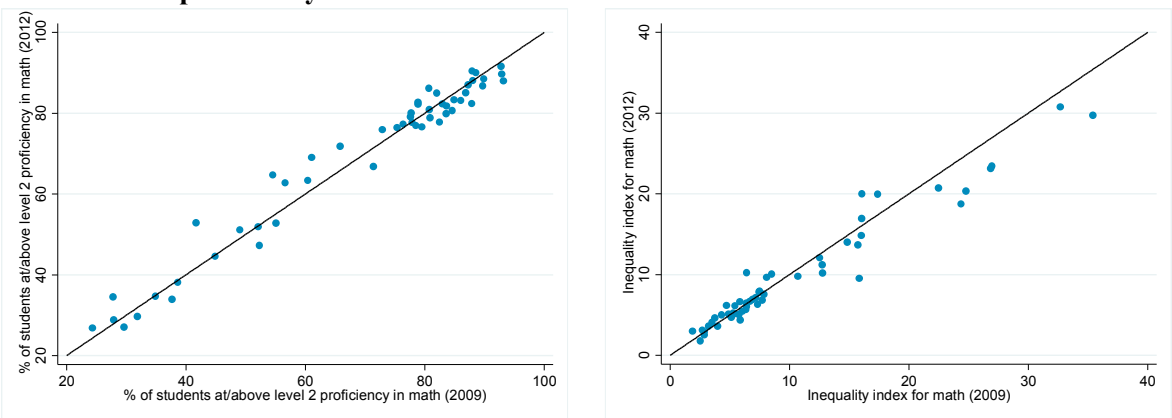
4. Changes in inequality of opportunity

Has inequality in educational achievement changed over time in these countries? To address this question we complement our data using data from the 2009 round of PISA, which provides us with information on the exact same circumstances we have been using so far. There are 52 countries that can be found in both rounds of PISA. [16] Figure 5, panel a, shows that there have been changes in the percentage of students at or above level 2 proficiency. For mathematics, half of the countries show a higher percentage of students scoring at or above level 2 proficiency compared to 2009; for reading and science (not shown here but in the Figure A3 in the Appendix) this positive trend occurs for 65% of countries. The changes, however, have been small in most cases.

Figure 5, panel b, shows that changes in inequality of opportunity have slightly more variation than changes in coverage rates (similarly for reading and science). For mathematics, around half of the countries report a fall in inequality of opportunity between 2009 and 2012; for reading and science this percentage is around 62%. The question we are interested in is the extent to which reduction in inequality of opportunity is attributable to changes in group specific coverage rates, as opposed to changes in distribution of the circumstances themselves.

Figure 5. Coverage and Inequality of opportunity in Math, 2012 vs. 2009

a. Percentage of students at or above level 2 proficiency **b. Inequality of opportunity**



Source: Authors' calculations based on data from the OECD, PISA 2012, and UNESCO Institute for Statistics.

The distribution of observable circumstances in all countries is likely to have changed between 2009 and 2012 due to sampling "noise" as well as real changes in the characteristics of the underlying population. This needs to be accounted for in order to understand how an observed

[16] Rounds previous to 2009 do not survey students on preschool attendance. PISA 2009 assesses 65 countries and economies. Nonetheless, of these 65 countries and economies, Azerbaijan, Kyrgyzstan, Panama and Trinidad and Tobago were not surveyed for PISA 2012. In contrast, of the 65 countries and economies surveyed in 2012, Croatia, Uruguay, United Arab Emirates, Costa Rica and Vietnam were not surveyed in the 2009 round. For 2009, economies and missing values are dropped from the sample, comprising 10% of the full sample. We also drop Albania and Israel due to a high share of missing values in the circumstances in consideration.

change in inequality of opportunity has occurred. Consider, for example, two extreme cases with the same reduction in D-index, where the reduction in one case is entirely due to an improvement in the distribution of circumstances and in another case attributable to improvements in achievement for one or more groups. Each of these scenarios has very different implications for how the education system in the country has worked and how future education policy should be shaped.

To account for these effects in the overall change in inequality of opportunity, we use a methodology that is now fairly standard (and very much in the same spirit as the standard growth-inequality decomposition of poverty changes), which consists of decomposing changes in inequality into two general components: coverage and composition effects. The coverage effect refers to changes in group specific coverage rates while the composition effect refers to changes in the distribution of circumstances between the two periods. The purpose of the exercise is to purge our estimates of the composition effect.

In general, the change in inequality can be expressed as:

$$\Delta = D_2 - D_1,$$

where the sub-indices 1 and 2 correspond to the first and second periods respectively. By adding and subtracting $D_c = E[D_2|X_1]$ –the counterfactual that corresponds to the value of the inequality index in the second period if distribution of circumstances were on average that of the first period – we obtain

$$\Delta = (D_2 - D_c) + (D_c - D_1).$$

The first component of the expression corresponds to the coverage effect and the second component to the composition effect.

The decomposition can be performed either parametrically or non-parametrically. The parametric decomposition consists in obtaining the coefficients of a discrete choice model for 2009 and computing the predicted probabilities for 2012 using the 2009 coefficients (Barros et al., 2010). Doing so, we can estimate D_c using the same procedure described in section 2.1. We use Ñopo (2008) matching approach to perform the non-parametric decomposition. This is done by resampling without replacement all students in PISA 2009, and matching each observation to one synthetic student in PISA 2012 averaging all students in the comparison group with exactly the same circumstances. Doing this we preserve the empirical distribution of circumstances for those students in the 2009 round of PISA.

Under non-parametric matching we can re-write Δ as:

$$\Delta = [(D_2 - D_c)|X_1 \cap X_2] + [(D_c - D_1)|X_1 \cap X_2] + [(D_2 - D_1)|(X_1 \cap X_2)^c],$$

where X_1 and X_2 correspond to the specific sets of the distribution of circumstances for the first and second periods respectively; $X_1 \cap X_2$ corresponds to those sets of the distribution of circumstances we can find for both the 1st and 2nd periods; and $(X_1 \cap X_2)^c$ denotes the sets that are outside of the common support of circumstances.

The advantage of the non-parametric decomposition over the parametric one is that the former allows us to estimate the coverage effect accounting for the potential problem of misspecification due to differences in the supports of the empirical distribution of circumstances between 2009 and 2012. For both parametric and non-parametric decompositions, we use the exact same set of circumstances described earlier in the text.

The common support in our case corresponds to all those circumstance groups in any given country that we can find in both 2009 and 2012. Restricting ourselves to the common support excludes 10% of the sample in 2009 and 3% of the sample in 2012. However, this still leaves us with a fairly large sub-sample: 365,699 students for 2009 and 364,168 students for 2012.

Table A4 in the appendix shows the results obtained from performing the parametric and non-parametric decompositions. Overall, changes in inequality range from a minimum of -6.3 to a maximum of 3.9 in math; analogously, -4.2 and 3.2 in reading, and -4.2 and 5.1 in sciences. On average these changes are around -0.54, which is fairly small. This result is perhaps due to the short time horizon: three years is hardly long enough to observe dramatic changes in inequality of learning outcomes.

For both the parametric and the non-parametric decompositions, we find that the composition effect is small and almost negligible in most cases. Thus, the changes that have occurred are by and large associated with overall improvements for all groups rather than a change in the distribution of underlying circumstances of the students over time. Similar results emerge for reading and science.

5. Conclusions

In this paper we have used the human opportunity index methodology to provide evidence on inequality of opportunity in educational attainment, where opportunity is defined as having the minimum level of academic performance necessary to participate effectively and productively in adult life. Unlike a few similar studies on the topic, our approach helps sharpen the focus on the most basic learning opportunities.

Our results not only provide a comparative view on inequality of opportunity in education across countries, but also provide several stylized facts to be considered by policy makers and the broad scientific community. First, our measure of inequality of opportunity is strongly correlated with the level of and inequality in human development across countries. Second, by decomposing our measure of inequality into its component parts, we find that wealth, city size, and parental education explain the bulk of the inequality in opportunities in educational achievement. We also highlight the role of gender –in the form of an advantage to girls – in inequality in reading proficiency, which might have important consequences for educational and labor market outcomes for boys. Third, our results show a robust and consistent correlation between public spending on education and inequality of opportunity. Although the results do not necessarily imply a causal relationship, they provide suggestive evidence on the redistributive nature of public spending in primary and (to a somewhat lesser extent) secondary education.

We also find that progress in educational achievement has been limited, with improvements –in terms of higher coverage (share of students with basic level 2 proficiency) or lower inequality of opportunity (between circumstance groups) – seen for half the countries in mathematics and about two-thirds of the countries in reading and science. The changes that have occurred (positive or negative) are in most cases mainly attributable to changes in achievements within groups, albeit with a few exceptions where changes in the distribution of circumstances have led to improvements in inequality of opportunity.

It is important to keep in mind that a three-year window might be too short a time span to observe discernible improvements, and many of the changes seen here are small enough to qualify as statistical noise as opposed to meaningful changes. If the three-year time window is indeed too short, it would imply that policies focused on reducing inequality of opportunity in educational achievement need to act for a long period of time to effect measurable improvements. The fact that public spending on primary education has a strong association with educational achievement suggests that redistributive policies during childhood years have an important role to play in promoting equality of opportunity in educational achievement in the long-run.

References

Barros, R., Ferreira, F., Molinas, J., and Saavedra, J. (2009). "Measuring Inequality of Opportunities in Latin American and the Caribbean," The International Bank for Reconstruction and Development and The World Bank.

Barros, R., Molinas, J., and Saavedra, J. (2010). "Measuring Progress Toward Basic Opportunities for All," Brazilian Review of Econometrics, 30(2): 335-367.

Barro, J., and Lee, W. (2013) "A new data set of educational attainment in the world, 1950–2010," Journal of Development Economics, 104: 184–198

Bedard, K., and Ferrall, C. (2003). "Wage and Test Score Dispersion: Some International Evidence," Economics of Education Review, 22: 31-43.

Blau, F., and Kahn, L. (2005). "Do Cognitive Test Scores Explain Higher US Wage Inequality?" Review of Economics and Statistics, 87: 184-193.

Brunori, P., Ferreira, F., and Peragine, V. (2013). "Inequality of Opportunity, Income Inequality and Economic Mobility: Some International Comparisons," IZA Discussion Paper Series No. 7155.

Castello, A., and Domenech, R. (2002). "Human Capital Inequality and Economic Growth: Some New Evidence," Economic Journal, Royal Economic Society, 112(478): C187-C200.

Cecchi, D. and Peragine, V. (2005). "Regional Disparities and Inequality of Opportunity: The Case of Italy," IZA Discussion Papers 1874.

--------. (2010), "Inequality of Opportunity in Italy," Journal of Economic Inequality, 8: 429-450.

Cohen, G., (1989). "On the Currency of Egalitarian Justice," Ethics, 99: 906-944.

Currie, J., and Thomas, D. (2001). "Early test scores, school quality and SES: Long-run effects on wage and employment outcomes," Worker Wellbeing in a Changing Labor Market, 20: 103-132.

Davis-Kean, P. (2005). "The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment," Journal of family psychology, 19(2): 294-304.

de Carvalho, M., Gamboa, L., and Waltenberg, F. (2012). "Equality of educational opportunity employing PISA data: taking both achievement and access into account," Universidad del Rosario, Serie Documentos de Trabajo 130.

Dworkin, R. (1981). "What is Equality? Part I: Equality of Welfare; Part 2: Equality of Resources," Philosophy and Public Affairs, 10: 185–246; 283–345.

Eccles, J. (2005). "Influences of parents' education on their children's educational attainments: The role of parent and child perceptions," London Review of Education 3(3) : 191-204.

Ferreira, F. (2001). "Education for the masses? The interaction between wealth, educational and political inequalities," The Economics of Transition, The European Bank for Reconstruction and Development 9 (2): 533-552.

Ferreira, F., and Gignoux, J. (2014). "The Measurement of Educational Inequality: Achievement and Opportunity," The World Bank Economic Review 26(3): 1-37.

Fleurbaey, M. (2008). "Fairness, responsibility, and welfare," Oxford: Oxford University Press.

Foster, J., Lopez-Calva, L., and Szekely, N. (2005). "Measuring the Distribution of Human Development: methodology and an application to Mexico," Journal of Human Development and Capabilities, 6(1): 5-25.

Heckman, J. (2011). "The economics of inequality: The value of early childhood education," American Educator, Spring 2011.

Hoyos, A., and Narayan, A. (2011). "Inequality of opportunities among children: how much does gender matter?" Background Paper for WDR 2012. Manuscript.

Molina, E., Narayan, A., and Saavedra, J. (2013). "Outcomes, opportunity and development: why unequal opportunities and not outcomes hinder economic development," The World Bank Policy Research Working Paper Series 6735.

Morrisson, C., and Murtin, F. (2008). "Education Inequalities and the Kuznets Curves 1870-2000," Working Paper, Paris School of Economics.

Ñopo, H. (2008). "Matching as a Tool to Decompose Wage Gaps," The Review of Economics and Statistics, 90(2): 290-299.

Ñopo, H. (2013). "The Paradox of Girls' Educational Attainment," from Gender Equality: Political Backrooms, Corporate Boardrooms and Classrooms (Summer 2012)

OECD. (2006). "PISA 2006 Technical Report," OECD Publishing.

--------. (2010a). "PISA 2009 Results: What Students Know and Can Do - Student Performance in Reading, Mathematics and Science (Volume I)," OECD Publishing.

--------. (2010b). "PISA 2009 Results: Overcoming Social Background – Equity in Learning Opportunities and Outcomes, Mathematics and Science (Volume II)," OECD Publishing.

--------. (2013). "OECD Skills Outlook 2013: First Results from the Survey of Adult Skills," OECD Publishing.

Roemer, J. (1998). "Equality of Opportunity," Harvard University Press, Cambridge MA.

Sahn, D., and Younger, S. (2000). "Expenditure incidence in Africa: microeconomic evidence," Fiscal Studies, Institute for Fiscal Studies, 21(3): 329-347.

Salehi-Isfahani, D., Belhaj-Hassine, N., and Assaad, R. (2012). "Equality of opportunity in education achievement in the Middle East and North Africa," Journal of Economic Inequality, 12: 489-515.

Sen, A. (1985). "Well-being, Agency, and Freedom: The Dewey Lectures 1984," Journal of Philosophy, 82: 169-221.

Stoet, G., and Geary., D. (2013). "Sex differences in mathematics and reading achievement are inversely related: within-and across-nation assessment of 10 years of PISA data," PloS one 8(3): e57988.

Thomas, V., Wang, Y., and Fan, X. (2001). "Measuring education inequality: Gini coefficients of education," The World Bank Policy Research Working Paper 2525.

UNDP. (2014). "Humand Development Index (HDI)," http://hdr.undp.org/en/content/human-development-index-hdi, accessed November 19, 2014

Appendix

Table A1. Sample size

Country	PISA 2012	
	Observations	Expanded observations
Argentina	5303	486624
Australia	12621	222427
Austria	4568	78992
Belgium	7808	106168
Brazil	16718	2077003
Bulgaria	4810	49379
Canada	19941	322008
Chile	6322	207498
Colombia	8035	486965
Costa Rica	4311	37720
Croatia	4864	43875
Czech Republic	4438	66981
Denmark	6398	56755
Estonia	4535	11024
Finland	8243	56380
France	4047	608502
Germany	3246	497482
Greece	4909	92464
Hungary	4576	86161
Iceland	3238	3290
Indonesia	5187	2437379
Ireland	4795	51519
Italy	27658	469584
Japan	6052	1077928
Jordan	6000	94787
Kazakhstan	5608	201710
Korea	4826	578591
Latvia	3984	14664
Liechtenstein	274	286
Lithuania	4416	31613
Luxembourg	4776	4776
Malaysia	4915	407953
Mexico	31397	1225403
Montenegro	4464	6931
Netherlands	3809	163573
New Zealand	3382	41845
Norway	4193	53186
Peru	5500	381252
Poland	4344	357424
Portugal	5322	89568
Qatar	9485	9485
Romania	4847	134905
Russian Federation	5002	1125383
Serbia	4011	58046
Singapore	5147	47108
Slovak Republic	4467	52061
Slovenia	5336	16553
Spain	23854	350353
Sweden	4327	86574
Switzerland	10238	71955
Thailand	6097	645028
Tunisia	3963	108560
Turkey	4558	815154
United Arab Emirates	9790	34521
United Kingdom	11005	578633
United States	4601	3268006
Uruguay	4760	35580
Vietnam	4774	919326

Note: Albania and Israel excluded from the sample. For Israel we do not count with data on pre-school attendance. For Albania we do not count with data on economic, social and cultural status. Hong-Kong, Chinese Taipei, Macao and Shanghai are excluded.
Source: Authors' calculations based on data from the OECD, PISA 2012.

Table A2. Shapley decompositions by country

a. Mathematics

Country	Inequality Index (multiplied by 100)	Share of the Inequality Index						
		Gender	Preschool attendance	Presence of parents	Immigration Status	Max education of the guardian	Wealth	City size
Argentina	**20.5**	7.4	5.7	9.6	1.4	24.5	42.6	8.6
Australia	**5.1**	5.4	4.7	11.2	0.3	25.9	37.8	14.7
Austria	**5.7**	6.1	1.2	4.7	7.0	18.0	55.8	7.2
Belgium	**5.9**	1.3	2.8	11.4	12.5	15.0	51.7	5.4
Brazil	**21.4**	8.4	9.4	7.2	0.2	23.2	38.0	13.6
Bulgaria	**15.2**	1.7	7.4	8.2	0.1	21.3	38.1	23.1
Canada	**3.1**	2.6	6.2	10.8	0.2	21.5	46.0	12.6
Chile	**17.7**	10.7	6.3	7.4	0.0	25.5	38.6	11.6
Colombia	**24.3**	18.9	5.2	7.3	0.2	19.3	36.0	13.1
Costa Rica	**20.3**	13.4	8.4	6.5	0.7	20.4	36.7	13.8
Croatia	**6.9**	1.5	7.5	2.4	1.3	19.8	48.5	18.9
Czech Republic	**6.5**	7.6	5.6	12.0	0.2	18.1	47.6	8.9
Denmark	**4.9**	6.2	1.4	13.7	7.8	18.6	49.3	3.0
Estonia	**2.7**	0.2	1.6	4.9	2.0	15.2	65.8	10.3
Finland	**3.1**	5.2	5.9	20.2	7.6	17.8	41.1	2.3
France	**7.4**	0.9	1.8	8.8	7.3	17.1	56.4	7.8
Germany	**5.1**	0.5	1.5	4.3	5.0	18.2	58.5	11.9
Greece	**10.1**	1.0	5.8	8.4	7.5	22.7	47.0	7.6
Hungary	**10.2**	1.5	1.4	7.8	0.1	20.4	49.3	19.6
Iceland	**4.3**	0.2	1.4	20.2	4.5	21.2	38.6	13.8
Indonesia	**24.5**	2.0	35.2	6.3	0.1	14.8	24.4	17.2
Ireland	**5.5**	6.1	2.5	15.0	0.1	21.9	44.7	9.8
Italy	**6.7**	5.8	6.1	5.1	6.2	14.0	57.0	5.9
Japan	**2.9**	2.2	2.4	11.5	0.5	38.1	31.9	13.3
Jordan	**20.8**	3.9	9.5	11.0	0.6	22.9	31.8	20.3
Kazakhstan	**9.4**	0.3	15.8	2.1	4.6	9.9	39.4	27.9
Korea	**2.0**	2.0	4.0	26.5	0.0	26.3	28.9	12.2
Latvia	**6.1**	3.3	0.9	8.0	0.5	12.6	52.4	22.3
Liechtenstein	**4.6**	3.6	2.4	3.1	14.8	33.3	42.8	0.0
Lithuania	**7.5**	3.7	8.9	7.1	0.4	15.1	44.4	20.4
Luxembourg	**8.0**	10.9	2.4	2.4	8.4	19.3	46.3	10.2
Malaysia	**14.9**	3.1	10.1	7.4	0.3	14.3	41.5	23.4
Mexico	**14.3**	8.8	7.8	9.6	1.9	18.6	27.4	25.9
Montenegro	**14.3**	0.1	13.6	6.4	1.4	26.0	48.0	4.4
Netherlands	**3.6**	2.3	3.2	15.7	2.3	18.5	50.8	7.3
New Zealand	**6.0**	4.3	10.4	10.3	0.4	14.6	49.0	11.1
Norway	**4.6**	0.1	7.2	9.6	9.5	11.9	51.0	10.7
Peru	**30.8**	6.2	8.3	2.3	0.1	25.1	32.7	25.4
Poland	**4.4**	1.8	3.6	13.1	0.0	31.2	39.4	10.9
Portugal	**7.9**	3.3	8.0	7.7	3.1	22.7	42.7	12.4
Qatar	**30.8**	0.3	9.1	9.9	40.2	10.3	10.1	20.1
Romania	**11.8**	0.1	4.5	10.6	0.1	16.6	52.4	15.8
Russian Federation	**6.4**	0.2	6.7	9.4	3.0	24.0	39.6	17.1
Serbia	**10.6**	2.3	4.0	10.3	0.1	16.0	41.7	25.5
Singapore	**2.5**	12.2	3.6	6.3	2.7	18.9	56.2	0.0
Slovak Republic	**10.6**	0.5	11.1	8.0	0.1	9.2	47.4	23.8
Slovenia	**5.4**	1.1	4.8	10.1	3.9	17.3	56.7	6.1
Spain	**6.9**	2.0	7.3	5.6	11.9	21.1	45.4	6.7
Sweden	**6.5**	0.6	11.5	12.4	13.4	10.4	44.5	7.2
Switzerland	**3.7**	1.3	4.2	9.5	11.1	13.7	57.1	2.9
Thailand	**11.2**	9.5	2.4	4.4	0.1	26.1	32.5	24.9
Tunisia	**19.4**	7.8	12.7	6.8	0.2	17.7	41.4	13.3
Turkey	**10.4**	3.3	26.6	5.2	0.7	20.2	36.2	7.7
United Arab Emirates	**15.9**	0.9	14.1	7.7	27.2	18.5	19.3	12.4
United Kingdom	**5.1**	7.0	7.8	16.9	1.0	10.2	50.4	6.6
United States	**7.4**	0.1	0.7	17.2	3.0	19.0	48.1	11.9
Uruguay	**20.4**	4.7	10.8	7.7	0.1	19.9	36.0	20.8
Vietnam	**4.0**	0.1	22.5	3.0	0.3	19.8	31.1	23.3

b. Reading

Country	Inequality Index (multiplied by 100)	Share of the Inequality Index						
		Gender	Preschool attendance	Presence of parents	Immigration Status	Max education of the guardian	Wealth	City size
Argentina	**16.6**	20.6	7.2	9.1	0.7	17.9	31.3	13.3
Australia	**4.2**	25.1	4.3	8.0	1.0	19.0	28.6	13.9
Austria	**6.5**	27.9	1.7	2.7	6.1	12.9	41.1	7.5
Belgium	**5.1**	13.0	3.0	7.5	11.3	12.0	47.8	5.4
Brazil	**14.9**	19.6	11.1	10.5	0.6	16.8	26.9	14.6
Bulgaria	**16.7**	22.8	7.3	5.9	0.2	16.4	28.7	18.8
Canada	**2.8**	30.8	7.4	9.9	0.3	12.4	32.9	6.3
Chile	**11.2**	14.7	6.9	10.1	0.3	19.9	32.9	15.2
Chinese Taipei	**4.0**	27.7	0.9	8.9	0.3	15.7	34.0	12.5
Colombia	**15.2**	13.6	6.9	8.6	0.4	19.8	33.1	17.7
Costa Rica	**9.5**	22.0	7.0	5.3	0.7	20.2	31.5	13.2
Croatia	**6.7**	52.1	3.2	0.9	1.2	9.7	21.5	11.4
Czech Republic	**5.7**	28.3	6.8	6.9	0.0	10.7	40.4	6.8
Denmark	**4.6**	18.2	1.4	9.2	6.0	16.4	42.8	5.9
Estonia	**3.0**	56.5	0.1	3.1	1.2	5.6	27.7	5.8
Finland	**4.1**	46.5	3.7	10.0	5.8	8.1	22.4	3.6
France	**6.2**	17.9	1.8	5.0	8.0	15.9	41.9	9.5
Germany	**4.4**	32.0	1.2	4.2	4.7	12.6	32.7	12.7
Greece	**7.8**	36.6	6.2	4.8	5.6	13.4	26.7	6.6
Hong Kong-China	**1.7**	47.5	6.6	8.7	3.0	15.1	19.1	0.0
Hungary	**8.3**	19.6	1.6	5.5	0.1	15.2	38.0	20.0
Iceland	**5.4**	42.8	0.9	10.6	11.3	8.6	17.7	8.1
Indonesia	**15.9**	15.4	30.3	9.0	0.0	7.6	19.1	18.5
Ireland	**3.6**	16.2	2.8	9.4	1.8	16.8	43.2	9.8
Italy	**6.1**	31.3	4.9	2.0	8.7	8.7	38.1	6.3
Japan	**2.6**	24.0	1.5	8.9	0.6	25.8	26.3	12.8
Jordan	**18.3**	49.7	6.0	9.0	0.3	8.5	13.9	12.6
Kazakhstan	**18.8**	23.1	12.6	2.3	5.9	7.2	31.1	17.7
Korea	**2.1**	29.2	1.4	17.4	0.0	17.9	21.5	12.6
Latvia	**7.0**	32.1	1.3	5.2	0.4	9.0	34.4	17.6
Liechtenstein	**4.8**	10.8	1.2	7.8	16.4	32.0	31.8	0.0
Lithuania	**8.0**	45.5	6.2	6.1	0.3	8.1	20.3	13.6
Luxembourg	**6.8**	8.9	3.5	2.3	9.0	18.1	46.4	11.8
Macao-China	**3.0**	64.0	9.3	6.9	3.9	7.1	7.7	1.1
Malaysia	**14.5**	32.9	7.8	4.7	0.3	14.6	27.0	12.6
Mexico	**11.9**	16.3	7.4	7.1	2.2	16.5	23.0	27.6
Montenegro	**15.0**	45.9	9.0	3.6	0.8	9.8	26.8	4.1
Netherlands	**3.7**	25.5	3.0	8.7	2.4	15.2	38.5	6.6
New Zealand	**4.6**	15.0	14.3	4.1	4.1	13.8	39.7	9.1
Norway	**4.2**	46.8	3.1	7.7	7.4	6.7	20.7	7.6
Peru	**24.4**	7.8	6.2	1.2	0.2	21.8	31.2	31.7
Poland	**4.0**	35.1	2.6	9.9	0.0	15.4	23.4	13.6
Portugal	**6.4**	25.2	3.2	3.1	2.6	19.2	32.5	14.2
Qatar	**23.3**	18.1	8.1	10.1	31.8	8.3	9.5	14.2
Romania	**12.8**	28.0	3.9	5.6	0.2	12.5	34.0	15.7
Russian Federation	**7.3**	22.3	9.8	4.6	1.4	14.3	28.8	18.9
Serbia	**10.4**	38.9	3.2	7.5	0.4	9.4	22.7	18.0
Shanghai-China	**1.1**	27.3	10.3	0.7	0.4	21.8	39.6	0.0
Singapore	**3.3**	25.1	5.9	9.1	0.8	17.5	41.6	0.0
Slovak Republic	**12.0**	17.8	10.9	5.1	0.0	7.1	40.9	18.1
Slovenia	**7.1**	42.2	3.1	2.5	2.6	11.6	33.1	4.9
Spain	**5.4**	24.4	6.0	3.0	7.5	17.5	34.0	7.6
Sweden	**6.9**	35.5	9.0	4.3	9.9	7.9	24.9	8.5
Switzerland	**4.6**	26.9	3.9	4.0	6.6	9.3	40.4	8.9
Thailand	**11.4**	57.6	2.2	1.1	0.1	11.5	16.8	10.7
Tunisia	**12.3**	22.9	9.3	8.5	0.0	12.9	35.8	10.6
Turkey	**7.3**	46.3	16.7	4.4	1.0	9.1	21.2	1.2
United Arab Emirates	**12.4**	30.8	12.2	6.7	17.7	12.5	12.1	8.0
United Kingdom	**3.9**	14.3	8.5	14.8	1.5	9.0	45.1	6.8
United States	**4.9**	26.7	0.7	14.2	5.2	9.7	30.3	13.2
Uruguay	**16.5**	12.3	11.1	5.6	0.1	15.9	30.3	24.6
Vietnam	**3.5**	32.2	14.1	1.4	0.2	12.5	21.6	17.9

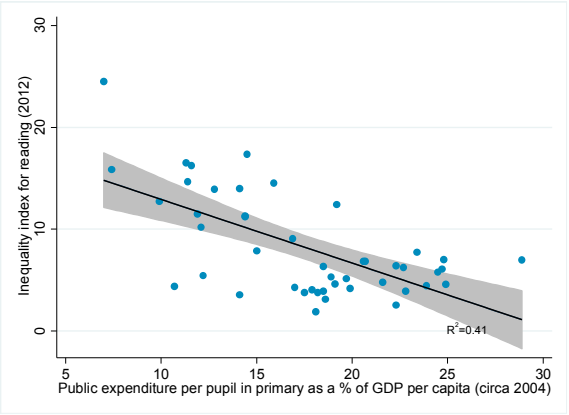
c. Science

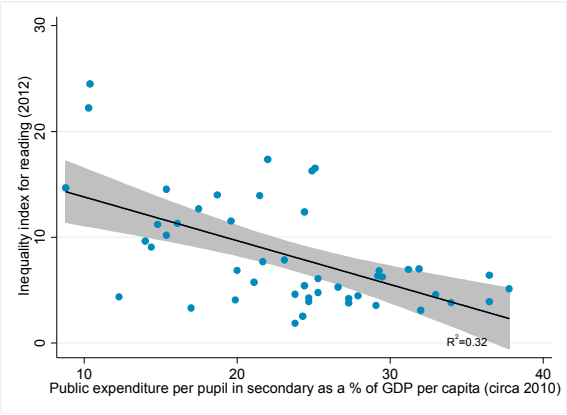
Country	Inequality Index (multiplied by 100)	Share of the Inequality Index						
		Gender	Preschool attendance	Presence of parents	Immigration Status	Max education of the guardian	Wealth	City size
Argentina	**16.6**	1.4	6.4	15.0	1.6	25.1	44.1	6.4
Australia	**4.2**	0.5	5.2	8.6	2.8	25.1	43.3	14.3
Austria	**6.5**	0.5	1.8	3.8	8.7	19.5	58.1	7.5
Belgium	**5.1**	0.4	4.5	10.9	11.8	14.7	50.9	6.9
Brazil	**14.9**	0.4	13.2	10.9	0.7	22.4	35.2	17.2
Bulgaria	**16.7**	6.2	6.5	6.6	0.0	22.4	36.6	21.6
Canada	**2.8**	1.8	9.6	9.1	2.1	19.0	46.5	12.1
Chile	**11.2**	1.2	6.3	10.2	0.0	23.9	42.0	16.4
Chinese Taipei	**4.0**	6.4	2.0	11.7	0.3	24.8	41.4	13.3
Colombia	**15.2**	7.5	8.5	12.9	0.3	21.2	35.2	14.5
Costa Rica	**9.5**	2.9	6.9	7.6	1.3	23.2	42.2	16.0
Croatia	**6.7**	14.1	4.9	3.8	3.6	18.3	37.9	17.5
Czech Republic	**5.7**	0.2	10.9	8.3	1.6	9.5	59.1	10.4
Denmark	**4.6**	0.4	1.6	10.6	6.5	27.5	48.9	4.4
Estonia	**3.0**	11.2	1.4	10.7	2.1	9.2	57.3	8.2
Finland	**4.1**	12.2	6.8	14.5	12.0	22.6	31.1	0.9
France	**6.2**	2.1	3.0	5.6	6.7	18.0	57.9	6.7
Germany	**4.4**	1.9	2.6	5.4	8.2	21.3	51.3	9.5
Greece	**7.8**	10.9	6.1	6.2	7.1	20.6	40.2	8.9
Hong Kong-China	**1.7**	10.7	13.8	7.0	3.5	24.0	41.0	0.0
Hungary	**8.3**	0.3	1.2	5.8	0.0	21.0	51.1	20.6
Iceland	**5.4**	2.4	3.4	22.3	7.6	22.0	36.6	5.6
Indonesia	**15.9**	1.2	37.4	7.5	0.2	14.3	24.3	15.2
Ireland	**3.6**	0.5	2.6	12.3	0.3	23.0	46.1	15.2
Italy	**6.1**	2.5	7.3	5.7	7.9	12.8	55.8	8.0
Japan	**2.6**	2.4	1.5	17.3	1.3	32.7	30.1	14.7
Jordan	**18.3**	26.1	6.4	12.7	0.3	16.9	23.7	14.0
Kazakhstan	**18.8**	2.9	13.8	3.3	6.3	9.7	40.9	23.0
Korea	**2.1**	10.4	4.7	25.3	1.1	15.3	27.3	15.8
Latvia	**7.0**	13.0	0.5	6.4	0.0	14.5	48.1	17.5
Liechtenstein	**4.8**	0.1	3.0	5.0	5.9	39.6	46.3	0.0
Lithuania	**8.0**	10.6	9.8	11.0	0.3	13.2	37.1	18.1
Luxembourg	**6.8**	4.5	2.4	2.2	10.3	24.5	50.1	6.1
Macao-China	**3.0**	15.5	16.8	18.7	3.5	24.9	18.1	2.5
Malaysia	**14.5**	5.3	7.7	8.8	0.0	22.7	37.1	18.4
Mexico	**11.9**	3.0	9.1	9.2	1.9	20.5	28.8	27.6
Montenegro	**15.0**	7.9	12.2	5.2	0.5	27.3	43.0	3.8
Netherlands	**3.7**	0.8	3.1	15.0	2.2	24.1	50.3	4.4
New Zealand	**4.6**	0.4	9.3	4.9	3.4	17.0	54.6	10.3
Norway	**4.2**	2.3	7.3	8.9	16.8	12.5	46.8	5.4
Peru	**24.4**	0.7	7.6	1.8	0.1	25.9	34.3	29.6
Poland	**4.0**	3.9	3.9	9.6	0.0	30.8	36.8	15.1
Portugal	**6.4**	2.4	4.7	5.1	3.1	25.9	39.4	19.5
Qatar	**23.3**	5.0	8.7	11.1	41.4	9.9	9.8	14.2
Romania	**12.8**	3.9	4.5	10.0	0.1	15.4	46.4	19.7
Russian Federation	**7.3**	3.0	8.4	6.9	3.4	21.5	34.9	21.9
Serbia	**10.4**	5.0	4.9	8.3	0.1	13.7	37.0	31.0
Shanghai-China	**1.1**	3.0	15.4	0.1	1.1	24.6	55.8	0.0
Singapore	**3.3**	5.5	3.3	7.5	1.1	24.4	58.3	0.0
Slovak Republic	**12.0**	0.2	13.1	6.7	0.0	8.8	47.4	23.7
Slovenia	**7.1**	8.3	3.3	5.1	6.2	12.1	55.8	9.2
Spain	**5.4**	0.2	6.8	4.2	12.3	24.7	42.1	9.7
Sweden	**6.9**	4.4	9.7	9.5	14.0	12.1	42.4	7.8
Switzerland	**4.6**	1.5	5.0	6.0	12.1	16.5	53.3	5.5
Thailand	**11.4**	21.0	1.9	3.0	0.1	22.4	29.8	21.8
Tunisia	**12.3**	0.7	14.9	11.2	0.4	17.2	43.0	12.6
Turkey	**7.3**	10.5	31.1	7.0	0.9	16.6	28.8	5.1
United Arab Emirates	**12.4**	13.0	15.6	9.7	21.7	15.9	17.0	7.3
United Kingdom	**3.9**	2.2	7.3	25.3	0.8	10.0	47.4	6.9
United States	**4.9**	3.6	1.0	16.9	4.8	17.9	44.4	11.4
Uruguay	**16.5**	0.3	11.3	8.2	0.1	20.4	35.2	24.5
Vietnam	**3.5**	9.3	21.4	1.2	0.3	14.7	27.5	25.6

Source: Authors' calculations based on data from the OECD, PISA 2012

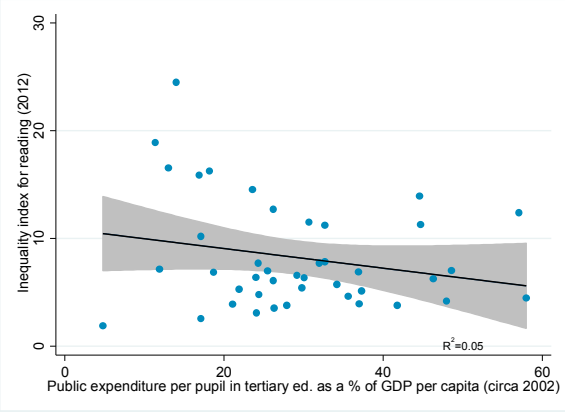
Figure A1. Public spending in education vs. inequality of opportunity in reading

a. Primary education **b. Secondary education**





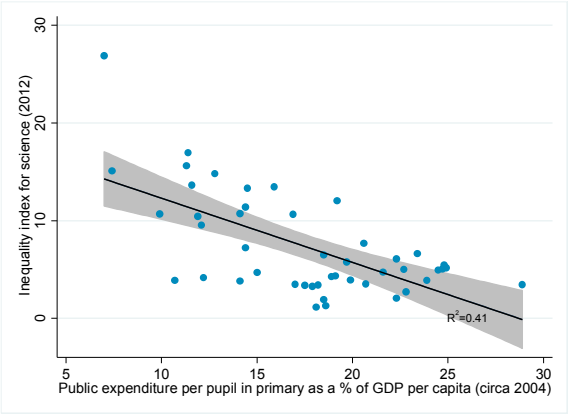
c. Tertiary education

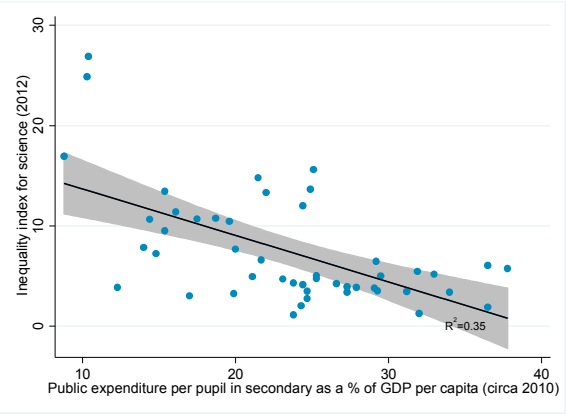


Note: 95% confidence intervals added (shaded area).
Source: Authors' calculations based on data from the OECD, PISA 2012, and UNESCO Institute for Statistics.

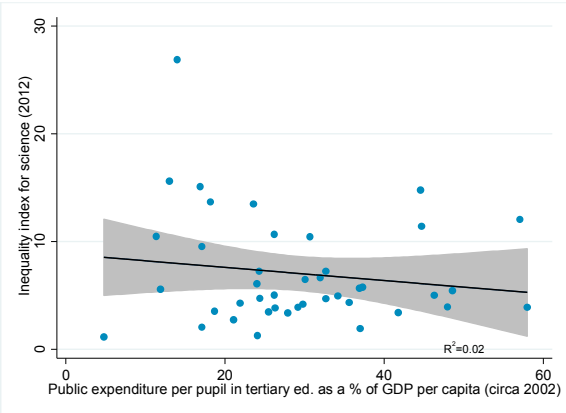
Figure A2. Public spending in education vs. inequality of opportunity in science

a. Primary education **b. Secondary education**





c. Tertiary education



Note: 95% confidence intervals added (shaded area).
Source: Authors' calculations based on data from the OECD, PISA 2012, and UNESCO Institute for Statistics.

Table A3. Ordinary least squares estimates for the effect of public spending on education on coverage

a. Mathematics

Estimated effect of public spending on education on the percentage of students at or above level 2 of proficiency: $C_c = \alpha + \beta spending_c + \boldsymbol{X}_c\boldsymbol{\theta} + \varepsilon_c$

Variable	Dependent variable: percentage of students at or above level 2 of proficiency in mathematics											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	2.3234***	1.6781***	1.1201***	0.8335**								
	(0.4327)	(0.3281)	(0.3266)	(0.3728)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					1.7531***	1.2416***	0.9339***	0.6971**				
					(0.3138)	(0.2060)	(0.2262)	(0.2792)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0132	0.0949	-0.0953	-0.1829***
									(0.1881)	(0.1450)	(0.0873)	(0.0627)
Constant	28.2687***	-19.6369**	30.7339*	33.7934**	28.0430***	-12.7021	33.6660**	34.2367**	70.1429***	4.7220	86.2150***	82.1684***
	(9.0432)	(9.6015)	(15.9090)	(16.4547)	(8.7057)	(9.3282)	(14.5612)	(15.0057)	(6.7087)	(13.4888)	(14.3643)	(13.1625)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.3357	0.7207	0.7960	0.8137	0.3691	0.6734	0.7257	0.7864	0.0002	0.4704	0.7251	0.7978
Observations	46	45	45	45	48	47	46	46	44	44	44	44

b. Reading

Estimated effect of public spending on education on the percentage of students at or above level 2 of proficiency: $C_c = \alpha + \beta spending_c + \boldsymbol{X}_c\boldsymbol{\theta} + \varepsilon_c$

Variable	Dependent variable: percentage of students at or above level 2 of proficiency in reading											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	1.7455***	1.3328***	1.0708***	0.8464**								
	(0.3410)	(0.2947)	(0.3022)	(0.3429)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					1.2438***	0.8986***	0.7134***	0.5253**				
					(0.2288)	(0.1718)	(0.1960)	(0.2225)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0344	0.0342	-0.1029	-0.2033***
									(0.1844)	(0.1665)	(0.1301)	(0.0714)
Constant	45.5490***	13.6072*	37.2520***	39.6477***	46.9921***	19.0021**	44.0147***	44.4681***	77.2121***	35.6910***	94.4547***	89.8202***
	(6.8837)	(7.4234)	(12.0152)	(12.3519)	(6.3460)	(7.1687)	(12.0180)	(11.9496)	(6.3847)	(11.5707)	(16.0151)	(12.9165)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.3586	0.6867	0.7181	0.7386	0.3507	0.6230	0.6312	0.7050	0.0016	0.3002	0.5090	0.6593
Observations	46	45	45	45	48	47	46	46	44	44	44	44

c. Science

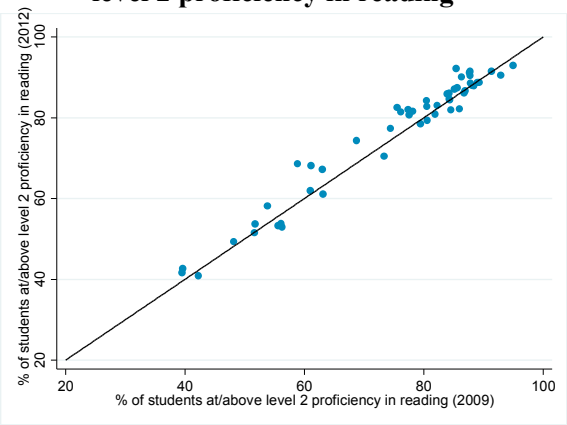
Estimated effect of public spending on education on the percentage of students at or above level 2 of proficiency: $C_c = \alpha + \beta spending_c + \boldsymbol{X}_c\boldsymbol{\theta} + \varepsilon_c$

Variable	Dependent variable: percentage of students at or above level 2 of proficiency in science											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Public expenditure per pupil in primary as a % of GDP per capita (circa 2004)	1.9448***	1.4261***	1.0921***	0.9697***								
	(0.3911)	(0.3078)	(0.3106)	(0.3563)								
Public expenditure per pupil in secondary as a % of GDP per capita (circa 2010)					1.5189***	1.1110***	0.9009***	0.7540***				
					(0.2881)	(0.2015)	(0.2215)	(0.2498)				
Public expenditure per pupil in tertiary ed. as a % of GDP per capita (circa 2002)									-0.0600	0.0230	-0.1334	-0.2055***
									(0.1584)	(0.1287)	(0.0801)	(0.0556)
Constant	41.7426***	3.0130	33.1610**	34.4677**	40.0840***	6.9303	35.4734**	35.8273**	78.3208***	28.0989**	95.1225***	91.7917***
	(8.0516)	(8.6447)	(15.8752)	(16.3203)	(7.8100)	(8.3313)	(14.2981)	(14.6517)	(5.8353)	(12.4689)	(14.4079)	(13.2724)
Average years of schooling (year 2000)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Gini index for income (circa 2002)	No	No	yes	Yes	No	No	yes	Yes	No	No	yes	Yes
GDP per-capita (US$, PPP, 2002)	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
R2	0.3421	0.7088	0.7480	0.7527	0.3967	0.6883	0.6999	0.7342	0.0044	0.3901	0.6300	0.6985
Observations	46	45	45	45	48	47	46	46	44	44	44	44

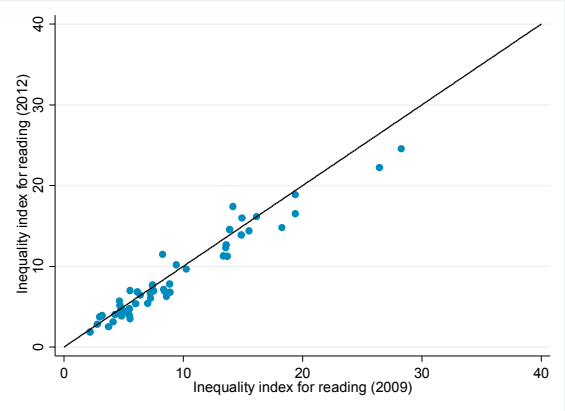
Robust standard errors in parentheses. * Significant at ten percent; ** significant at five percent; *** significant at one percent.
Note: Data on average years of schooling comes from Barro and Lee (2013), we restrict to individuals above 25 years of age; data un public expenditure and GDP per-capita comes from UNESCO's Institute for Statistics to guarantee homogeneity; the data on Gine comes from Milanovic's compilation of Gini indexes.
Source: Authors' calculations based on data from the OECD, PISA 2012, UNESCO, Barro and Lee (2013), and Milanovic:
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22301380~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html

Figure A3. Coverage and inequality of opportunity, 2012 vs. 2009

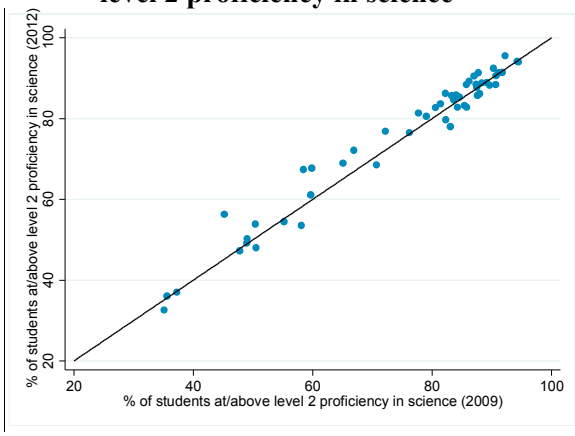
a. Percentage of students at or above level 2 proficiency in reading



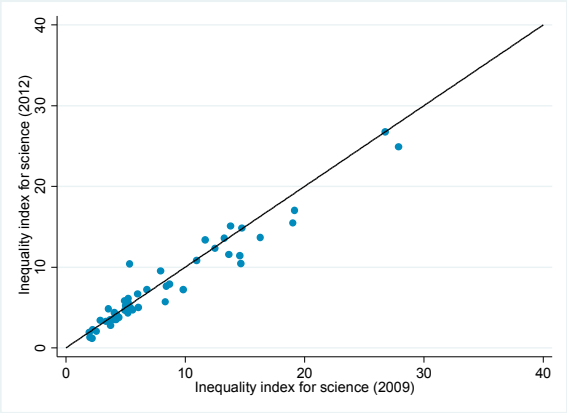
b. Inequality of opportunity in reading



c. Percentage of students at or above level 2 proficiency in science



d. Inequality of opportunity in science



Source: Authors' calculations based on data from the OECD, PISA 2012, and UNESCO Institute for Statistics.

Table A4. Time decomposition by subject and country

Country	Mathematics			Reading			Science		
	Overall change in inequality	Coverage effect (parametric)	Coverage effect (non-parametric)	Overall change in inequality	Coverage effect (parametric)	Coverage effect (non-parametric)	Overall change in inequality	Coverage effect (parametric)	Coverage effect (non-parametric)
Argentina	-4.41	-0.36	-3.51	-2.88	-0.24	-2.83	-3.58	-2.62	-2.74
Australia	0.71	0.49	0.89	-0.25	-0.40	-0.26	-0.07	-0.26	-0.04
Austria	-0.71	-1.37	-0.92	-2.34	-2.85	-2.40	-0.36	-0.97	-0.82
Belgium	0.67	0.44	0.26	0.45	0.19	0.14	0.89	0.62	0.58
Brazil	-1.75	-0.75	-0.43	-0.96	-0.32	-0.58	0.07	1.10	0.70
Bulgaria	-1.19	-1.19	-2.33	-0.03	-0.34	-1.56	0.31	0.12	-0.68
Canada	0.41	0.38	0.49	0.02	-0.01	0.03	0.00	-0.07	0.08
Chile	0.91	1.20	1.05	0.78	1.07	1.02	1.61	2.09	1.69
Colombia	-3.53	-1.77	-2.91	0.69	2.26	0.64	-2.62	-0.94	-2.36
Croatia	-0.86	-1.35	-1.22	-0.61	-1.13	-0.71	-0.24	-0.38	-0.51
Czech Republic	0.06	-0.10	-0.16	-1.58	-1.67	-1.33	-0.06	-0.33	-0.19
Denmark	0.20	0.50	0.66	-0.13	0.14	0.34	0.23	0.51	0.73
Estonia	-0.33	-0.18	0.02	-1.01	-0.64	-0.25	-0.70	-0.57	-0.34
Finland	1.12	1.19	1.00	0.73	0.76	0.78	-0.05	-0.12	-0.12
Germany	-0.31	-0.32	-0.59	-1.12	-1.22	-1.44	-0.53	-0.35	-0.58
Greece	1.56	1.50	1.15	0.23	0.13	0.12	0.47	0.41	0.20
Hungary	1.55	1.05	0.74	0.24	-0.32	-0.59	0.68	0.55	0.13
Iceland	0.92	1.25	0.87	1.04	1.51	0.86	1.28	1.57	1.08
Indonesia	-3.68	-3.95	-3.66	-3.51	-3.70	-4.56	-2.16	-1.61	-1.86
Ireland	-0.60	-0.60	-0.96	-2.00	-1.71	-2.07	-0.67	-0.48	-0.96
Italy	-0.01	0.09	0.11	-1.26	-1.14	-1.13	-1.04	-0.80	-0.63
Japan	0.04	0.16	0.08	-1.20	-1.06	-1.08	-0.52	-0.37	-0.44
Jordan	2.59	3.25	3.03	3.23	4.00	4.27	1.71	2.37	2.42
Kazakhstan	-6.30	-5.22	-5.16	-0.54	0.91	1.13	-4.22	-3.61	-3.34
Korea	-0.77	-0.13	-0.59	-0.32	0.28	-0.15	-1.00	-0.45	-0.98
Latvia	-0.38	0.08	-0.46	0.68	0.88	0.83	-0.36	-0.09	-0.37
Liechtenstein	0.58	1.59	2.88	-0.79	0.73	0.40	-0.09	0.89	0.76
Lithuania	-0.26	-0.36	-0.79	-1.05	-1.24	-1.30	-0.30	-0.48	-0.78
Luxembourg	0.42	0.22	0.13	-2.10	-2.59	-2.35	-0.79	-1.04	-1.17
Mexico	-2.07	-1.19	-1.06	-2.07	-1.23	-1.18	-3.14	-2.48	-2.33
Montenegro	-0.83	0.07	0.96	-1.12	-0.69	0.42	-0.19	0.43	1.35
Netherlands	0.39	0.58	0.56	0.73	0.80	0.84	0.52	0.74	0.87
New Zealand	1.44	1.24	1.34	-0.25	-0.29	-0.38	0.32	0.17	0.14
Norway	-0.37	-0.48	-0.35	-0.60	-0.59	-0.51	-0.35	-0.62	-0.51
Peru	-1.95	-0.14	-0.78	-3.74	-2.00	-2.30	0.01	1.42	1.61
Poland	-1.47	-1.70	-1.49	-1.53	-1.50	-1.42	-0.97	-1.04	-0.88
Portugal	0.42	0.21	-0.32	0.00	-0.46	-0.54	0.86	0.60	0.32
Qatar	-5.70	-1.64	-5.46	-4.24	-2.24	-3.15	-3.01	-0.05	-3.11
Romania	-0.48	-0.96	-2.23	-0.92	-1.86	-2.48	-0.09	-0.55	-1.19
Russian Federation	-1.06	-0.52	-0.84	-1.25	-0.57	-0.68	0.36	0.61	0.79
Serbia	-0.91	-3.19	-2.44	-0.64	-2.44	-2.16	-0.81	-0.20	-1.56
Slovak Republic	3.84	2.21	1.22	3.18	1.39	0.49	5.08	3.67	2.17
Slovenia	-0.06	0.56	0.41	-0.56	-0.22	-0.18	-0.24	-0.13	-0.12
Spain	0.02	0.24	0.25	-0.67	-0.44	-0.42	-0.87	-0.62	-0.64
Sweden	0.80	0.39	0.55	1.45	1.07	0.85	0.28	-0.35	0.06
Switzerland	-0.36	-0.26	-0.19	-0.80	-0.70	-0.76	-0.33	-0.25	-0.22
Thailand	-1.54	-0.56	-0.94	-2.43	-1.82	-2.58	-2.60	-1.88	-2.24
Tunisia	-5.62	-3.76	-5.64	-1.27	-0.22	-1.61	-2.08	-1.08	-2.28
Turkey	-2.58	-1.97	-3.33	-1.56	-0.84	-1.38	-2.64	-1.74	-2.83
United Kingdom	-0.69	-0.42	-0.50	-0.99	-0.63	-0.87	-0.70	-0.42	-0.53
United States	-0.05	-0.08	-0.58	-0.76	-0.69	-1.04	-0.89	-0.86	-1.16
Uruguay	3.93	3.29	2.57	1.02	0.51	-0.56	1.29	0.87	-0.25

Source: Authors' calculations based on data from the OECD, PISA 2009 and 2012