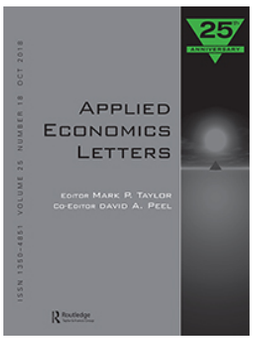

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Achievement effectiveness and equity: the role of tracking, grade repetition and inter-school segregation

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Grouping students together according to their ability – in vocational versus academic tracks, in different grades or schools – is frequently denounced as being ineffective and/or a source of additional inequality. Yet very few international studies have evaluated the effects of these practices on educational performance. This study attempts to fill this gap using standardized scores in maths, science and reading literacy at the age of 15 published by the OECD in 2000. Results are that ability grouping has no impact on effectiveness (country mean scores). And the intensity of inequality (within country dispersion of scores) is also hard to predict. It is only for maths that higher inter-school segregation, but not tracking or grade repetition, leads to higher inequality.

I. Introduction

The persistence of tracks (academic versus vocational) separating pupils according to their ability, the prevalence of grade repetition for low achievers, and school segregation are frequently denounced within educational circles as being detrimental to performance. There is a theoretical literature that generally concludes that ability segregation is not optimal from a societal point of view (Bénabou, 1996). Empirical literature, exploiting national data (Gamoran and Nystrand, 1994), or focusing on segregation and labour market outcomes (Kidd and Goninon, 2000) is also abundant. But, to the author's knowledge, very few empirical studies, using international data, have evaluated the link between ability grouping and educational performance. One possibility to fill this gap is to examine scores at the age of 15 collected in 2000 by the OECD. This data set might help answer a simple question: does ability grouping comes at cost either in terms of lower effectiveness (lower mean score for the country) or higher inequality (higher standard deviation of scores for example)?

This paper is organized in three sections. Section II briefly exposes the methodology. Section III presents the data used, while Section IV contains the results and concluding comments.

II. How to Properly Measure Effectiveness and (In)equality and Relate it to Tracking, Grade Repetition and Inter-school Segregation?

Producing some measure of inequality or effectiveness is really easy. Yet, direct comparison of countries in terms of inequality of achievement or average achievement can be seriously misleading. Gross achievement still largely reflects inter-individual

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Table 1. Descriptive statistics. Average (mean) and standard deviation of scores and socio-economic status (SES) indices. Breakdown by topic and country

	Score						SES					
	Maths		Reading		Science		Maths		Reading		Science	
Country	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
AUS	527.07	94.61	524.65	103.53	522.29	98.44	0.34	0.92	0.34	0.91	0.32	0.90
AUT	505.98	94.85	498.27	94.82	508.02	95.03	0.30	0.73	0.29	0.73	0.28	0.73
BELF	493.65	108.44	480.79	111.77	472.61	118.30	0.11	0.89	0.11	0.89	0.09	0.89
BELN	541.65	95.69	537.36	92.51	519.26	95.10	0.13	0.80	0.17	0.78	0.15	0.80
BRA	352.34	89.04	390.18	91.03	378.60	101.48	−1.37	1.25	−1.39	1.24	−1.37	1.24
CAN	522.21	87.47	522.63	95.74	518.14	90.92	0.26	0.91	0.25	0.91	0.25	0.92
CHE	527.75	97.64	496.08	98.03	496.82	97.67	0.20	0.80	0.21	0.80	0.23	0.79
CZ	499.07	98.17	497.11	94.95	510.51	96.51	−0.29	0.84	−0.25	0.84	−0.26	0.84
DEN	514.22	87.79	498.01	97.56	484.39	100.87	0.22	0.85	0.22	0.84	0.23	0.83
ESP	480.63	91.81	494.12	85.86	491.14	97.24	−0.01	0.85	−0.02	0.84	−0.01	0.85
FIN	533.11	83.19	544.89	88.20	534.02	90.02	0.22	0.82	0.21	0.83	0.21	0.83
FRA	513.58	94.35	502.93	93.36	498.51	102.83	0.05	0.84	0.06	0.82	0.07	0.83
GER	499.77	99.32	498.22	102.91	496.71	100.80	0.34	0.79	0.35	0.78	0.35	0.79
GRC	451.81	103.31	473.86	96.90	463.71	98.02	−0.31	0.94	−0.33	0.94	−0.36	0.93
HUN	486.12	96.83	482.24	91.08	494.17	100.60	−0.27	0.91	−0.26	0.90	−0.28	0.91
IRE	501.72	85.91	526.36	92.81	513.30	91.23	0.01	0.87	0.02	0.88	0.02	0.89
ISL	513.70	87.25	506.49	92.89	496.53	90.27	0.50	0.78	0.50	0.82	0.51	0.84
ITA	461.65	92.53	489.51	90.70	480.47	98.07	0.14	0.81	0.16	0.80	0.18	0.81
JPN	554.55	88.90	523.50	87.30	546.59	93.70	0.06	0.77	0.05	0.77	0.07	0.76
KOR	536.76	86.97	519.57	72.99	540.77	85.43	−0.50	0.80	−0.50	0.79	−0.47	0.80
LEI	511.86	106.59	483.73	93.66	479.22	91.67	0.27	0.77	0.29	0.76	0.28	0.78
LUX	453.52	98.07	449.81	103.42	452.91	99.39	0.22	0.88	0.22	0.87	0.24	0.87
LVA	466.24	102.69	462.76	100.68	464.24	100.24	−0.64	0.97	−0.63	0.96	−0.63	0.97
MEX	406.34	86.88	429.34	88.70	435.11	84.23	−0.99	1.25	−1.00	1.24	−0.99	1.25
NOR	497.97	93.33	503.92	103.74	499.44	98.48	0.50	0.81	0.51	0.83	0.50	0.86
NZ	532.50	97.77	526.10	106.32	523.30	98.63	0.23	0.93	0.24	0.93	0.24	0.93
POL	464.28	100.30	469.13	99.92	475.85	98.20	−0.64	1.00	−0.66	0.99	−0.64	0.99
PRT	462.33	91.95	478.43	95.49	468.68	89.48	−0.04	0.93	−0.04	0.92	−0.05	0.92
RUS	479.18	104.07	463.86	91.72	462.99	101.25	−0.93	0.97	−0.95	0.97	−0.94	0.96
SWE	509.15	94.52	515.36	92.78	510.38	94.76	0.41	0.85	0.42	0.84	0.43	0.84
UK	526.50	92.93	522.00	100.58	525.19	99.05	0.25	0.89	0.24	0.88	0.23	0.88
USA	484.60	97.52	496.19	102.46	490.41	100.36	0.23	1.04	0.22	1.05	0.22	1.05

endowment differences (parental socio-economic background…) (Rainey and Murova, 2004). Ignoring this or assuming implicitly that the average endowment and – more importantly – its distribution within countries is uniform must inevitably skew the results.

We should only conclude to differentials among countries once the effect of structural differences in terms of background/socio-economic status (*SES*) variables has be extracted from the initial variance. This can be done by focusing on *the residual* of a model predicting score using the coefficients obtained with pooled data (all countries together). Any comparison based on a measure of dispersion of the residual (R_{ij}) instead of observed scores should provide a better representation of actual performance of the country in terms of inequality of achievement.

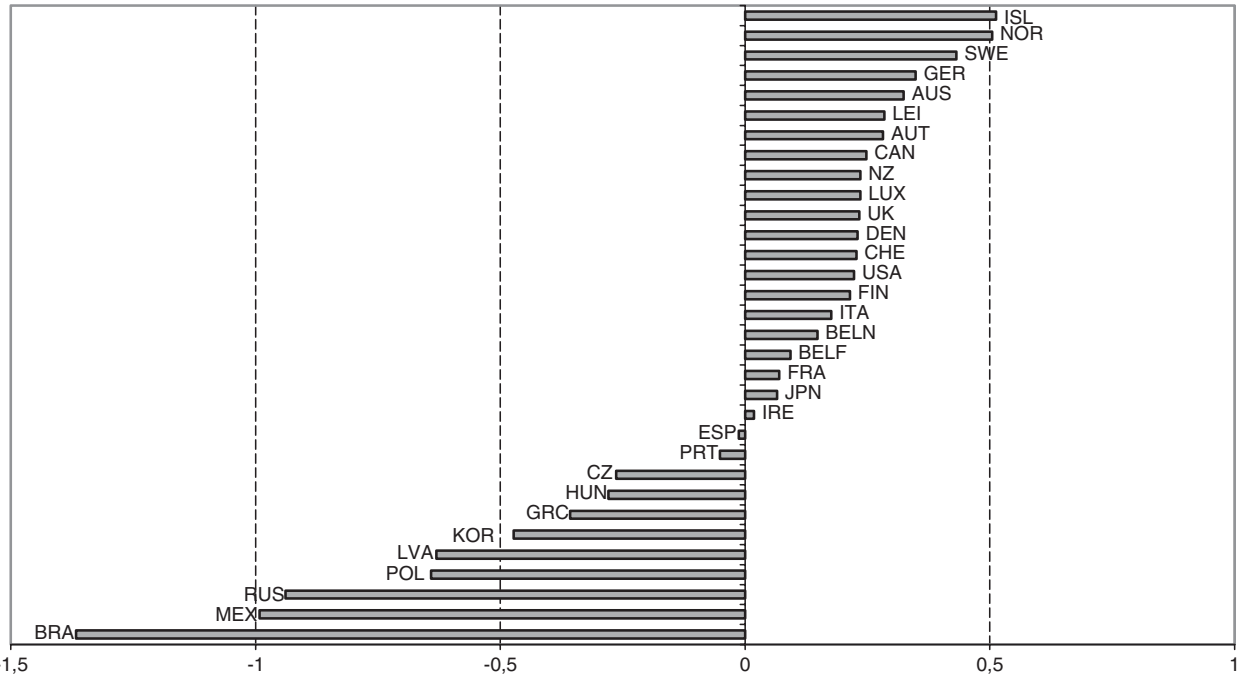
Algebraically, assuming a country fixed-effect and an *SES* slope common to all countries, one has:

$$Pscore_{ij} = \alpha_j + \beta * (SES_{ij} - SES\ldots) \quad (1)$$

$$R_{ij} = Score_{ij} - Pscore_{ij} \quad (2)$$

where:

$Pscore_{ij}$ = expected achievement given a student' *SES*;
SES_{ij} = student' socio-economic profile and *SES*.. the international average;
β = capturing (cross-country) average tendency of scores to vary due to *SES* changes;
$Score_{ij}$ = observed achievement;
R_{ij} = is the residual;
i = student index and j: country index



Australia (AUS), Austria (AUT), French-speaking Belgium (BELF), Dutch-speaking Belgium (BELN), Brazil(BRA), Canada (CAN), Switzerland (CHE), Czech Republic (CZ), Denmark (DEN), Spain (ESP), Finland (FIN), France (FRA), Germany (GER), Greece (GRC), Hungary (HUN), Ireland (IRE), Iceland (ISL), Italy (ITA), Japan (JPN), South Korea (KOR), Liechtenstein (LEI), Luxembourg (LUX), Latvia (LVA), Mexico(MEX), Norway (NOR), New-Zealand (NZ), Poland (POL), Portugal (PRT), Russia (RUS), Sweden (SWE), theUnited Kingdom (UK), the United States (USA).

Fig. 1. Socio-Economic Status (*SES*). Difference to the international mean. Average by country based on the sample of students who took the sciences test.

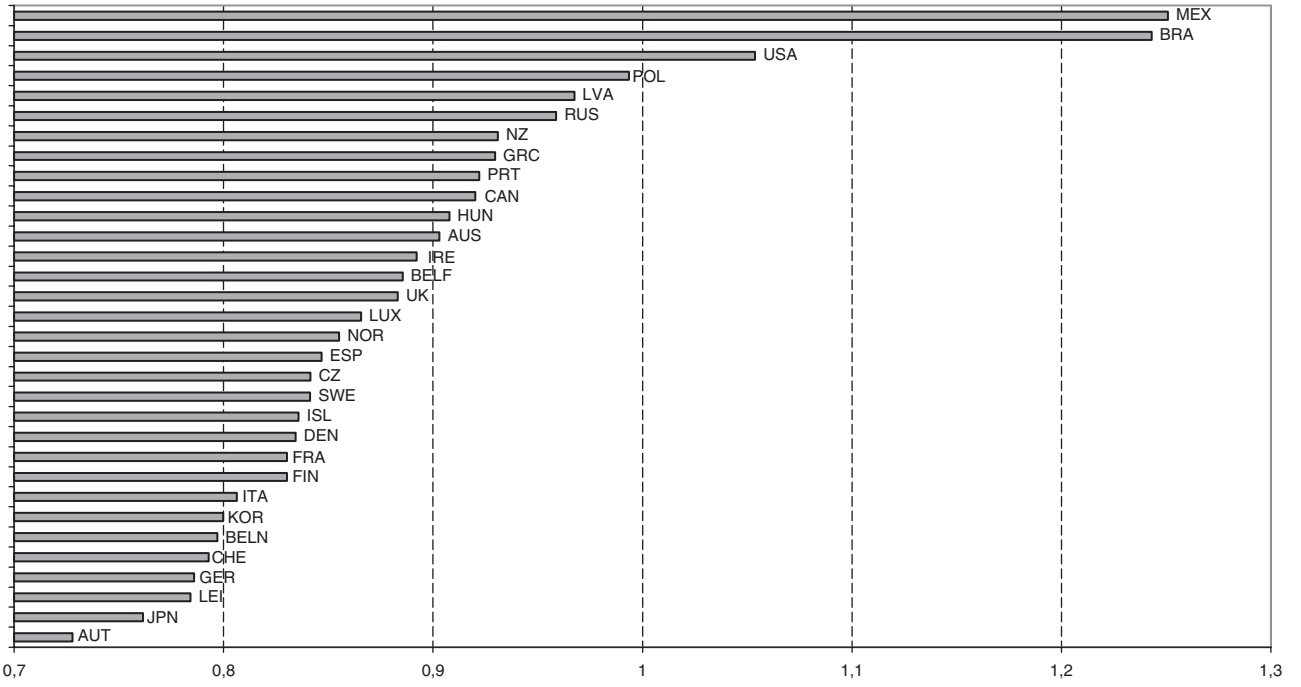


Fig. 2. Socio-Economic Status (*SES*). Difference to the international mean. Standard deviation by country based on the sample of students who took the sciences test.

Table 2. The importance of tracking percentage of pupils attending vocational or prevocational programs. Breakdown by topic and countries.

Country	Maths	Reading	Science
AUS	22.49	22.68	22.41
AUT	43.26	43.65	43.54
BELF	15.77	15.90	15.30
BELN	21.26	19.72	21.10
BRA	0.00	0.00	0.00
CAN	0.00	0.00	0.00
CHE	2.21	2.13	1.94
CZ	15.95	16.46	16.17
DEN	0.25	0.26	0.34
ESP	0.00	0.02	0.00
FIN	0.00	0.00	0.00
FRA	9.24	9.37	8.83
GER	1.94	1.95	2.03
GRC	27.02	27.23	27.42
HUN	29.15	29.51	29.39
IRE	1.88	1.45	1.17
ISL	0.00	0.00	0.00
ITA	0.07	0.08	0.11
JPN	25.55	25.80	25.98
KOR	35.21	35.31	35.07
LEI	0.57	0.32	0.00
LUX	17.82	18.14	18.05
LVA	50.81	49.96	49.65
MEX	38.45	38.89	39.32
NOR	0.00	0.00	0.00
NZ	0.00	0.00	0.00
POL	68.32	67.71	66.96
PRT	4.32	4.43	4.47
RUS	20.38	20.07	19.63
SWE	0.00	0.00	0.00
UK	70.84	71.06	71.00
USA	6.56	5.95	5.78

Table 3. Lagging behind. Percentage of pupils attending a grade inferior the most frequent (modal) grade. Breakdown by topic and country

Country	Maths	Reading	Science
AUS	7.59	6.99	6.71
AUT	49.77	49.19	48.56
BELF	41.45	41.01	42.15
BELN	25.92	24.55	25.5
BRA	59	58.94	24.21
CAN	20.17	20.16	20.25
CHE	15.84	15.84	15.51
CZ	43.41	42.39	43.76
DEN	8.14	8.6	8.31
ESP	28.06	27.24	28.00
FIN	10.91	10.96	11.29
FRA	46.13	45.97	45.83
GER	15.97	15.63	15.9
GRC	4.84	4.64	4.78
HUN	6.65	4.26	6.5
IRE	3.95	3.94	3.98
ISL	1.28	1.63	1.56
ITA	17.29	17.58	17.39
JPN	0.00	0.00	0.00
KOR	1.26	1.3	1.31
LEI	18.86	18.79	18.75
LUX	9.81	19.33	19.13
LVA	44.72	44.8	44.55
MEX	44.29	44.3	44.27
NOR	1.69	1.9	2.43
NZ	7.71	7.83	8.38
POL	0.00	0.00	0.00
PRT	44.72	44.23	44.00
RUS	26.62	26.92	27.29
SWE	2.88	2.88	2.74
UK	34.05	33.82	33.75
USA	43.23	42.2	41.76

By centring SES_{ij} on the international mean ($SES..$), estimated α_j can also be interpreted as expected mean achievement had the average socio-economic profile in country j be equal to the international average ($PSE._j = PSE..$).

The central aim is to capture the potential effect of ability segregation on both effectiveness and inequality. The adopted strategy is based on the estimation of an Ancova[1] model, for each country, capturing the percentage of total (adjusted) variance ($RSQUARE_j$) of adjusted achievement (RES_{ij} in Equation 2) explained by track, grade and school attended ($TRACK$, $GRADE$ and $SCHOOLID$).

The higher the $RSQUARE$, the higher is the level of ability segregation in the country. The absence of segregation would correspond to a situation where all pupils attend the same track, grade and where low and high achievers are present in equal proportions in every school sampled. And in that context our model would be a poor predictor of achievement (i.e., $RSQUARE$ would be close to zero). If, on the contrary, track, grade and school attended are good predictors of achievement then $RSQUARE$ would be close to 1.

$$RES_{ij} = \chi_j + \delta_{ij} * TRACK_{ij} + \phi_{ij} * GRADE_{ij} + SCHOOLID_{ij} + \varepsilon_{ij} \quad (3)$$

where:

$TRACK_{ij} = 1$ if student is attending vocational track; 0 otherwise

$GRADE_{ij} = 1$ if student has undergone grade repetition;[2]

$SCHOOLID_{ij} =$ a school fixed-effect.

[1] Ancova models are regression models combining categorical variables (generally analyzed with Anova models) and continuous ones (i.e. covariates).

[2] i.e. is attending (modal) grade 10.

Table 4. Interschool segregation. Standard deviation of school mean scores. Breakdown by topic

Country	Maths	Reading	Science
AUS	46.48	48.94	45.61
AUT	75.86	83.84	73.80
BELF	79.91	83.35	83.16
BELN	62.93	68.40	62.04
BRA	54.37	59.67	57.97
CAN	47.55	49.88	47.03
CHE	66.00	65.27	63.10
CZ	63.88	68.50	57.71
DEN	43.69	51.21	54.39
ESP	41.36	39.20	43.82
FIN	29.64	33.61	28.95
FRA	63.24	64.36	66.72
GER	71.81	79.10	68.24
GRC	68.61	69.03	58.14
HUN	71.06	80.52	76.98
IRE	34.61	41.01	39.37
ISL	45.30	37.33	44.00
ITA	58.77	67.38	61.22
JPN	58.19	56.57	56.86
KOR	53.63	42.91	50.57
LEI	68.72	58.79	54.94
LUX	54.31	60.31	49.44
LVA	56.97	58.83	53.25
MEX	55.57	62.97	48.10
NLD	60.60	60.97	61.72
NOR	38.56	42.10	41.94
NZ	46.39	46.21	45.72
POL	69.88	75.83	63.21
PRT	50.26	58.10	48.70
RUS	66.13	55.83	57.06
SWE	33.89	32.96	33.59
UK	51.95	54.35	55.44
USA	58.13	57.62	61.05

The last step of the analysis consists of regressing the (adjusted) measure of performance (α_j) and various measures of residual inequality ($INEQ_j$)) on $RSQUARE_j$ (i.e., the level of variance explained by tracking, grade repetition and inter-school segregation in Equation 3).

$$INEQ_j(RES_{ij}) = \gamma + \eta * RSQUARE_j + u_j \quad (4)$$

$$\alpha_j = \zeta + \lambda * RSQUAREj + v_j \quad (5)$$

III. Data

Data used here come from the PISA[3] 2000 OECD survey. They contain maths, science and reading test scores of students aged 15 across 34 OECD and non-OECD countries. These students are nested within schools, potentially attending different grades in countries with grade repetition or tracks. To carry out the analysis, only the 32 countries meeting sampling requirements defined by the OECD is selected.

Table 5. Adjusted measure of *effectiveness* (mean score) regressed on percentage of total variance explained by tracking, grade repetition and inter-school segregation. Breakdown by topic.

		Effectiveness as mean score		
		Tracking	Tracking + grade repetition	Tracking + grade repetition + Interschool segregation
Maths	Estimate	1.69	−0.04	0.20
	Probt	*0.0864*	*0.9559*	*0.7056*
	R^2	0.09	0.00	0.00
Read	Estimate	0.76	−0.30	−0.48
	Probt	*0.2178*	*0.4800*	*0.1215*
	R^2	0.05	0.02	0.08
Science	Estimate	1.73	0.22	0.03
	Probt	*0.0610*	*0.7400*	*0.9577*
	R^2	0.11	0.00	0.00

PISA contains three sorts of indices: (a) highest parental index of occupational status (*HISEI*); (b) family wealth (*WEALTH*); (c) home educational resources (*HEDRES*)[4] that are used to compute the *SES* index. First each index (*HISEI*, *WEALTH*, *HEDRES*) is standardized by topic. The average is then computed and the result standardised again by topic.[5]

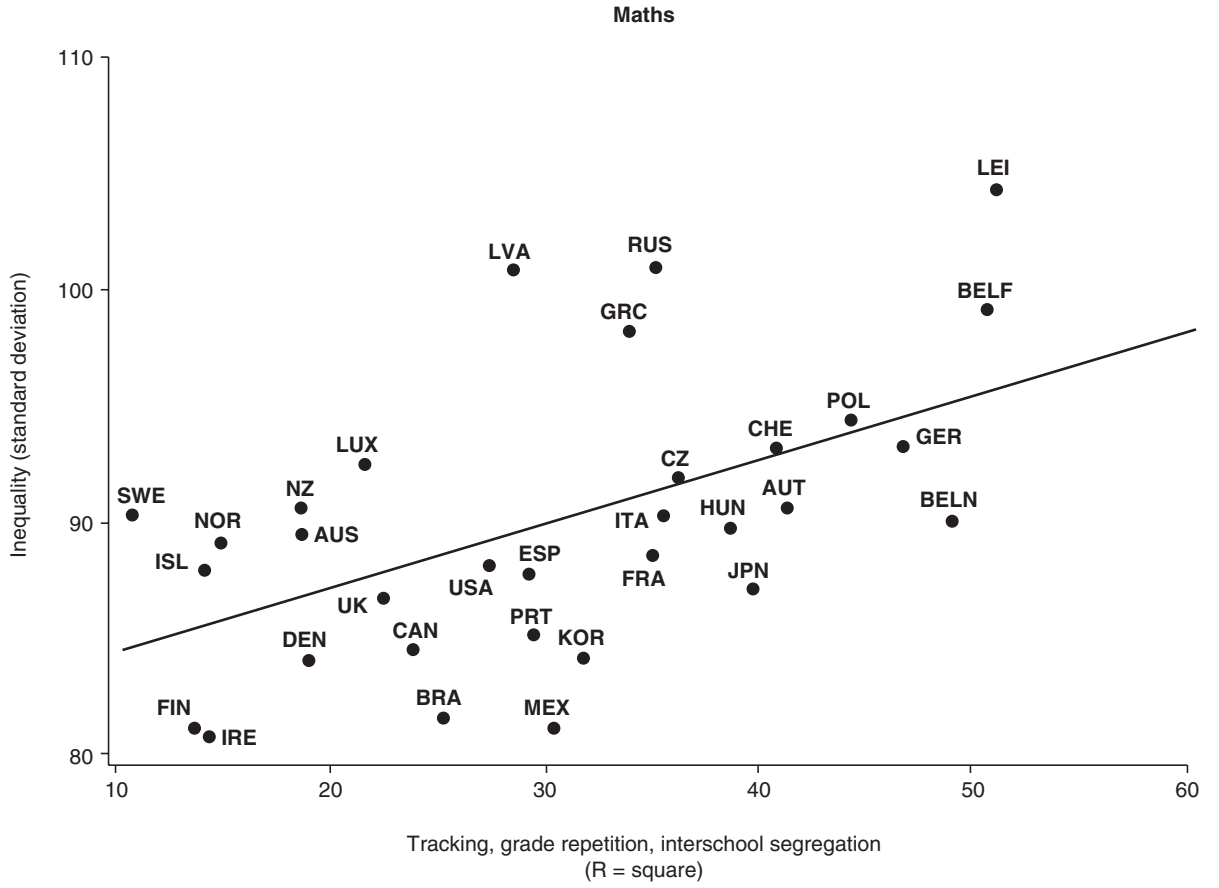
Table 1 gives descriptive statistics about achievement (*SCORE*) and *SES*. As stated in, it is wrong to assume that the average endowment as well as its distribution is the same among countries. A rapid look at the data suggests that countries represented in PISA display diverging *SES* patterns. Average socio-economic profile compared with the international average (i.e. $SES.j - SES..$) is much lower in Brazil, Mexico or Russia than in Nordic countries like Iceland (ISL), Norway or Sweden (Fig. 1). The same is true of distribution as captured by the standard deviation. It is much higher in Mexico, Brazil or the USA than in Austria (AUT) or Japan (JPN) (Fig. 2).

[3] Programme for International Student Assessment.
[4] The reader interested by the methodologies underlying each of these indices should refer to OECD (2002).
[5] In both cases, standardization means imposing that Mean = 0 and Standard deviation = 1.

Table 6. Adjusted measures of *inequality* regressed on percentage of total variance explained by tracking, grade repetition and inter-school segregation. Breakdown by topic.

		Inequality as Interdecile range (9°decile/1°decile)			Inequality as Interquartile range (3° quartile/1°quartile			Inequality as Standard deviation		
Topic		Tracking	Tracking + grade repetition	Tracking + grade repetition + Interschool segregation	Tracking	Tracking + grade repetition	Tracking + grade repetition + Interschool segregation	Tracking	Tracking + grade repetition	Tracking + grade repetition + Interschool segregation
Maths	Estimate	0.47	0.25	0.72**	0.28	0.16	0.42**	0.16	0.07	0.27**
	Probt	0.3619	0.4901	0.0041	0.2529	0.3385	0.0003	0.3908	0.5605	0.0025
	R^2	0.03	0.02	0.24	0.04	0.03	0.36	0.02	0.01	0.27
Read	Estimate	−0.20	−0.33	−0.14	−0.07	−0.14	−0.09	−0.08	−0.15	−0.08
	Probt	0.6439	0.2656	0.5329	0.7875	0.3957	0.4560	0.6542	0.1933	0.3785
	R^2	0.01	0.04	0.01	0.00	0.02	0.02	0.01	0.06	0.03
Science	Estimate	0.04	0.14	0.36	−0.05	0.10	0.26	0.04	0.06	0.15
	Probt	0.9454	0.6944	0.2159	0.8481	0.5912	0.0702	0.8141	0.6413	0.1395
	R^2	0.00	0.01	0.05	0.00	0.01	0.11	0.00	0.01	0.07

Notes: ** significant at 1%.



Au stralia (AUS), Austria (AUT), French-speaking Belgium (BELF), Dutch-speaking Belgium (BELN), Brazil (BRA),Canada (CAN), Switzerland (CHE), Czech Republic (CZ), Denmark (DEN), Spain (ESP), Finland (FIN), France (FRA),Germany (GER), Greece (GRC), Hungary (HUN), Ireland (IRE), Iceland (ISL), Italy (ITA), Japan (JPN), South Korea (KOR), Liechtenstein (LEI), Luxembourg (LUX), Latvia (LVA), Mexico (MEX), Norway (NOR), New-Zealand (NZ), Poland (POL), Portugal (PRT), Russia (RUS), Sweden (SWE), the United Kingdom (UK), the United States (USA).

Fig. 3. Inequality performance and ability grouping – Maths

Table 2 contains descriptive information about tracking and grade repetition. To capture the importance of tracking in each country, a dummy variable (*VOC*) was constructed equal to 1 if student was attending a vocational or pre-vocational programme and equal to 0 otherwise. Table 2 simply reports frequencies by topic and by country.

Table 3 reports the same kind of information about the attended grade. Most likely due to diverging policy options, students' distribution between grade can be: (a) totally concentrated (all 15 year-olds attend the same 'normal' grade[6]) or (b) extremely dispersed (significant proportion of 15 year-olds attend 'below-normal' grades).

Finally, Table 4 gives an idea of countries' propensity to concentrate low and high achievers into different schools (i.e. inter-school segregation). It displays standard deviation of school mean score, and suggests significant differences across countries, with some strong correlation between topics inside each country.

IV. Results and Comments

Tables 5 and 6 contain the main results. Table 5 clearly hint at a lack of correlation between effectiveness defined as the (adjusted) mean score and tracking alone (column 1), tracking + grade repetition (column2) and tracking + grade repetition + inter-school segregation (column 3). This result holds for maths, reading and sciences.

[6] Modal grade is used as reference (grade 10 in most countries).

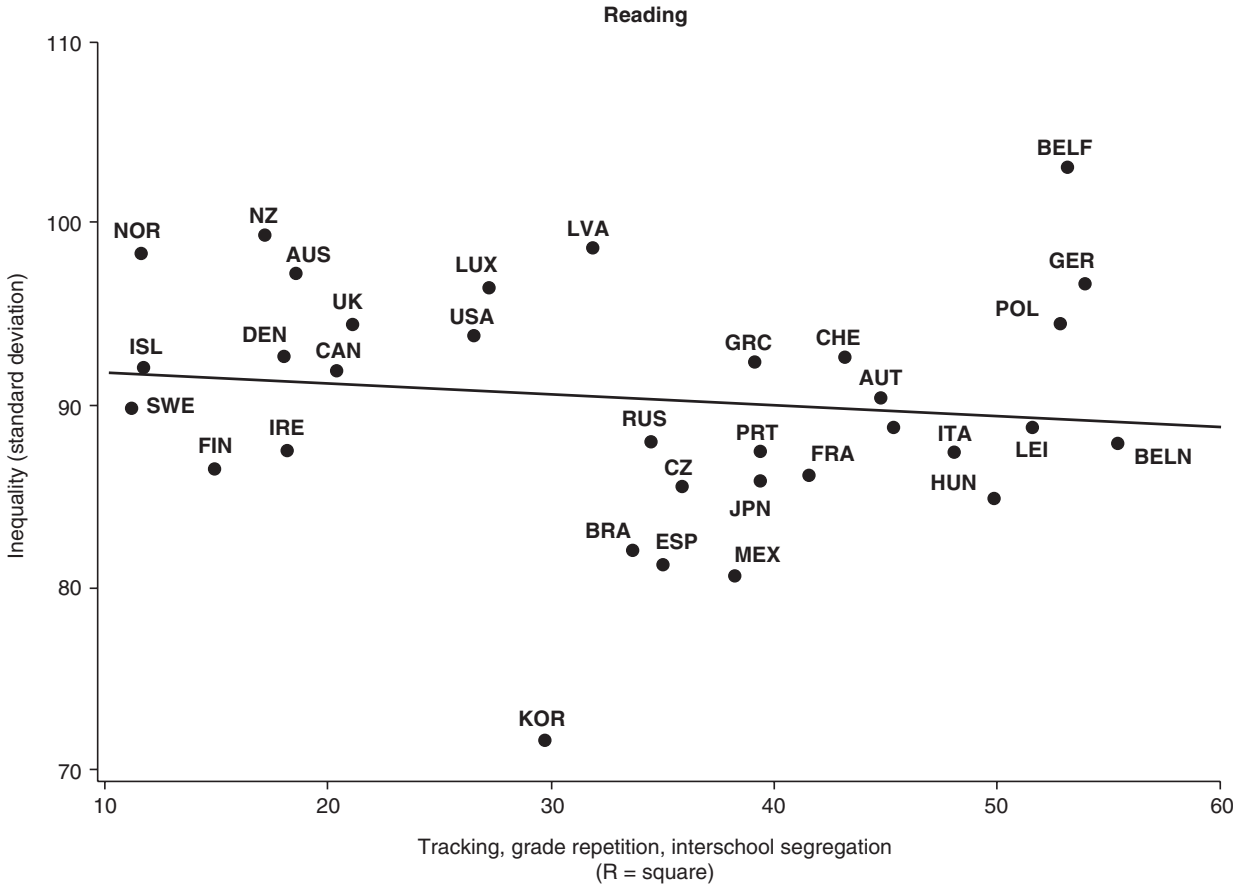


Fig. 4. Inequality performance and ability grouping – reading

As regards to inequality (Table 6), some robust and positive impact of segregation is found; but for maths only (see Fig. 3 for visualization) and only for the marginal gain in explained variance generated by the addition of a school fixed-effect in Equation 3. Coefficients and *pvalues* reported in columns 1 and 2 of Table 6 also suggest that nor tracking nor tracking + grade repetition reliably predicts the level of inequality.

In brief, these results indicate that ability grouping does not systematically predict educational performance. None of the results supports the view that effectiveness (mean score) is affected by the intensity of ability grouping. And the intensity of inequality (dispersion of scores among students) is also hard to predict. It is only for maths that we have some piece of evidence suggesting that inter-school segregation (but not tracking or grade repetition) leads to more inequality.

The usual reservations apply. Results presented here are based on a definition of ability segregation that completely ignores inter-classroom segregation: a practice that is commonplace across most educational systems. Yet, our results are in line with those of Betts and Shkolnik (1999) or Vandenberghe (2002) and suggest that could be abusive to systematically see ability-grouping as the main source of poor educational performance.

As to inequality in particular, one would suggest the need for further research, using other international data. But one would also be advised to consider other determinants of achievement, particularly non-monetary parameters (Hanushek and Luke, 2003) like organization and incentives.

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