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School Segregation Across the World: Has Any Progress Been Made in Reducing the Separation of the Rich from the Poor?

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Abstract
The segregation of secondary school students into different schools has important implications for educational inequality, social cohesion and intergenerational mobility. Previous research has demonstrated how between-school segregation varies significantly across countries, with high levels of segregation occurring in central European nations that 'track' children into different schools and much lower levels in Scandinavia. This paper contributes to this literature by examining whether industrialised countries have made any progress in reducing levels of between-school segregation over time. Using six waves of data from the Programme for International Student Assessment (PISA), this work shows how the segregation of rich and poor students has remained broadly unchanged across OECD countries. This is despite major economic and political events occurring during this period, along with the introduction of numerous policy initiatives designed to reduce socioeconomic gaps. Therefore, the conclusions indicate that structural factors are likely to be the main drivers of between-school segregation (e.g. neighbourhood segregation or long-standing school admission policies) and that education policymakers may need to be much more radical if they are to foster greater levels of integration between the rich and the poor.

Keywords School segregation · PISA · School composition

1 Introduction

The uneven distribution of students from different social classes across schools is a matter of concern to educational policymakers across the world. Although the extent and mechanisms

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by which school composition effects are displayed is a matter of dispute, there is a general agreement that composition matters and shapes educational outcomes (Thrupp 1995). Indeed, previous research has suggested that having a higher proportion of students from advantaged backgrounds as one's peers has a positive effect on a range of educational outcomes (Van Ewijk and Sleegers 2010). Moreover, student performance is more strongly related to socioeconomic status than to other compositional characteristics such as gender, immigrant condition or race (Rumberger and Palardy 2005). Consequently, schooling systems which tend to cluster students of low socioeconomic status together could be increasing educational inequality and reducing social mobility over time (Levaçić and Woods 2002). The effects of social segregation between schools is not limited, however, to student achievement alone; previous research has also found that greater levels of between-school segregation also have an effect on school attendance, grade retention and behaviour (Palardy 2013; Palardy et al. 2015). The extent of between-school segregation in an education system therefore matters, with some believing that encouraging greater mixing of young people from different social backgrounds is key to reducing educational inequalities. Indeed, some scholars have even argued that socioeconomically segregated schools fail to prepare students for facing diversity (Massey and Fischer 2006) and may even be a threat to social cohesion (Gorard 2009; Mickelson and Nkomo 2012).

Yet despite the significant academic and policy interest that has been shown in school segregation, relatively little work has investigated how between-school segregation compares across countries and whether this cross-national picture has changed over time. This is in spite of comparative benchmarks (be they historical levels of segregation within a country or relative standings compared to other countries) being critical to interpreting the results. In other words, the only way to really judge whether segregation is 'too high' is to draw comparisons either (a) across countries and/or (b) over time. Important exceptions include Gorard and Smith (2004), who use PISA 2000 to estimate segregation levels in 15 European Union (EU) countries. They concluded that segregation based on parental occupation was greatest in Greece and Portugal and lowest in Luxembourg, Sweden and Ireland. Likewise, Jenkins et al. (2008) also used PISA data (from 2000 and 2003) to compare school segregation levels in England with 26 other industrialised countries. England was found to have average levels of segregation, with Austria, Belgium, Germany and Hungary being high-segregation countries, while Scandinavia had comparatively low-levels of between-school segregation. More recently, Chmielewski and Savage (2015) analysed the segregation of the United States (US) and Latin American countries. Their estimates, based upon PISA 2012, found that Latin American countries were more segregated than the OECD average and the United States. This is consistent with the results of Murillo and Martínez-Garrido (2017), who found that Latin American countries exhibit high levels of segregation—and is perhaps the most socially-segregated region anywhere in the world.

This paper aims to contribute in several ways to this small but growing literature on how between-school segregation compares across the world. First, rather than focusing on only one region or 'type' of education system, it includes all OECD countries. This provides a more comprehensive set of benchmarks against which to

compare each country. Second, some previous papers have focused upon segregation using a single threshold—typically the median value in a socioeconomic status index (e.g. Jenkins et al. 2008). However, such an approach potentially misses out important and interesting differences, such as segregation between the poorest (or richest) students and the rest of the population. Such an approach may therefore give only a partial insight into the level of segregation across education systems. In contrast, this paper provides a range of results for each country using different thresholds to separate students into different groups. Third, the two previous cross-national studies on school segregation using PISA based their estimates on the parental occupation of the students (Gorard and Smith 2004; Jenkins et al. 2008). There are some limitations with this measure since it is based upon parental occupational status alone and is only quasi-continuous. In contrast, this work relies upon the PISA Economic, Social, and Cultural Status index, which is a more comprehensive measure of students' socioeconomic status, encompassing maternal and paternal education, maternal and paternal occupation, and household possessions (a commonly used proxy for household wealth).

Finally, a significant limitation of the existing literature is that it is cross-sectional and has not considered whether countries have made any progress in reducing between-school segregation over time. With six cycles and 15 years of PISA data now available, this represents the first study to consider this issue. This is important as the world has changed in many ways over the last decade and a half, including undergoing a major worldwide recession and significant changes to the distribution of income. Moreover, many countries have introduced educational policies attempting to widen school choice for parents, while also striving to increase competition between schools. At the same time, a lot of policy attention has focused upon 'narrowing the gap' between the richest and poorest pupils, all of which could influence the segregation of students from different social classes into different schools.

With the above in mind, this paper therefore attempts to answer two research questions:

> Research Question 1. How does between-school segregation compare across OECD countries? Do some countries stand out as more highly segregated than others?
> Research Question 2. How has between-school segregation changed across the OECD between 2000 and 2015? Which countries have made progress in reducing segregation, and which have regressed?

The paper now proceeds as follows. Section 2 describes common measures of between-school segregation, while section 3 describes the PISA data. The results follow in section 4, with conclusions and directions for future research in section 5.

2 Measures of Segregation

A variety of indices have been developed to measure the segregation of individuals across different groups. These indices differ in terms of their statistical properties (Massey and Denton 1988; Allen and Vignoles 2007), as well as whether they attempt to measure segregation between just two or multiple groups (Reardon and Firebaugh 2002). In the

school-segregation literature, measures usually incorporate "evenness" and "exposure". Evenness refers to differences in the distribution of two social groups among schools in a country. A school system is even if the allocation of students to schools matches their overall proportion at a national level. A school system is uneven if the proportion of students within one or both groups at schools greatly differs from their national proportion.

Exposure refers to the degree of potential contact, or the possibility of interaction, between two different groups within schools in a country. The probability of interaction between groups is given by the proportion of individuals per school who are part of each group. A very segregated school shows low exposure, as there are very few students from other groups than the majority group. Examples of indicators measuring exposure are the interaction index or the isolation index.

The most frequently used indices of segregation in education are the Dissimilarity Index (D), usually called the Duncan Index (Duncan and Duncan 1955), and the Square Root Index (H), or Hutchens Index (Hutchens 2001). These two indices will be used in this paper. Both are measures of evenness, as they assess whether the distribution of students in two defined groups within a school differs or not from the overall proportions in the population.

The Dissimilarity Index is a measure which aims to reflect the different distribution of two groups (e.g. students of high and low socioeconomic status) among specific units (e.g. schools). Formally, and in order to measure school segregation among groups A and B in country c, the D-index is defined as follows:

$$D_c = \frac{1}{2}\sum_{i=1}^{S}\left|\frac{a_i}{A}-\frac{b_i}{B}\right| \tag{1}$$

In reference to this paper, A and B represent the total number of students in country c who belong to groups A and B, respectively. The total number of schools in country c is S, and the number of pupils in school i for group A and B are a_i and b_i respectively. The index ranges from zero to one. A value of zero indicates that the proportion of both groups in every school is equal to the proportions found in the population (i.e. there is no segregation). In contrast, a value of one indicates that there is complete segregation of pupils, such that all schools only have one group of students represented. The dissimilarity index thus measures the percentage of students from a group that would have to change school in order for each school to have the same percentage of that group as is found in the national population.

The Square Root (H) index also aims to reflect the distribution of two groups of students across schools. The main advantage of H over the D index is that it is possible to decompose segregation into different parts (e.g. into segregation that occurs within state schools to segregation that occurs within private schools). Using the same notation as for the dissimilarity index above, the square root index is defined as:

$$H_c = \sum_{i=1}^{S}\left(\frac{a_i}{A}-\sqrt{\frac{a_i b_i}{A B}}\right) \tag{2}$$

For each school (i) a measure of how far students from group B are from the average proportion of students in group A is estimated. If the proportion of students in group B is exactly the same as the proportion of students in Group A in each school, then there is no segregation, and the index takes the value zero. On the other hand, when the proportion of Group B students is zero, there is complete segregation, meaning the index is then equal to 1.

When estimating segregation between two groups, the dissimilarity index has several attractive features. It is straightforward to compute, can be interpreted by a wide audience, and has the important properties of composition and scale invariance when measuring segregation between two groups.[1] However, one of its main weaknesses is that it does not comply with the so-called principle of exchanges (see Reardon and Firebaugh, 2002). That is, the D index does not remain constant after a fixed number of students exchange places between two schools which are over or underrepresented in a certain group.[2] It also does not allow for the decomposition of segregation between and within schools.

On the contrary, one of the main advantages of the H index is its property of decomposability, which allows segregation to be decomposed by subcategories. For instance, total segregation can be decomposed between and within schools, or between private and public schools. In practice, however, it produces very similar estimates to the D-index, as it shall be illustrated in this paper (for details, see Appendix A). Consequently, we focus upon results using the dissimilarity index (D) due to its desirable interpretation and previous use throughout a wide literature spanning the social sciences (e.g. Jargowsky 1996; Burgess et al. 2005; Gorard 2009). Nevertheless, in Appendix B, alternative results using the Hutchens index are reported, illustrating that this does not have an impact upon the substantive conclusions presented in this work.

The choice of using two alternative measurements of 'evenness' (D and H) is to test the robustness of the results, as neither index is flawless. Hence it seems prudent to check whether estimates of segregation for different countries are affected by features of the particular segregation measure used. Moreover, in this work, no attempt has been made to assess the levels of segregation using other dimensions (such as 'exposure'). This is due to the fact that exposure indices typically take into consideration not only the distribution of a minority group across the units (e.g. schools), but also the size of the minority group. As has been argued in previous work, education policy can only influence the distribution of students across and within schools but has no power to influence the size of the social groups (Allen and Vignoles 2007).

3 Data

This work uses data from six waves of the Programme for International Student Assessment (PISA), covering the years 2000 to 2015. Most current OECD members have participated in every round, though a handful began their participation later than 2000.[3] Consequently, this

[1] Composition invariance refers to the fact that a measure of segregation does not change if all inputs change their scale simultaneously (for instance, if they are weighted for a specific factor). Scale invariance, on the other hand, means that the index will not be affected by the size of the groups under analysis as soon as they are representative.

[2] For instance, if n people from group A are transferred from school x to school y, and another group of n people from group B are transferred from school y to school x, then the final index remains constant if school x or y are under or overrepresented by a certain group.

[3] The following OECD countries are included in the analysis: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. For the United Kingdom, estimates are presented separately for England, Northern Ireland, Scotland and Wales.

paper considers how between-school segregation compares over this 15-year period for most of the OECD member states. The analysis focuses upon the OECD nations only as (a) non-OECD members have tended to enter PISA post-2006, and hence have limited data available to consider trends over time and (b) some suffer from the problem of having a significant number of 15-year-olds who are no longer enrolled in school (Spaull 2019).

The PISA target population are 15-year-old students who are in school, irrespective of school type and grade. A two- or three-stage sampling procedure is used in each country in order to draw a nationally representative sample. Specifically, a random sample of schools is first drawn as the primary sampling unit (with probability proportional to size) and then at least 30 pupils are then randomly selected within each school. To be included in the PISA study, the OECD demands each country achieves an 85% response rate for schools and 80% for students, with most countries exceeding these criteria. However, as illustrated by Table 1 with respect to the 2015 round of PISA, in some countries there are non-trivial levels of non-response (e.g.

Table 1 School and student participation rates in PISA 2015

	School response % (after replacement)	Student participation rate (%)
Luxemburg	100	96
Finland	100	93
Estonia	100	93
Spain	100	89
South Korea	99	99
Japan	99	97
Greece	99	94
Germany	99	93
Sweden	99	91
Czech Republic	99	89
Ireland	99	89
Poland	99	87
Austria	99	71
Slovak Republic	98	91
Mexico	97	95
Chile	97	94
Switzerland	97	93
Hungary	97	92
Turkey	96	95
Belgium	95	91
Slovenia	95	91
Norway	95	91
France	95	88
Iceland	95	86
Portugal	94	82
Latvia	92	90
Netherlands	92	85
Australia	92	81
Israel	91	91
UK	91	88
Denmark	89	87
Italy	87	89
New Zealand	84	80
USA	83	90
Canada	72	81
OECD average	**95**	**89**
OECD median	**97**	**91**

Canada, the Netherlands, New Zealand). Response weights have been calculated by the OECD to adjust estimates for non-random non-response, and these are applied throughout the analyses. Although the total number of participating students and schools varies across countries, in each nation at least 150 schools and 2069 students take part.

As argued by an anonymous reviewer of this paper, whether one should report standard errors, confidence intervals and statistical significance tests when there is non-response to a sample survey is open to debate. The convention is that such inferential statistics are still reported, despite the non-response meaning that the sample is no longer technically completely random (as respondents are likely to differ in their characteristics from non-respondents, this is likely to induce an element of non-random sample selection). However, some have argued this is not appropriate, and no such statistical inference (whether it be *p*-values, confidence intervals or standard errors) should be reported (Gorard 2015). Regardless of the approach taken, our substantive conclusions remain unchanged. But, to recognise both perspectives, we use the following approach in this paper. At the request of the anonymous referee, we have excluded confidence intervals, standard errors and significance tests when reporting the results in the main body of the paper. Such inferential statistics are however provided in the supplementary material – and do little to alter our substantive interpretation of the results.

To estimate between-school segregation within each country the PISA Economic, Social, and Cultural Status (ESCS) index was used. This combines students' self-reported information on parental occupation, parental education and household possessions into a continuous index via a principal components analysis.[4] With the release of PISA 2015, the OECD has created a rescaled version of the ESCS index to ensure it is comparable across all years (this is available from http://www.oecd.org/pisa/data/2015database/). Yet some limitations with this measure of socio-economic status remain. First, by combining information across different socio-economic status indicators, some information (and variation) is lost compared to using the underlying original variables. Second, all the socio-economic information available in PISA is based upon student reports and may thus be subject to some measurement error (see Jerrim and Micklewright 2014 for further discussion of this issue). These caveats with respect to the quality of the ESCS measure should be kept in mind when interpreting the results.

3.1 Measuring Segregation in Schools

The analysis began by dividing the population into two groups and then estimating the Dissimilarity index detailed in eq. (1). In other words, the proportion of pupils of high and low socioeconomic status within each school was calculated and compared to the proportion of students of high and low socioeconomic status in each country's population. Given that the

[4] Although the ESCS is coded for most students, a small proportion did not provide complete information answers. Where one of the socio-economic status measures that form the ESCS index was missing, the survey organisers used imputation to fill-in the missing data. Where two or more socio-economic status indicators were missing, the ESCS index was defined as missing. In general, response rates to the students' questionnaire were very high.

ESCS index is continuous, any cut-off point could be used to divide pupils into high and low socioeconomic groups. For instance, previous international comparative research has chosen the national median of the ESCS index, with half of pupils defined as 'high SES' and half the population as 'low SES'.

However, given that the decision on where to set this cut-off point is arbitrary, a series of results using multiple different values is presented. Specifically, each country is divided into high and low SES groups defined using each national ESCS decile. For instance, to estimate how segregated the poorest 20% are from the remaining 80%, the population in each country is divided into two groups based upon the 20th ESCS percentile.

This process is then repeated using a different decile of the ESCS index as a cut-off point (e.g. separating the bottom 30% of the national population according to the ESCS index from the remaining 70%). This has been done for each OECD country and each round of PISA. For selected countries with interesting findings, graphs illustrating the full set of results are presented. Otherwise, this paper focuses upon:

- Segregation of the bottom ESCS quintile from the remaining 80% (P20 cut-off point).
- Segregation at the ESCS median (P50 cut-off point).
- Segregation of the top ESCS quintile from the bottom 80% (P80 cut-off point).

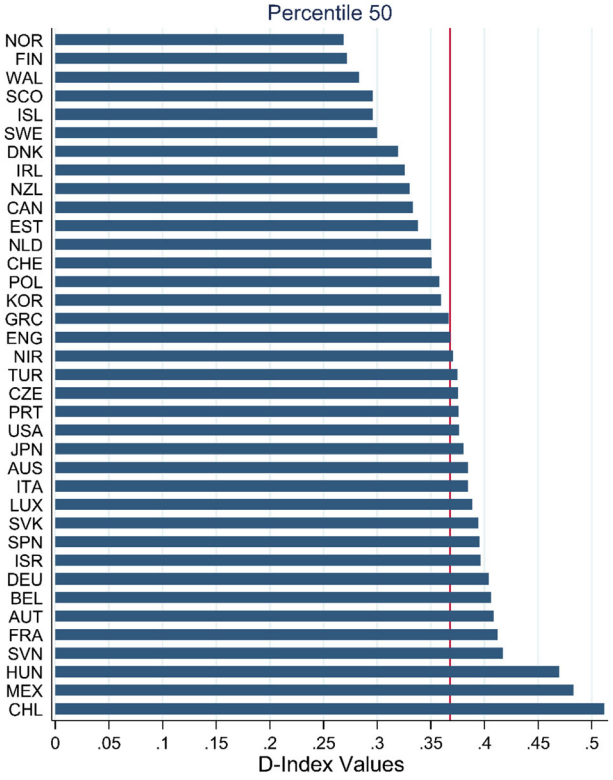

Fig. 1 Estimates of School Segregation Across OECD. Countries. Notes: Figures refer to the value of the D index when dividing students into 'high' and 'low' socioeconomic groups based upon the national median of the ESCS index

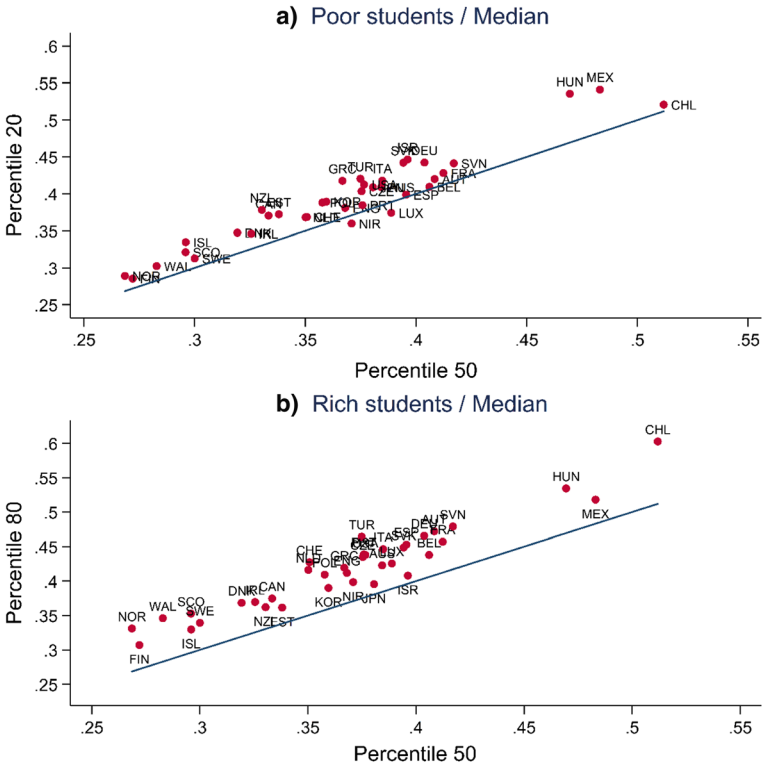

Fig. 2 Comparison of D-Index Values for Three Social Groups. Notes: Figures refer to the value of the D index. Values along the x-axis refer to estimates when dividing students into 'high' and 'low' socioeconomic groups based upon the national median of the ESCS index. The y-axis in the left-hand panel presents the estimated D-index when the 20th percentile of the ESCS is used to separate the most disadvantaged 20% of children from the remaining 80%. In contrast, the y-axis in the right-hand panel uses the 80th percentile of the ESCS index to divide the most advantaged 20% of children from the remaining 80% of the population

4 Results

Before considering trends over time, a comparison is presented of how the between-school segregation is displayed across countries. To smooth differences between years and obtain a general picture regarding levels of segregation, we averaged the estimated value of segregation across all the PISA rounds. This produced one value for each country, representing the average across the six PISA cycles (covering 15 years). These results are presented in Fig. 1, using the median value of the ESCS index as the cut-off point. Alternative results using P20 and P80 are provided in Appendices C and D, with the cross-national picture not differing substantially regardless of which cut-off point is used (indeed, the correlation between results is typically above .90 using the various different threshold values). The vertical red line in Fig. 1 illustrates the OECD average.

The average value of the D-index across OECD countries is 0.38. Countries, where between-school segregation is distinctly below this value are Norway, Finland, Wales, Scotland, Iceland and Sweden. On the contrary, Hungary, Mexico and Chile are amongst the countries with greater levels of segregation. In terms of general patterns, these results are

Table 2 Estimates of Between-School segregation (D) Across Countries (2000–2015)

	Percentile 20							Percentile 50							Percentile 80						
Country	2000	2003	2006	2009	2012	2015	Trend	2000	2003	2006	2009	2012	2015	Trend	2000	2003	2006	2009	2012	2015	Trend
Australia	.42	.39	.39	.38	.42	.45	N	.40	.38	.35	.37	.39	.41	N	.45	.41	.40	.40	.43	.44	N
Austria	.43	.45	.41	.42		.39	N	.38	.46	.41	.38		.41	N	.45	.49	.48	.48		.46	N
Belgium	.39	.45	.40	.40	.41	.41	N	.37	.42	.40	.43	.41	.40	N	.45	.44	.42	.48	.43	.42	N
Canada	.36	.38	.37	.38	.37	.36	N	.32	.35	.35	.32	.32	.33	N	.38	.36	.41	.37	.37	.36	N
Chile	.52		.53	.51	.54	.51	N	.51		.52	.52	.52	.49	N	.60		.63	.59	.62	.57	N
Czech Republic	.40	.41	.39	.38	.42	.43	N	.40	.39	.35	.34	.38	.40	N	.45	.45	.40	.38	.46	.47	N
Germany	.43	.47	.46	.44	.44	.41	N	.40	.44	.37	.40	.43	.38	N	.47	.51	.44	.47	.46	.43	N
Denmark	.34	.33	.33	.35	.36	.38	N	.30	.30	.30	.34	.34	.33	N	.37	.39	.33	.37	.38	.37	N
England			.36	.40	.39	.37	N			.35	.38	.36	.38	N			.40	.43	.41	.42	N
Estonia				.33	.38	.41	U				.31	.36	.35	N				.33	.37	.38	U
Finland	.29	.28	.27	.27	.28	.32	N	.28	.27	.26	.28	.26	.29	N	.32	.30	.29	.31	.30	.32	N
France	.40	.44	.45	.43	.44	.41	N	.39	.43	.45	.39	.42	.40	N	.44	.46	.50	.47	.44	.44	N
Greece	.38	.43	.44	.42	.44	.40	N	.34	.38	.37	.39	.37	.35	N	.42	.42	.42	.42	.42	.42	N
Hungary	.53	.56	.50	.54	.54	.54	N	.50	.49	.46	.46	.45	.46	N	.56	.53	.53	.51	.54	.53	N
Iceland	.34	.34	.35	.35	.33	.29	D	.30	.32	.31	.30	.28	.27	N	.35	.33	.34	.31	.33	.32	N
Ireland	.32	.36	.34	.35	.38	.33	N	.31	.33	.33	.34	.33	.31	N	.35	.38	.38	.39	.37	.35	N
Israel	.47			.44	.44	.43	N	.43			.39	.41	.35	D	.47			.39	.42	.34	D
Italy	.40	.45	.42	.42	.40	.42	N	.39	.41	.37	.40	.38	.36	N	.45	.49	.42	.46	.44	.42	N
Japan		.42	.46	.39	.39	.39	N		.41	.39	.39	.36	.36	N		.43	.39	.36	.42	.38	D
Korea	.39	.43	.38	.41	.37	.36	N	.36	.39	.36	.36	.36	.33	N	.40	.43	.38	.39	.37	.38	N
Luxembourg	.36	.36	.35	.38	.41	.38	N	.34	.39	.38	.39	.42	.41	U	.38	.46	.41	.42	.43	.46	N
Mexico	.50	.50	.60	.54	.56	.55	N	.49	.47	.50	.49	.49	.46	N	.56	.50	.52	.52	.51	.50	D
Netherlands	.34	.39	.38	.38	.35	.36	N	.32	.37	.38	.34	.34	.35	N	.35	.45	.45	.44	.40	.41	N
New Zealand	.35	.37	.37	.37	.41	.39	N	.33	.31	.31	.34	.35	.34	N	.37	.33	.36	.39	.40	.34	N
Northern Ireland			.34	.37	.37	.36	N			.35	.37	.39	.37	N			.37	.38	.45	.39	N
Norway	.31	.29	.29	.28	.28	.30	N	.26	.28	.28	.26	.26	.27	N	.30	.35	.36	.30	.35	.32	N
Poland	.44	.39	.40	.35	.40	.35	N	.43	.34	.35	.31	.38	.34	N	.51	.39	.38	.41	.42	.36	D
Portugal	.37	.36	.42	.37	.40	.40	N	.35	.37	.41	.39	.38	.36	N	.42	.39	.45	.46	.48	.44	N
Scotland			.34	.35	.30	.30	N			.32	.30	.28	.29	N			.33	.35	.37	.35	N
Slovak Republic		.46	.44	.39	.47	.45	N		.41	.40	.37	.42	.37	N		.46	.45	.42	.48	.44	N
Slovenia				.44	.46	.42	N				.42	.42	.41	N				.47	.50	.46	N

Table 2 (continued)

Country	Percentile 20							Percentile 50							Percentile 80						
	2000	2003	2006	2009	2012	2015	Trend	2000	2003	2006	2009	2012	2015	Trend	2000	2003	2006	2009	2012	2015	Trend
Spain	.40	.40	.41	.40	.38	.41	N	.40	.41	.39	.38	.38	.41	N	.46	.44	.46	.45	.44	.47	N
Sweden	.28	.31	.30	.32	.35	.31	N	.28	.27	.31	.31	.32	.32	N	.31	.33	.35	.36	.35	.35	N
Switzerland	.40	.40	.36	.35	.35	.35	D	.36	.37	.35	.33	.34	.34	N	.43	.44	.43	.43	.42	.42	N
Turkey		.43	.43	.43	.40	.41	N		.43	.35	.39	.35	.36	N		.52	.44	.47	.45	.44	D
United States	.43	.40	.40	.43	.40	.41	N	.36	.36	.37	.40	.39	.39	N	.42	.44	.42	.47	.43	.43	N
Wales			.32	.29	.30	.29	N			.30	.30	.27	.26	N			.35	.37	.35	.32	N

Note: In the "Trend" column, the abbreviation 'N' establishes that no trend was detected during the period. The letter 'D' was assigned to the cases in which a downward trend was observed, while the letter 'U' represents cases where an upward trend is noticed. The online supplementary file provides full results of tests of statistical significance between each PISA round for each country, using difference ESCS deciles as the cut-off

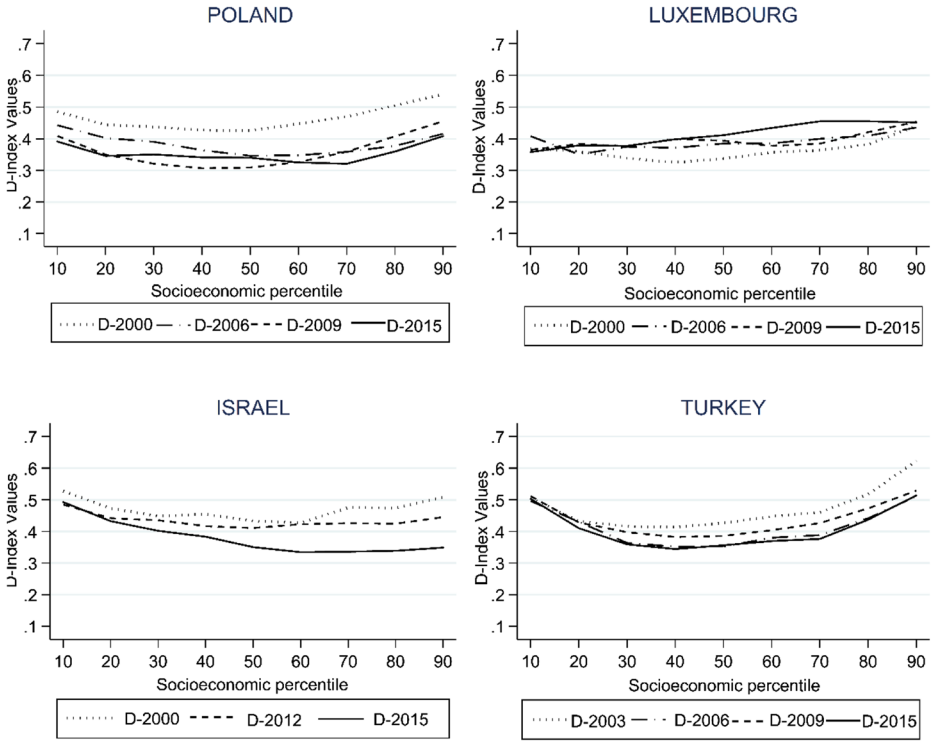

Fig. 3 Estimates of Between-School Segregation for Selected Countries Between 2000 and 2015. Note: The years vary across countries as not all them took part in the same PISA rounds. Figures on the x-axis refer to the percentile used to separate students into different groups. For example, a value of 25 means that the D-index was calculated based on how segregated the most disadvantaged 25% of students are from the most advantaged 75%. Figures for 2006 and 2009 are excluded for clarity of presentation

similar to those of Jenkins et al. (2008). They highlight how Scandinavia has comparatively low levels of between-school segregation, while central and Eastern European countries with heavily "tracked" secondary school systems are amongst the most segregated. However, the results are different for Japan and Australia, which present somewhat higher levels of segregation. This difference may be due to the different measure of socioeconomic status that is used in this work (the PISA ESCS index rather than the ISEI measure of occupational prestige). The high D-index values of Mexico and Chile match the findings by Murillo and Martínez-Garrido (2017) who highlight the high levels of segregation amongst Latin-American countries.

There are, however, some important differences in the value of the segregation index depending on the threshold used to define the socioeconomic groups. For the vast majority of countries, segregation is higher in the extremes of the socioeconomic distribution rather than in the middle of it. Figure 2 presents values of the D-Index using the 20th and 80th percentiles of the ESCS index as cut-points (representing poor and rich students, respectively) and comparing them with the values obtained using the median (50th percentile).[5] It is immediately clear that, in a large number of

[5] The D-Index values presented are an average based on the rounds of PISA in which each country participated.

countries, the values of the segregation index are higher for the poorest and richest students than when using the median as the threshold. This is most prominent for the difference in results when using the median and the 80th percentile.

However, there are also some differences in countries where segregation of pupils is most intense. Hungary and Mexico stand out as countries where the most disadvantaged 20% of pupils are very highly segregated from the remaining 80%. In contrast, Chile has particularly pronounced segregation of the most socioeconomically advantaged students, with a radical separation from all the other social groups. Portugal and Luxembourg present similar values of the D-index when thresholds for the median and poor students are compared, but differ with respect to the rich pupils, where the segregation index is higher. Finally, in some countries, such as Finland, Iceland, Japan, Northern Ireland and Korea, there is less evidence of differences in the segregation index depending on where the threshold to divide socioeconomic groups is drawn.

Table 2 turns to results for changes in segregation over time. For each country, the table summarises the estimates of segregation for each PISA round, using three thresholds (P20, P50, and P80). Full results are available in the online supplementary information.

For simplicity, only the mean values for each percentile/year have been included in this table, along with a column summarising whether a trend was observed or not. As the number of PISA rounds in which the countries took part varies, and issues associated with sampling variation cannot be discarded, a conservative approach has been used to identify a trend. Two factors are taken into consideration. On the one hand, we have identified countries with substantial differences (>.04) between the first and last round with available data. On the other hand, we have only included countries with a relatively stable pattern of results throughout rounds (as we cannot discard that some changes in-between is simply due to sampling variation). Therefore, we have excluded cases where there is a large difference (>.03) in adjacent years that cannot be interpreted as a part of a trend. These cases are mentioned throughout in the text.

First, the results using the median as the cut-off point for defining the two socioeconomic groups are presented. The results show that 35 out of 37 educational systems show no sign of change over time. While in some cases almost no difference can be observed between any round (e.g. Canada, Finland, Iceland, Norway, and Spain among others), in other cases upward or downward changes are observed in specific years, but those changes later fade away (returning to the initial situation). For example, in the case of the Czech Republic, there is a reduction in the level of segregation (from 0.40 to 0.34) between the year 2000 and 2009. However, in the later rounds, the D-index value rises and returns to the original value of 0.40. In the case of Portugal, an increase of segregation can be seen from 2000 to 2006, but in the subsequent years the segregation values shrink again. While in Israel a clear, sustained downward trajectory in segregation is observed (from 2000 to 2015), the opposite happens in Luxembourg with values rising from .34 to .41 over the same period. In the case of Poland, the Slovak Republic, and Turkey a decrease in the level of segregation is observed comparing the first and last rounds. However, the data is characterised by instability over time, with several rounds of data where there is a sudden change (meaning we advise that any change over time for these three countries should be interpreted cautiously).

Regarding the most disadvantaged students (percentile 20), there is even less evidence that the D-index has changed over time. Although three countries show changes that could be interpreted as a trend, one of them has missing information for three rounds (Estonia). While Switzerland and Iceland show a relatively constant reduction in segregation over time, there is important fluctuation in the results for Poland and Mexico.

The D-index values for the wealthy students (percentile 80) suggest that only in Estonia is there any evidence of some increase in segregation (0.33 to 0.38). However, this country only has available information for the last three PISA rounds. In contrast, there is some suggestion that segregation of the wealthiest pupils from the rest of the population has declined in Israel, Japan, Mexico, Poland, and Turkey. Although some countries do show some variation over time (e.g. Luxembourg, Portugal), there is no clear evidence of a genuine trend.

This, despite there being some change in segregation in a small number of countries for some specific groups, the general message from Table 2 is that educational systems have typically seen (at best) only minimal changes in the amount of between-school segregation. Indeed, only Poland has shown important declines in segregation over time in all the social groups under analysis. However, the instability of the D-index does not suggest a decrease in the level of segregation. Overall, the amount of between-school variation in most countries did not change between 2000 and 2015. This leads to an important conclusion; it appears that between-school segregation is to a great extent structurally ingrained.

To further illustrate this point, Fig. 3 investigates in greater detail the results for four countries where the variation in segregation across the period is greatest. These are Poland, Luxembourg, Israel and Turkey. For purposes of clarity, not all rounds of PISA have been used. Except for Poland, all the countries show very similar values in the D-index across the PISA rounds for the socioeconomically disadvantaged students. Greater variation is observed when assessing the wealthier students. This is especially noticeable for Israel and Turkey. Poland shows a decrease in the levels of segregation of the wealthy students, but the same is not clear for the other social groups. Both Luxembourg and Poland show important variation in the D-index between the PISA rounds (with frequent increases and decreases), indicating that these features are not limited to the groups previously analysed (Table 2) but to all the sample under analysis. Hence, this strongly suggests that sampling variation is likely to be responsible for the (small) changes in segregation in these countries. In other words, this provides further support for the key finding of this work; that almost no progress has been made in reducing the segregation of rich and poor pupils in any industrialised country since 2000, when the PISA study began.

5 Conclusions

The extent to which social groups mix is thought to be an important factor influencing inequality, social cohesion and social mobility (Gorard 2009; Levaçić and Woods 2002). As long-lasting friendships and peer groups are developed during young people's time in school,

the extent of between-school segregation is a key indicator of whether particular social groups live in isolation from one another. Moreover, previous research has suggested that greater levels of between-school segregation may have negative effects on a range of outcomes, including attendance, behaviour, grade retention and greater inequality in students' test scores. Understanding the extent of between-school segregation is therefore important for a better assessment of social and economic inequality, including how this varies across the industrialised world.

Previous international comparative research on this topic has found countries that separate students into different school tracks at an early age (e.g. Germany, Austria, Hungary) also tend to be more socially-segregated (Jenkins et al. 2008). The present study has attempted to contribute new evidence to this literature by considering the extent to which industrialised countries have made progress in reducing between-school segregation over the last 15 years. Using six cycles of PISA data, the key conclusion is that the level of between-school segregation has remained stable within almost every OECD country. This is a striking and perhaps surprising finding, given how much the world has changed over this period. In particular, despite a host of school-system reforms occurring across the world, and major world events such as the Great Recession of 2008, the segregation of students from different backgrounds into different schools has hardly altered at all.

Consequently, in the latest round of PISA (2015), the data continue to suggest that the Nordic countries are amongst the most socially integrated (with the relative exception of Denmark, which presents somewhat higher levels for both rich and poor students), whereas Chile, Mexico, and Hungary have particularly socially-segregated schools. In all countries, segregation of the wealthiest and poorest 20% of students from other groups remains pronounced, though this pattern is especially marked in countries with high levels of segregation.

There are several possible explanations for the key finding that school segregation has barely changed in any OECD country over time. First, many factors will have already shaped school segregation before 2000, when the PISA data became available. In other words, one interpretation of the results is that long-term structural factors of a country and its school system (e.g. long-standing admissions criteria used to gain entry into schools) are much more important for between-school segregation than the set of policy changes and economic shocks that have taken place over the last 15 years. Second, location matters for parental school choice in many countries, meaning residential segregation of parents is pivotal in determining the segregation of students into different schools. At the same time, there may have been less effort in tackling residential segregation than the range of education policy and initiatives that have been implemented. Yet it could be that tackling the residential segregation of parents directly is critical to reducing the segregation of students in different schools, thus enhancing educational equality and social mobility. Third, many education policy reforms implemented in several OECD countries have attempted to incentivise competition between schools (e.g. the routine publication of schools' results), but may not necessarily have led to changes in the socioeconomic composition of the student body that are observable at the national level. Finally, in certain contexts—especially those where choice is extended—efforts to reduce segregation might be counteracted or diminished by families being

determined to separate themselves from other social groups. In other words, because parents want the best for their children, families from more privileged backgrounds will always find some way to segregate their children from those from less advantaged homes.

It is also important to recognise the limitations of the present study, and possible directions for future research. First, the measure of socioeconomic status preferred in this paper is based on information reported by students themselves, rather than from their parents. Although this could mean that measurement error may have some impact upon the results, existing evidence from the literature suggests that the impact this is likely to have upon the comparative analysis of countries over time is likely to be minimal (Jerrim and Micklewright 2012). Secondly, as PISA is a sample survey, the number of schools included in this study for each country per year is quite limited (typically around 150). Hence the results for any given year are subject to a non-trivial degree of sampling error. Given this limitation, it is perhaps even more striking how highly correlated the results are between the various PISA cycles; the correlation for the between-school segregation results based upon PISA 2000 and 2015 is .85 for P20, .86 for P50, and .79 for P80 (in Appendix E country-level correlations across all PISA waves are available). Third, although survey response rates are generally quite high in most countries, there are some countries where they are somewhat lower (recall Table 1). This could introduce some non-response bias into the analysis for a handful of countries, with the data no longer a fully random sample from the secondary school population. Fourth, due to PISA focusing upon the 'within-school' population, this work has been restricted to OECD countries only. Further work may extend our analysis to the wider array of lower- and middle-income countries that now also take part in PISA. Fifth, this paper has focused exclusively on between-school tracking and not on the use of 'setting' or 'streaming' within schools. Yet, as noted by Chmielewski (2014), such within-school segregation is likely to be just as significant, effectively cutting off lower socioeconomic status pupils from their peers of higher socioeconomic status. Further work in the spirit of Chmielewski (2014) is required to better understand how countries separate pupils between schools versus within schools. Finally, the analysis contained in this paper has been limited to a medium time horizon (15 years). Although the world has changed dramatically over this period, significant structural factors of a country's education system such as between school-segregation perhaps take much longer to change.

Despite these limitations, this paper has made an important contribution to the literature. It has highlighted how, in many countries, the children of the rich are still effectively segregated from the children of the poor. Moreover, it has shown that changes to this situation should not be expected any time soon. Despite a lot of rhetoric and policy efforts designed to 'narrow the achievement gap', provide high quality education to all pupils and raise the educational attainment of disadvantaged groups, there remains significant levels of school segregation for young people from different social backgrounds. Based on these findings, much more radical thinking will be needed in order to change this situation over the coming 15 years and if real progress is to be made in narrowing the achievement gap between the rich and poor.

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APPENDIX A

Table 3 Correlation in Between-School Segregation Measures Across Countries. Dissimilarity Index vs. Hutchens Index (2000–2015)

Deciles	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation	Year	Correlation
10	2000	.977	2003	.966	2006	.980	2009	.988	2012	.991	2015	.989
20	2000	.965	2003	.966	2006	.969	2009	.972	2012	.974	2015	.983
30	2000	.966	2003	.959	2006	.968	2009	.978	2012	.958	2015	.976
40	2000	.954	2003	.951	2006	.963	2009	.965	2012	.958	2015	.964
50	2000	.958	2003	.943	2006	.956	2009	.958	2012	.956	2015	.944
60	2000	.966	2003	.943	2006	.960	2009	.961	2012	.952	2015	.947
70	2000	.973	2003	.939	2006	.966	2009	.962	2012	.960	2015	.937
80	2000	.979	2003	.938	2006	.975	2009	.967	2012	.959	2015	.955
90	2000	.970	2003	.958	2006	.975	2009	.971	2012	.975	2015	.964

APPENDIX B

Table 4 Estimates of between-school segregation (H) across countries (2000–2015)

Country	Percentile 20						Percentile 50						Percentile 80					
	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015
Australia	.18	.14	.14	.14	.18	.21	.14	.12	.11	.11	.14	.14	.20	.15	.14	.15	.19	.20
Austria	.17	.18	.17	.17		.17	.12	.17	.15	.13		.12	.20	.23	.23	.23		.20
Belgium	.14	.19	.16	.16	.15	.15	.12	.15	.13	.16	.14	.14	.18	.19	.16	.21	.18	.16
Canada	.12	.14	.15	.14	.14	.13	.09	.11	.11	.10	.09	.09	.13	.13	.16	.14	.13	.12
Chile	.26		.30	.27	.29	.26	.25		.27	.24	.26	.22	.34		.37	.34	.37	.33
Czech Republic	.17	.18	.17	.14	.18	.20	.14	.14	.12	.11	.15	.16	.19	.21	.17	.15	.22	.22
Denmark	.13	.12	.11	.12	.14	.14	.08	.09	.08	.10	.10	.09	.14	.16	.10	.14	.15	.14
Germany	.19	.21	.20	.19	.20	.16	.13	.16	.13	.14	.16	.12	.21	.23	.19	.22	.21	.17
England			.13	.14	.14	.13			.11	.11	.12	.13			.16	.16	.16	.16
Estonia				.11	.16	.17				.10	.12	.12				.12	.14	.16
Finland	.09	.07	.07	.07	.08	.09	.06	.06	.05	.06	.06	.07	.10	.08	.07	.08	.09	.09
France	.15	.17	.19	.18	.18	.16	.13	.16	.17	.15	.15	.15	.19	.21	.24	.24	.22	.20
Greece	.15	.17	.19	.18	.20	.16	.13	.13	.15	.15	.14	.12	.18	.19	.20	.19	.18	.18
Hungary	.27	.30	.25	.29	.27	.28	.23	.21	.20	.20	.19	.20	.30	.29	.26	.27	.27	.26
Iceland	.10	.10	.10	.11	.10	.08	.08	.10	.08	.08	.07	.07	.12	.12	.12	.10	.11	.11
Ireland	.09	.13	.12	.13	.15	.11	.09	.10	.11	.11	.10	.09	.12	.15	.15	.16	.14	.11
Israel	.20			.18	.18	.17	.16			.12	.13	.10	.20			.15	.17	.11
Italy	.16	.19	.15	.17	.15	.17	.13	.15	.12	.14	.13	.12	.18	.22	.16	.19	.19	.18
Japan		.17	.18	.14	.15	.15		.13	.12	.12	.11	.10		.16	.14	.11	.16	.12
Korea	.13	.17	.14	.14	.13	.12	.10	.13	.11	.11	.11	.10	.16	.16	.12	.15	.13	.15
Luxembourg	.10	.11	.10	.12	.14	.14	.08	.12	.11	.12	.14	.13	.11	.14	.13	.13	.14	.16
Mexico	.25	.27	.35	.29	.32	.29	.25	.24	.27	.24	.24	.21	.31	.26	.29	.28	.27	.25
Netherlands	.11	.14	.14	.14	.12	.12	.08	.12	.12	.10	.10	.10	.13	.20	.18	.19	.14	.16
New Zealand	.12	.13	.13	.14	.17	.14	.09	.08	.08	.10	.12	.10	.13	.12	.13	.15	.16	.12
Northern Ireland			.11	.12	.14	.11			.10	.11	.12	.10			.15	.13	.17	.13
Norway	.10	.09	.09	.08	.08	.09	.07	.07	.07	.06	.06	.06	.09	.11	.13	.08	.12	.10
Poland	.18	.15	.16	.13	.14	.13	.16	.10	.10	.10	.13	.11	.24	.13	.13	.16	.16	.14
Portugal	.13	.12	.17	.14	.16	.15	.11	.12	.16	.14	.15	.12	.16	.18	.21	.22	.24	.20

Table 4 (continued)

Country	Percentile 20						Percentile 50						Percentile 80					
	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015	2000	2003	2006	2009	2012	2015
Scotland			.12	.12	.09	.09			.09	.08	.08	.08			.10	.14	.14	.12
Slovak Republic		.22	.19	.16	.24	.20		.15	.15	.11	.17	.13		.21	.19	.17	.23	.19
Slovenia				.20	.20	.18				.16	.16	.15				.22	.24	.19
Spain	.16	.16	.16	.16	.15	.18	.14	.15	.14	.13	.12	.15	.21	.18	.20	.19	.17	.20
Sweden	.09	.10	.09	.10	.12	.10	.07	.07	.08	.08	.09	.09	.08	.10	.12	.11	.11	.11
Switzerland	.17	.16	.14	.11	.11	.11	.12	.12	.10	.10	.10	.10	.17	.19	.18	.16	.16	.15
Turkey		.19	.18	.19	.16	.16		.17	.12	.13	.12	.12		.27	.19	.21	.18	.18
United States	.21	.18	.14	.18	.17	.16	.12	.13	.12	.15	.13	.13	.19	.21	.18	.22	.17	.17
Wales			.10	.08	.09	.09			.07	.07	.06	.06			.11	.12	.12	.10

APPENDIX C

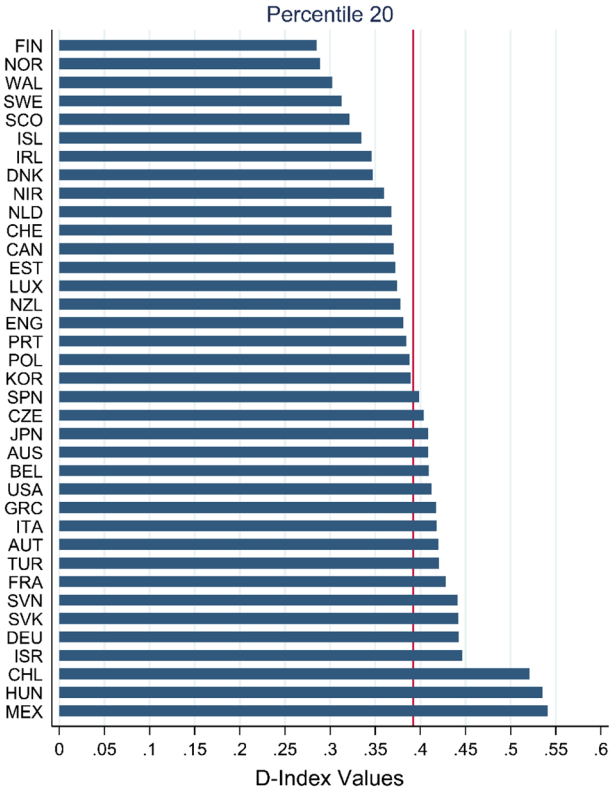

Fig. 4 Estimates of Between-School Segregation (D) Across OECD Countries (Percentile 20)

APPENDIX D

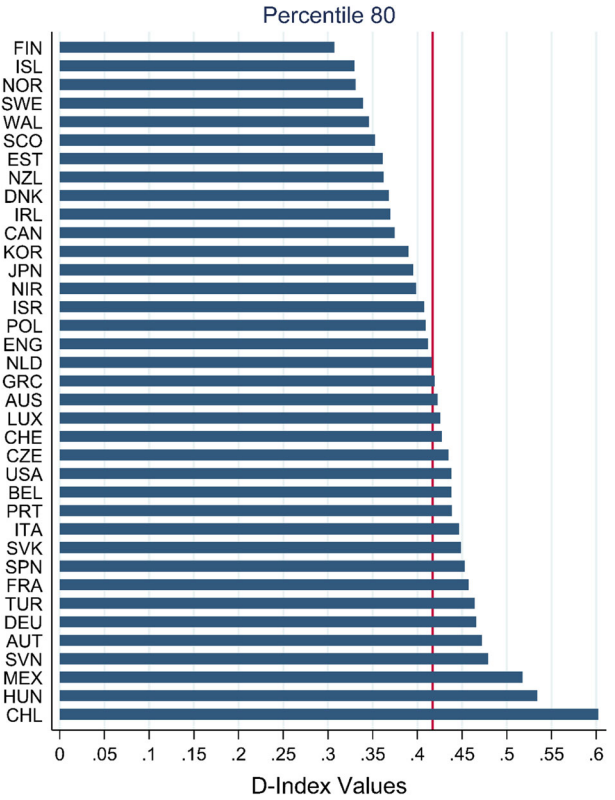

Fig. 5 Estimates of Between-School Segregation (D) Across OECD Countries (Percentile 80)

APPENDIX E

Table 5 D-Index Country-Level Correlation Matrix by PISA Wave. OECD Countries

Percentile 50						
	2000	2003	2006	2009	2012	2015
2000	1					
2003	.841	1				
2006	.880	.880	1.			
2009	.816	.860	.903	1		
2012	.891	.846	.908	.909	1	
2015	.851	.833	.872	.877	.923	1
Percentile 20						
	2000	2003	2006	2009	2012	2015
2000	1					
2003	.871	1				
2006	.872	.875	1			
2009	.886	.908	.915	1		
2012	.853	.869	.901	.894	1	
2015	.857	.830	.869	.855	.923	1
Percentile 80						
	2000	2003	2006	2009	2012	2015
2000	1					
2003	.756	1				
2006	.811	.804	1			
2009	.823	.820	.907	1		
2012	.887	.822	.907	.880	1	
2015	.788	.847	.894	.864	.908	1

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