Longitudinal study of school segregation in the United Kingdom
Estudio longitudinal de la segregación escolar por nivel socioeconómico en Reino Unido

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The UK has participated in PISA since the first version in 2000 generating longitudinal data for understanding trends in school segregation due to poverty. Segregation by poverty is one of the longstanding concerns of the UK education system. Our analysis has shown that the segregation between schools has declined somewhat from 2000 to 2015, the clustering of poorest 25% of students remained relatively static in the UK since 2006. England remain highly segregated by poverty as compared with Wales, Scotland and Northern Ireland. Although, the segregation levels of the 10% poorest student has declined in the state-maintained schools but shown a sharp increase in private schools. However, the student data for the poorest students in private schools is very small and sometimes incomplete for some PISA data sweeps. The paper analysed the level of isolation showing that the disadvantaged students are better of attending public schools than private schools where chances of isolation are less likely as compared with private schools. The findings have shown that the poverty segregation trends in PISA match with the segregation trends previously analysed using the national datasets of state-maintained schools. Therefore, the indication of relatively higher segregation by poverty in England, as compared with other home countries, could be related with the highest number of student in-take in private schools. This finding leads to research implications for a detailed analysis of national school segregation trends, including student data from private school.

Keywords: PISA, socioeconomic segregation between schools, UK home countries, clustering by poverty, equality of opportunity

El Reino Unido ha participado en la evaluación PISA desde el año 2000 aportando datos longitudinales que ayudan a comprender el comportamiento de la segregación escolar por nivel socioeconómico. La segregación por nivel socioeconómico es una de las preocupaciones habituales del sistema educativo del Reino Unido. El análisis realizado ha demostrado que la segregación entre las escuelas ha disminuido entre 2000 y 2015, y que la segregación del 25% de los estudiantes más pobres se ha mantenido relativamente estática en el Reino Unido desde el año 2006. Las escuelas de Inglaterra están muy segregadas por su nivel socioeconómico en comparación con Gales, Escocia e Irlanda del Norte. Los niveles de segregación del 10% de estudiantes más pobres han disminuido en las escuelas públicas, mientras que se observa un fuerte aumento en las escuelas privadas. Sin embargo, los datos de los estudiantes más pobres en las escuelas privadas son muy escasos y, a veces, incompletos en algunas de las bases de datos de PISA. Este estudio analiza también el nivel de aislamiento que muestra que los estudiantes desfavorecidos asisten más a las escuelas públicas que a las privadas, es decir, existen menos posibilidades de aislamiento en las escuelas públicas en comparación con las privadas. Los resultados han demostrado que la tendencia de la segregación escolar por nivel socioeconómico utilizando los datos PISA es coherente con la tendencia de segregación analizada utilizando datos nacionales de las escuelas públicas. Nuestros resultados muestran que Inglaterra cuenta con un mayor nivel de segregación escolar por nivel socioeconómico, en comparación con los países de su entorno, ello podría estar relacionado con el mayor número de estudiantes que acuden a escuelas privadas. Este hallazgo conlleva implicaciones de investigación para un análisis detallado de las tendencias nacionales de segregación escolar, incluidos los datos de estudiantes de escuelas privadas.

Palabras clave: PISA, segregación por nivel socioeconómico entre escuelas, Países del Reino Unido, Agrupación por nivel socioeconómico, Igualdad de Oportunidades.

1. Introduction

The four home countries of the United Kingdom are England, Scotland, Wales and Northern Ireland. Since 1975, education has gradually devolved and controlled by separate home country governments. Many of the salient features of the education systems are common, such as no tuition cost in state-maintained schools, free lunch provision for primary school-level, and full- time compulsory education for all children until at least the age of 16. All schools are organized into year groups, so children of the same age are taught together in groups . Although in very small schools, or those that admit more than 30 children in one year, year groups may be combined within the same class. The state-funded school system aims to equalise the learning and development opportunities for all children, independent of factors such as gender, ethnicity, family socioeconomic status, and place of residence. Equality is the fundamental promise of the state-funded education system and in order to achieve this promise each home country adopts education policies depending on the demography, nature of challenges and available resources.

The UK education system diverges at various points making state-maintained schooling somewhat diverse across the four countries. But in most areas, school years are then grouped together in larger stages or phases, usually with different curriculum requirements and outcomes for each. Each country of the UK has its own curriculum. Although much of the content is similar, there are structural and pedagogical differences in the delivery of the contents. In England and Northern Ireland, the National Curriculum applies to children in Key Stages 1 and 2. In Wales, schools follow the National Literacy and Numeracy Framework (NLF), which emphasises applying literacy and numeracy across the whole curriculum. On the other hand, the Curriculum for Excellence in Scotland includes subjects like expressive arts or health and wellbeing.

Wales has a language policy of Welsh as a medium of instruction or compulsory language for learning in all state-maintained schools. England and Northern Ireland have state-maintained Grammar schools which select pupils on the basis of their performance in ability test called 11- plus. State-maintained schools in Northern Ireland are also segregated on the basis of catholic or protestant religious education. Disparities across the four countries are largely related to historical changes and geo-political reforms which lead to considerable independency of the education systems. However, none of these countries have overcome the challenge of segregation by poverty in schools, establishing a state-governed system where rich and poor have equal access and opportunity of education. Recently some policy initiatives have been adopted to equalise the learning outcomes such as additional funding allocation to schools depending on the intake of children from disadvantaged families (Gorard, Siddiqui and See, 2019). However, more evidence is required to judge if school segregation by poverty has changed with policy initiatives.

In all four UK countries, state-maintained system run in parallel with private fee-paying school system which are also referred as independent schools or public schools. There are nearly 2500 independent schools in the United Kingdom. These schools do not have to follow national curriculum and the student admission policy does not have to be aligned with comprehensive policy. This means there is selection of students on criterions such as academic ability, socioeconomic status or parental religious affiliation. The proportion of independent schools is not balanced across all four home countries. England has the highest number of independent schools (N=1289) where 7.2% of the total student population in England receive private education. In Wales, there are only 8 independent schools where less than 2% of the Welsh student population receive education. In Scotland, there are 102 independent schools in which nearly 4% of the Scottish student population receiving education and in the Norther Ireland there are 16 private schools in which 2% of children receive education.

According to Gorard (2000), segregation between schools is defined as the proportion of students who would have to change schools for there to be an even spread of disadvantage between schools within the area of analysis. Segregation by poverty is one of the different kinds of school segregation (ethnicity, religion, sex, prior performance) that are nowadays putting the equality of opportunities to the education at risk (Gorard 2000; Taylor and Gorard 2003; Murillo and Martínez-Garrido, 2018a). There is research

evidence that shows clustering children with similar background characteristics in schools isolates them from a wider society, and this stratification is most harmful for those children who are disadvantaged (Siddiqui 2017, Strand and Winston 2008, Harris and Williams 2012; Bartholo and da Costa 2014; Billings, Deming, and Ross 2016). Equality of access to resources and opportunities in schools is still an issue exasperated by socioeconomic segregation which no policy so far has successfully tackled.

International student assessments are a tremendous progress towards the development of quality empirical studies in Educational sciences. The rigor of its methodology, as well as the validity and the sampling techniques in each of the countries are key qualities. Program for International Student Assessment (PISA) is an example of these international student assessments among other like Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy (PIRLS). PISA is a worldwide study by the Organization for Economic Co-operation and Development (OECD) in member and non-member nations of 15-year-old school pupils' scholastic performance on Mathematics, Science, and Reading. It was first performed in 2000 and then repeated every three years.

The UK has participated in PISA since the first version in 2000 generating a large amount of data from the UK over 15 years. The data is comprised of students' academic performance in literacy, numeracy, science and contextual information collected from schools, teachers and parents. The data allows analysing school segregation in the United Kingdom, as well as how political, economic and social changes over the last 15 years reflect any changes in patterns of school segregation by poverty. The unit of sampling in PISA is school which means that both private and state schools are included in the study. It is worth mentioning that the data from private schools are not included in the national school census and therefore the analysis based on national figures do not allow comparison between private and state schools in the UK.

The studies on high quality population data sets have found that school types are associated with clustering of children on the basis of socioeconomic group, sex, language, religion and ethnicity (Gorard 2015, Gorard et al. 2006). If schools are given choice of pupil selection, then the intake of children would not be balanced and possibly be dominated by certain other unobservable characteristics (Morris 2015; Norwich and Black 2015). The non-state schools could genuinely intend to support the cause of education for a disadvantaged community. However, this clustering would not only share poverty as a common variable but can also be a proxy for all associated characteristics of poverty such as one ethnic group or religion, same caste or tribe, parents not educated, siblings involved in labour, history of crime or drug abuse etc. Segregation on the basis of a targeted characteristic can also become a contentious issue for example non-state independent schools supporting religious minority would group children on the basis of their parents' religion but the scope of such education is highly contentious in a secular society (Borooah and Knox 2015; Oldfield et al., 2013).

The results from international research has shown that the average of school segregation by poverty in UK is below the average of the EU countries. For example, Murillo and Martínez-Garrido (2018b) estimate the magnitude of school segregation by poverty in the 27 of the 28 countries that participate in PISA 2015 (Cyprus did not participate). Authors use Gorard index and Isolation index to estimate the school segregation. Their results show that the average of school segregation by poverty between the different countries of the EU is 0.35 (using Gorard index) and 0.31 (using Isolation index). That means that in the EU average, the 35% of poor students should change the schools to equalise the schools in terms of socioeconomic clustering of children. In the UK, those estimations go down to 0.33 (using Gorard index) and 0.29 (using Isolation index). According to the authors, the situation of school segregation by poverty in the UK is similar than the level of school segregation in countries like Luxemburg (0,34), Netherlands (0,33), Denmark (0,32).

There could be several underlying factors of segregation at school level such as independent school policy, geographical limitations, housing and residential schemes, school allocation policy, parents' choice etc. There is no experimental evidence of the causal nature of such clustering and its long-term impact. However, the secondary data analyses on large population data sets and longitudinal studies

have shown that school level segregation on the basis of disadvantaged characteristics is one of the determinants of low academic attainment (Condron, 2011, 2013; Gorard 2015; Knowles and Evans 2012) and therefore less chances of access to university education (Boliver 2011, Cavalcanti et al. 2010).

2. Method

We used the data PISA datasets, generated between 2003 and 2015. In each cycle of PISA, representative samples of all school types are invited to take part in the student assessments and questionnaires from teachers, families and students. Over the past decade, PISA assesses the extent to which 15-year-old students have acquired key knowledge and skills in three fundamental areas: mathematics, language and science. Additional information is also obtained on factors associated with learning that allows contextualising the academic performance of students. For the data collection, PISA uses performance tests, and context questionnaires from school teachers, families and students.

Sample

The number of students assessed in PISA has increased from 2003 and 2015. While in PISA 2003 more than a quarter of a million students, representing almost 30 million 15-year-olds enrolled in the schools of the 41 participating countries. In PISA 2015, approximately 540000 students completed the assessment in 2015, representing about 29 million 15-year-olds in the schools of the 72 participating countries and economies, in PISA 2003, more than a quarter of a million students, representing almost 30 million 15-year-olds enrolled in the schools of the 41 participating countries. Specifically, in United Kingdom, 9535 students from 381 schools were assessed in PISA 2003 and, 14157 students from 2200 schools in PISA 2015 (Table 1).

Table 1 – The number of cases in each year and home country, PISA 2000-2015

	2000	**2003**	**2006**	**2009**	**2012**	**2015**
England	2,292	6,812*	10,708*	9,548*	9,714*	5,194
Wales	-					3,451
Northern Ireland	1,586					2,410
Scotland	1,317	2,723	2,444	2,631	2.945	3,111
UK	5,195	9.535	13,152	12,179	12,659	14,517
Number of schools	362	381	502	482	507	550
Percentage of state schools	95.2	94.1	95.0	96.1	80.4	91.2

Note: - Wales did not participate in PISA 2000. * The data from England, Northern Ireland and Wales is reported together 2003-2012. Elaborated by the authors.

Coding

For in-depth analysis of the school segregation of disadvantaged students, we selected a sub-group of 10% and 25% of the students with less socioeconomic level of their families. Both analyses shows the patterns of segregation of most disadvantaged students in state and private school type and if the trends have changed over time.

The level of socioeconomic disadvantage has been judged according to ESCS-index of Economic, Social and Cultural Status, provided by PISA international evaluation. ESCS is created on the basis of the following variables: The International Socio-Economic Index of Occupational Status (ISEI); the highest level of education of the student's parents, converted into years of schooling; the PISA index of family wealth; the PISA index of home educational resources; and the PISA index of possessions related to "classical" culture in the family home. The ESCS variable is typified for each country.

Analysis

School Segregation has been analyzed using the segregation index known as the Gorard Segregation Index (GS) (Gorard and Fitz 1998, 2000a, 2000b), and the Dissimilarity index (D) - one of the oldest estimators of segregation (Duncan and Duncan, 1955). On one hand GS is defined "as the proportion of students who would have to change schools for there to be an even spread of disadvantage between schools within the area of analysis" (Gorard & Fitz, 2000a, p. 117). On the other hand, D is defined as the percentage of students one group or another who would have to change schools so that there was no segregation between the groups.

After studying of the analysis conducted by researchers as Taylor, Gorard and Fitz (2000a), Allen and Vignoles (2007) where they explain the advantages and disadvantages of the different segregation indexes, we agreed with Gorard (2007) that neither can establish the superiority of one index over the other. So, the use of both indices guarantees the dissemination of our results and their impact on the research community and give us the information about the school segregation as unevenness dimension.

To measure the exposure dimension of school segregation we used the isolation index (Lieberson, 1981), considered as the best for exposure by Massey and Denton (1988). It is interpreted as the probability that a student from a minority group will be at school with another student from the same minority group. The greater the isolation of the group, the lower its exposure to the members of the other groups (Echenique and Fryer 2007).

More precisely the formulae of segregation indexes are:

GORARD INDEX

$$G = \frac{1}{2}\sum_{i=1}^{k}\left|\frac{x_{1i}}{X_1} - \frac{T_i}{T}\right|$$

DISSIMILARITY INDEX

$$D = \frac{1}{2}\sum_{i=1}^{k}\left|\frac{x_{1i}}{X_1} - \frac{x_{2i}}{X_2}\right|$$

ISOLATION INDEX

$$A = \sum_{i=1}^{k}\frac{x_{1i}}{X_1}\frac{x_{1i}}{T_i}$$

Where:

x_1 is the number of students of the minority group in each school
X_1 is the number of students of the minority group in the country
x_2 is the number of students of the majority group in each school
X_2 is the number of students of the majority group in the country
T_1 is the number of students in each school
T is the number of students in the country

The analysis has been conducted to observe segregation by poverty in state-funded and private schools. Schools were grouped into the four countries of United Kingdom (England, Scotland, Northern Ireland, and Wales). For the analysis of segregation by poverty, proportion of rich and poor children in each school were calculated. We conducted the analyses weighting each dataset through the variable weight

supplied by PISA. The schools were then sorted in public and private school types and for each category GS, D and A indexes were calculated. The figures presented as segregation Index (GS) between public and private schools in PISA, and as a result of school residuals from the two-different index showing the distribution in relation with percentage of poor student in each country

The analysis is presented in three sections. First, the estimation of segregation indexes for the 25% of students with the lowest socioeconomic level, looking at differences between home countries and between state-funded and private schools. Second, the same for the 10% lowest SES students. Finally, a study in deep of the school segregation in 2015 for 25% and 10% of poorest students in the UK and each of its countries.

3. Results

The results of Gorard index, Dissimilarity index and Isolation index for 2015 are in table 2, as it can be seen, the results are similar for any year. The table contains the correlations between the school residuals (deviations from no segregation) for each index. It shows yet again that GS and D are measuring the same thing, and their correlation is 1, whether looking at the segregation of the poorest 25% or the poorest 10% of students. This means that the results for GS and D are generally interchangeable. This has been shown many times, and we hope that this puts an end to prior claims that D was somehow superior to GS (Gorard 2007). The A index, as it is designed to, is measuring something different to either GS or D. So, it has a lower correlation with both of them.

Table 2. Correlations between the different school segregation residuals, UK, PISA 2015

	GS index 25%	D index 25%	A index 25%	GS index 10%	D index 10%	A index 10%
GS index 25%	1	1.00	0.71	0.78	0.78	0.55
D index 25%	1.00	1	0.71	0.78	0.78	0.55
A index 25%	0.71	0.71	1	0.62	0.62	0.80
GS index 10%	0.78	0.78	0.62	1	1.00	0.73
D index 10%	0.78	0.78	0.62	1.00	1	0.73
A index 10%	0.55	0.55	0.80	0.73	0.73	1

Note: Elaborated by the authors.

Segregation indexes for UK schools

More substantively, all three indices show that the segregation between schools of the poorest 25% of students has remained relatively static in the UK since 2006 (Table 3). There was an apparent decrease in segregation from 2000 to 2003 that may be part of the bigger national picture or could be due to the sampling and methodology of PISA settling down at that early stage. Wales has relatively low segregation as far as it is possible to tell (Gorard et al. 2003), and did not take part in 2000 PISA. So, the drop could be partly due to the addition of figures for Wales in 2003.

Table 3 – Segregation 2000-2015, lowest 25% SES, all schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	0.29	0.25	0.27	0.27	0.27	0.26
Dissimilarity index	0.38	0.33	0.36	0.37	0.36	0.35
Isolation index	0.37	0.35	0.37	0.36	0.36	0.35

Note: Elaborated by the authors.

The same pattern appears for the majority (94%) state-funded schools in the UK (Table 4). Here though the levels of segregation are slightly lower, and correspondingly much higher for the small proportion of private schools (Table 5). For private schools the Isolation index diverges from the other two because there are so few poor students in the private schools anyway, however they are clustered between private

schools. In general, either private schools have become less segregated (from each other) in terms of poverty, or the private schools entering PISA have become more representative.

Table 4 – Segregation 2000-2015, lowest 25% SES, state-funded schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	0.26	0.23	0.25	0.26	0.23	0.25
Dissimilarity index	0.35	0.32	0.33	0.35	0.32	0.34
Isolation index	0.37	0.35	0.36	0.36	0.37	0.35

Note: Elaborated by the authors.

Table 5 – Segregation 2000-2015, lowest 25% SES, private schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	0.78	0.50	0.56	0.49	0.31	0.48
Dissimilarity index	0.80	0.62	0.59	0.51	0.39	0.52
Isolation index	0.13	0.09	0.20	0.06	0.33	0.21

Note: Elaborated by the authors.

The pattern is slightly different for the 10% most poorest students in the UK. Segregation between schools for this group has declined somewhat from 2000 to 2015 in terms of GS and D measures of evenness (Tables 6 to 8). For 2012 and 2000 data relating to private schools is no recorded. There will be even fewer of the 10% poorest students in private schools (than 25% poorest), and so they would "meet" very rarely.

Table 6 – Segregation 2000-2015, lowest 10% SES, all schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	0.40	0.34	0.38	0.40	0.37	0.35
Dissimilarity index	0.46	0.38	0.42	0.44	0.41	0.39
Isolation index	0.24	0.18	0.20	0.20	0.19	0.17

Note: Elaborated by the authors.

Table 7 – Segregation 2000-2015, lowest 10% SES, state-funded schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	0.37	0.32	0.36	0.38	0.33	0.34
Dissimilarity index	0.41	0.36	0.41	0.43	0.38	0.38
Isolation index	0.24	0.18	0.20	0.20	0.20	0.17

Note: Elaborated by the authors.

Table 8 – Segregation 2000-2015, lowest 10% SES, private schools, UK

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.75	0.80	0.79	0.42	0.78
Dissimilarity index	-	0.76	0.80	0.80	0.46	0.79
Isolation index	-	0.05	0.04	0.04	0.16	0.05

Note: Elaborated by the authors.

There are no separate figures for Wales until later cycles of PISA, and for some years the results for England, Northern Ireland and Wales were reported together. These results are shown in the Appendix, along with those of Scotland. In general, the pattern of chance for each home country is similar.

Table 9 compares the segregation in each home country in 2015. It shows that segregation in Scotland is markedly lower than the UK average, for both state and private sectors. The same is true for Wales to a lesser extent. The picture, overall and for state schools, is very similar in England and Northern Ireland. However, private schools in Northern Ireland are even less segregated than those in Scotland (but not Wales).

Table 9 – Segregation GS index, 2015, England, Scotland, and Northern Ireland

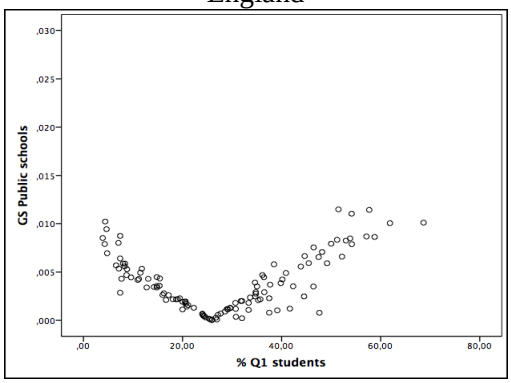
	England	Scotland	Wales	Northern Ireland	UK
All schools 25%	0.27	0.22	0.21	0.27	0.26
All schools 10%	0.37	0.29	0.32	0.35	0.35
State schools 25%	0.26	0.20	0.21	0.27	0.25
State schools 10%	0.35	0.28	0.33	0.35	0.34
Private schools 25%	0.50	0.33	0.20	0.25	0.48
Private schools 10%	0.82	0.57	-	0.39	0.78

Note: Wales had no students in private schools among the lowest 10% SES. Elaborated by the authors.

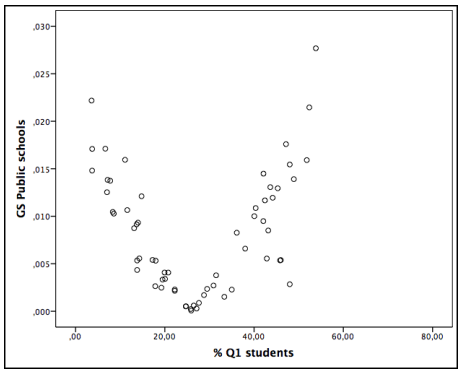
The apparent level of school segregation has dropped from 2000 to 2015 in all three home countries for which there are figures. Using the GS index for the 25% lowest SES students, in England it dropped from 0.31 in 2000 to 0.27 in 2015 (and from 0.44 to 0.37 for the 10% lowest SES). This is similar to the fuller figures reported for England for all state schools, based on official figures of pupils eligible for free school meals. These were 0.33 in 2000, and 0.29 in 2015 (Gorard, Siddiqui and See, 2019). This comparison suggests that at least some the changes and differences in the smaller sampled PISA figures are valid estimates of alterations in segregation. In NI, segregation dropped from 0.29 to 0.27 for the 25% lowest SES students, and from 0.45 to 0.35 for the 10% lowest SES students. The equivalent figures for Scotland were 0.26 to 0.22, and 0.41 to 0.29.

Figure 2 presents another way of visualize the segregation between schools in each home country, using the GS segregation residual for each school, the equivalent figure for D residuals appears in the Appendix. Both indexes can be examined in a similar way, however, it is important to remember the special property of GS index, of remaining unchanged in the face of changes in the composition of the minority group. Each graph shows a V shape, with the point at 25% on the x axis where schools have exactly their fair share of the 25% most disadvantaged students, and at 0 on the y axis since these schools add nothing to the overall segregation figure.
Each of the bubbles represented in the graphs shows the value of the residual of school segregation for each student. As can be seen, Northern Ireland has a smaller sample, followed by Scotland, Wales, and England. The four countries have a similar magnitude of school segregation showing a V shape comparable in terms of its amplitude, the difference between the country with the higher school segregation (England), and the one with the least (Wales) is 6%. However, the graphs seem to indicate that school segregation by poverty in Northern Ireland is the highest with a narrower V-shape with higher values of school segregation ratio in comparison to the other three countries..

England



Northern Ireland



Scotland

Wales

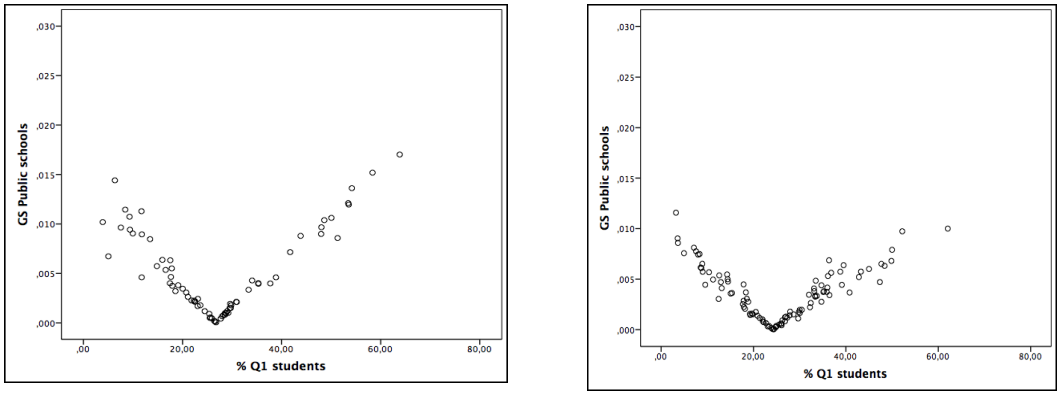


Figure 2 – Crossplots GS segregation residuals with % of 25% most disadvantaged students, home countries, 2015
Note: Elaborated by the authors.

The data of England, Northern Ireland and Wales comes together from 2003 to 2012 in the PISA dataset so doesn't allow us to study the differences over time. Instead we only can compare two different point in the complete temporal line. Intriguing, the data from England, Northern Ireland and Wales show the segregation in 2015 in 1.31% bigger than 2003. This result so far is the consequence of the different number of sample from each country and their different school systems, as long as the different policy, and economic circumstances of each country.

The study of the isolation index of the 25% or the poorest students show that the probability that a student from this minority group will be at school with another student both members of the minority group in 16.7% in UK, slightly bigger in the public sector (16.9%). The greater the isolation of the group, the lower its exposure to the members of the other groups. In private sector this probability is only 5%.

The results in table 3 show how segregated is the education system for the 10% of the students from poorest families. Our results shown that not only for the overall, as is expected in each country, poorest students are more segregated than the others. In the overall picture, England is the most socioeconomically segregated school systems for the most disadvantages student. Over the time segregation by poverty in England has decreased from 44% to 37%. In Scotland segregation has decreased the most (12%) followed by Northern Ireland (10%) and England (7%).

Overall, the exposure measure shows that the 10% of student with less socioeconomic level are more isolated than the students from the first quartile. Indeed, this pattern is persistent across all the UK countries. The isolation become better if the students attend public schools than private schools.

A study in-depth segregation indexes in 2015 for 25% and 10% of poorest students in the UK

The results indicate that the most segregated schools are found in England followed by Northern Ireland, Wales and Scotland. This same pattern is repeated in the schools of the public sector. However, the 2015 data for the private schools suggests that Northern Ireland and Wales are the countries with the least segregation by poverty. Again, and reflected in the four countries, private sector has higher socioeconomic segregation as compared to the public schools (figure 1). This is perhaps linked with student selection process observed in the private sector and to a lot extent private schools have tuition fees paid by parents which naturally leads to clustering of students from wealthy families who can afford the additional cost of their child's education.

The analysis of the exposure dimension of the school's segregation of the four countries in the United Kingdom indicates, as expected, that the greater the number of students who should change schools to

obtain an equal distribution in terms of socioeconomic level, the greater is their isolation. As in previous occasions, and for all countries, 10% of students are less distributed and more isolated than 25% of the most disadvantaged students.

Both graphs show a V shape created between the school's residuals of the school segregation in the four countries using the percentage of student from the first quartile in public schools. The wide or narrow of the V shape that let us know how different are the schools in each country. The figure 3 shows that as less student from the most disadvantaged backgrounds are in each school, bigger is the segregation residual in the school.

As both figures have shown, the state of school segregation by poverty in England, Scotland and Wales is very similar, the V shape has comparable amplitude, and depth in the four countries. However, the graphs seem to indicate that school segregation by poverty in Northern Ireland has a more extreme behavior, showing a narrower V-shape with higher values of school segregation ratio.

4. Discussion

Our results highlighted a similar pattern of school segregation by poverty between England, Scotland, and Wales. The levels of school segregation in all three cases have decreased over the 15 years studied. Specifically, England is the country where it has declined the most, from 0.31 in the year 2000 to 0.27 in the year 2015, values measured with GS index. On the other hand, school segregation in Northern Ireland seems to show different trends. Figure 2 that appears in the previous section shows graphically how the school segregation of students with social and economic disadvantages increases more drastically in the country. The overall picture has pointed out that, although the segregation in Northern Ireland is less than 15 years ago, it has a very similar value. It is only 1.7% lower in 2015 (0.27) than in 2000 (0.28). International research explains that school segregation evolves over time are relative to the particular economic and social characteristics of the country, but perhaps it would not be unfortunate to indicate that in the Northern Ireland the processes of school selection is based on parental choice of faith school for their children which is generating implicit clusters that affect the trends of school segregation in the country. Religion could be the proxy of socioeconomic poverty which leads to clustering of disadvantaged children in a specific faith-based school typed.

Our findings have shown that the private sector in the UK segregates students according to their level of poverty. Private schools have increased segregation by 17% in 3 years (from 31% in 2012 to 48% in 2015), while the situation in public schools has only slightly increased less than 2%. This needs further investigation with recommendations that the segregation analyses must include data from independent schools. Most studies on poverty segregation in England exclude independent schools considering that the independent school student intake is consistently 7% which does not contribute to overall spread of poverty in schools. This is perhaps not the case and including students from independent schools can change the extent and patterns of school segregation by poverty.

Our results highlight important findings for the Departments for UK education. Private education has contributed to education in different educational systems since its inception, private education satisfies the specific needs of the student population from many different backgrounds (religious, sports, languages etc). The present study has demonstrated that school segregation by poverty in private schools is greater than in public schools over the 15 years studied, a situation that occurs in all countries (0.48 versus 0.24, data from UK in 2015).

Unfortunately, PISA dataset does not provide information that allows us to know more about the characteristics of these private schools in order to explain why the segregation seems to have increased over time, geographical location of schools and type of school (faith school, grammar school, sponsored academy schools). It would be very interesting if the UK government would allow researchers to have access to know which schools participated in the PISA study in a way. This enables researchers to use information from the National Database which contain a large amount of information and more detailed

information from each of the schools. The combination of both databases gives us the opportunity to develop quality empirical research that can explain whether or not the private school sector is the generator of school segregation or, instead, is the intake of the school.

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Appendix

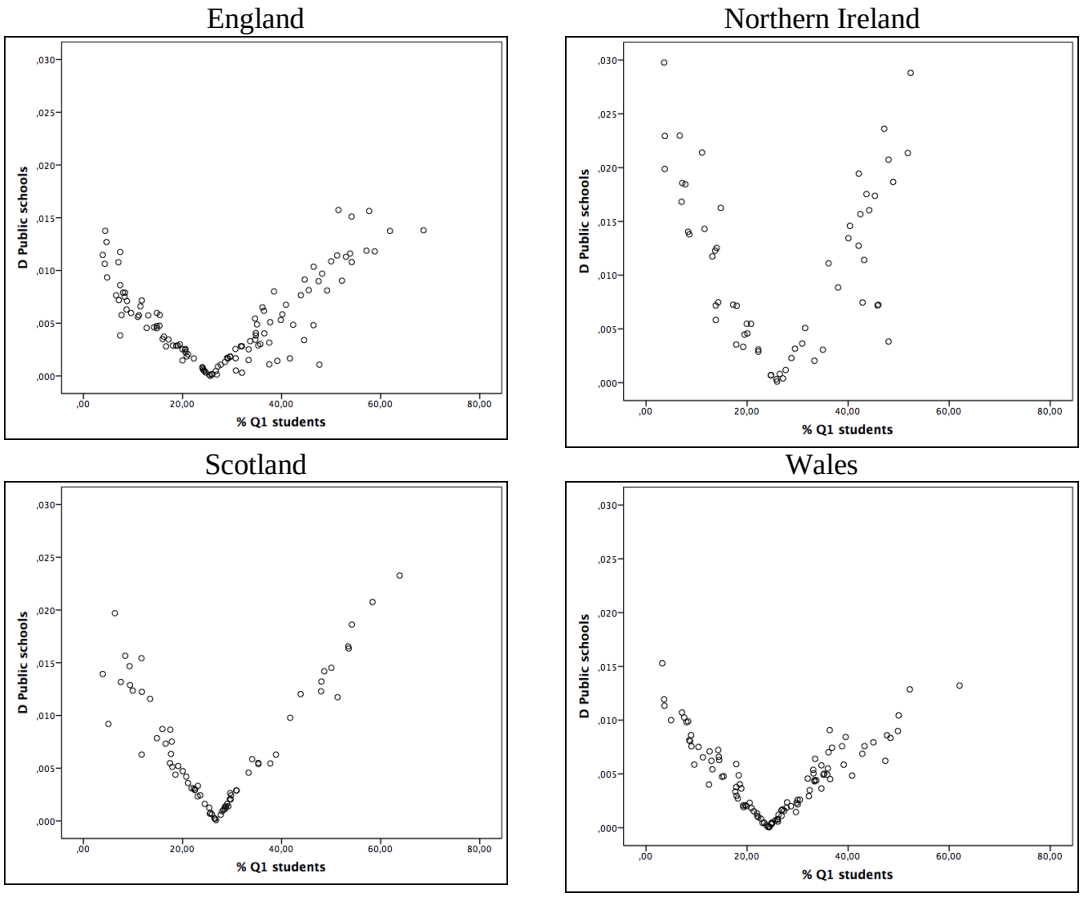


Figure A1 – D index segregation residuals, UK, PISA 2015

England, Wales, NI 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.26	0.27	0.28	0.27	0.27
Dissimilarity index	-	0.34	0.36	0.37	0.37	0.36
Isolation index	-	0.36	0.36	0.36	0.37	0.36

England, Wales, NI 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.24	0.25	0.26	0.24	0.25
Dissimilarity index	-	0.32	0.33	0.35	0.33	0.34
Isolation index	-	0.36	0.36	0.36	0.37	0.35

England, Wales, NI 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.62	0.56	0.51	0.31	0.48
Dissimilarity index	-	0.64	0.58	0.52	0.39	0.52
Isolation index	-	0.09	0.20	0.06	0.34	0.22

England, Wales, NI 10% lowest all schools

	2000	2003	2006	2009	2012	2015

Gorard index	-	0.35	0.38	0.40	0.37	0.36
Dissimilarity index	-	0.384	0.42	0.44	0.407	0.40
Isolation index	-	0.18	0.20	0.20	0.19	0.18

England, Wales, NI 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.33	0.37	0.39	0.34	0.35
Dissimilarity index	-	0.37	0.41	0.43	0.38	0.39
Isolation index	-	0.18	0.20	0.20	0.20	0.18

England, Wales, NI 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.79	0.80	0.79	0.41	0.80
Dissimilarity index	-	0.80	0.81	0.80	0.45	0.81
Isolation index	-	0.07	0.04	0.04	0.17	0.04

England 25% lowest all schools

	2000	2015
Gorard index	0.31	0.27
Dissimilarity index	0.42	0.36
Isolation index	0.41	0.36

England 25% lowest state schools

	2000	2015
Gorard index	0.28	0.26
Dissimilarity index	0.38	0.35
Isolation index	0.41	0.36

England 25% lowest private schools

	2000	2015
Gorard index	0.78	0.50
Dissimilarity index	0.79	0.54
Isolation index	0.07	0.22

England 10% lowest all schools

	2000	2015
Gorard index	0.44	0.37
Dissimilarity index	0.49	0.41
Isolation index	0.26	0.18

England 10% lowest state schools

	2000	2015
Gorard index	0.41	0.35
Dissimilarity index	0.45	0.39
Isolation index	0.26	0.18

England 10% lowest private schools

	2000	2015
Gorard index	0.93	0.82
Dissimilarity index	0.93	0.82

Isolation index	0.07	0.04

Northern Ireland 25% lowest all schools

	2000	2015
Gorard index	0.29	0.27
Dissimilarity index	0.38	0.36
Isolation index	0.37	0.35

Northern Ireland 25% lowest state schools

	2000	2015
Gorard index	0.28	0.27
Dissimilarity index	0.37	0.36
Isolation index	0.37	0.35

Northern Ireland 25% lowest private schools

	2000	2015
Gorard index	0.19	0.25
Dissimilarity index	0.33	0.29
Isolation index	0.55	0.16

Northern Ireland 10% lowest all schools

	2000	2015
Gorard index	0.45	0.35
Dissimilarity index	0.49	0.39
Isolation index	0.22	0.17

Northern Ireland 10% lowest state schools

	2000	2015
Gorard index	0.43	0.35
Dissimilarity index	0.48	0.38
Isolation index	0.22	0.17

Northern Ireland 10% lowest private schools

	2000	2015
Gorard index	-	0.39
Dissimilarity index	-	0.40
Isolation index	-	0.06

Scotland 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.26	0.21	0.24	0.24	0.22	0.22
Dissimilarity index	-	0.34	0.36	0.37	0.37	0.36
Isolation index	-	0.36	0.36	0.36	0.37	0.36

Scotland 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.24	0.20	0.21	0.23	0.20	0.20
Dissimilarity index	0.33	0.27	0.29	0.31	0.27	0.27
Isolation index	0.36	0.32	0.31	0.35	0.34	0.34

Scotland 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.32	0.31	0.47	0.31	0.33

Dissimilarity index	-	0.33	0.32	0.48	0.32	0.34
Isolation index	-	0.06	0.05	0.06	0.06	0.05

Scotland 10% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.41	0.31	0.35	0.36	0.31	0.29
Dissimilarity index	0.46	0.34	0.38	0.39	0.34	0.32
Isolation index	0.20	0.16	0.19	0.18	0.16	0.15

Scotland 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.39	0.29	0.32	0.33	0.28	0.28
Dissimilarity index	0.44	0.33	0.36	0.37	0.31	0.32
Isolation index	0.20	0.17	0.18	0.18	0.16	0.15

Scotland 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.28	0.77	-	0.82	0.57
Dissimilarity index	-	0.29	0.77	-	0.82	0.59
Isolation index	-	0.03	0.02	-	0.03	0.06

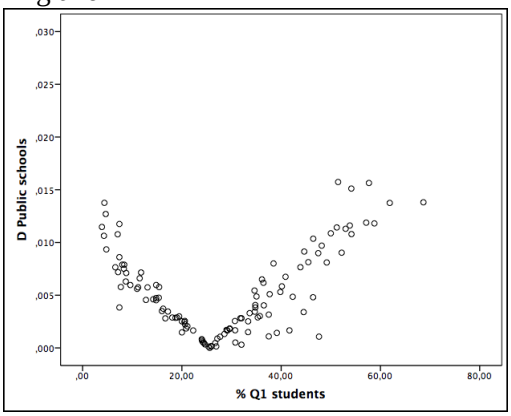
Wales 2015

	All schools 25%	All schools 10%	State schools 25%	State schools 10%	Private schools 25%	Private schools 10%
Gorard index	0.21	0.32	0.21	0.33	0.20	-
Dissimilarity index	0.28	0.36	0.28	0.37	0.21	-
Isolation index	0.32	0.17	0.31	0.17	0.07	-

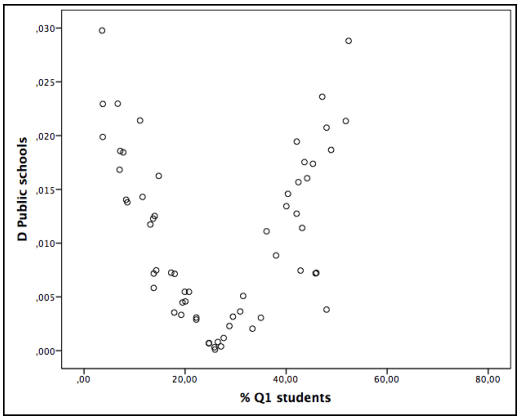
Appendix

Figure A1 – D index segregation residuals, UK, PISA 2015

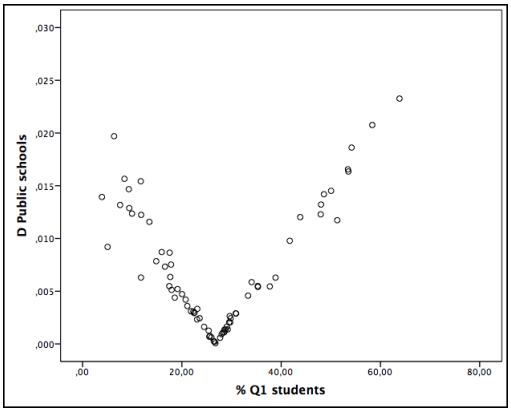
England



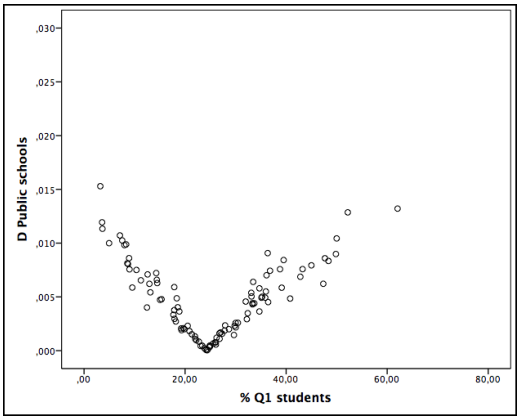
Northern Ireland



Scotland



Wales



England, Wales, NI 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.26	0.27	0.28	0.27	0.27
Dissimilarity index	-	0.34	0.36	0.37	0.37	0.36
Isolation index	-	0.36	0.36	0.36	0.37	0.36

England, Wales, NI 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.24	0.25	0.26	0.24	0.25
Dissimilarity index	-	0.32	0.33	0.35	0.33	0.34
Isolation index	-	0.36	0.36	0.36	0.37	0.35

England, Wales, NI 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.62	0.56	0.51	0.31	0.48
Dissimilarity index	-	0.64	0.58	0.52	0.39	0.52
Isolation index	-	0.09	0.20	0.06	0.34	0.22

England, Wales, NI 10% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.35	0.38	0.40	0.37	0.36

Dissimilarity index	-	0.384	0.42	0.44	0.407	0.40
Isolation index	-	0.18	0.20	0.20	0.19	0.18

England, Wales, NI 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.33	0.37	0.39	0.34	0.35
Dissimilarity index	-	0.37	0.41	0.43	0.38	0.39
Isolation index	-	0.18	0.20	0.20	0.20	0.18

England, Wales, NI 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.79	0.80	0.79	0.41	0.80
Dissimilarity index	-	0.80	0.81	0.80	0.45	0.81
Isolation index	-	0.07	0.04	0.04	0.17	0.04

England 25% lowest all schools

	2000	2015
Gorard index	0.31	0.27
Dissimilarity index	0.42	0.36
Isolation index	0.41	0.36

England 25% lowest state schools

	2000	2015
Gorard index	0.28	0.26
Dissimilarity index	0.38	0.35
Isolation index	0.41	0.36

England 25% lowest private schools

	2000	2015
Gorard index	0.78	0.50
Dissimilarity index	0.79	0.54
Isolation index	0.07	0.22

England 10% lowest all schools

	2000	2015
Gorard index	0.44	0.37
Dissimilarity index	0.49	0.41
Isolation index	0.26	0.18

England 10% lowest state schools

	2000	2015
Gorard index	0.41	0.35
Dissimilarity index	0.45	0.39
Isolation index	0.26	0.18

England 10% lowest private schools

	2000	2015
Gorard index	0.93	0.82
Dissimilarity index	0.93	0.82
Isolation index	0.07	0.04

Northern Ireland 25% lowest all schools

	2000	2015
Gorard index	0.29	0.27
Dissimilarity index	0.38	0.36
Isolation index	0.37	0.35

Northern Ireland 25% lowest state schools

	2000	2015
Gorard index	0.28	0.27
Dissimilarity index	0.37	0.36
Isolation index	0.37	0.35

Northern Ireland 25% lowest private schools

	2000	2015
Gorard index	0.19	0.25
Dissimilarity index	0.33	0.29
Isolation index	0.55	0.16

Northern Ireland 10% lowest all schools

	2000	2015
Gorard index	0.45	0.35
Dissimilarity index	0.49	0.39
Isolation index	0.22	0.17

Northern Ireland 10% lowest state schools

	2000	2015
Gorard index	0.43	0.35
Dissimilarity index	0.48	0.38
Isolation index	0.22	0.17

Northern Ireland 10% lowest private schools

	2000	2015
Gorard index	-	0.39
Dissimilarity index	-	0.40
Isolation index	-	0.06

Scotland 25% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.26	0.21	0.24	0.24	0.22	0.22
Dissimilarity index	-	0.34	0.36	0.37	0.37	0.36
Isolation index	-	0.36	0.36	0.36	0.37	0.36

Scotland 25% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.24	0.20	0.21	0.23	0.20	0.20
Dissimilarity index	0.33	0.27	0.29	0.31	0.27	0.27
Isolation index	0.36	0.32	0.31	0.35	0.34	0.34

Scotland 25% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.32	0.31	0.47	0.31	0.33
Dissimilarity index	-	0.33	0.32	0.48	0.32	0.34

Isolation index	-	0.06	0.05	0.06	0.06	0.05

Scotland 10% lowest all schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.41	0.31	0.35	0.36	0.31	0.29
Dissimilarity index	0.46	0.34	0.38	0.39	0.34	0.32
Isolation index	0.20	0.16	0.19	0.18	0.16	0.15

Scotland 10% lowest state schools

	2000	2003	2006	2009	2012	2015
Gorard index	0.39	0.29	0.32	0.33	0.28	0.28
Dissimilarity index	0.44	0.33	0.36	0.37	0.31	0.32
Isolation index	0.20	0.17	0.18	0.18	0.16	0.15

Scotland 10% lowest private schools

	2000	2003	2006	2009	2012	2015
Gorard index	-	0.28	0.77	-	0.82	0.57
Dissimilarity index	-	0.29	0.77	-	0.82	0.59
Isolation index	-	0.03	0.02	-	0.03	0.06

Wales 2015

	All schools 25%	All schools 10%	State schools 25%	State schools 10%	Private schools 25%	Private schools 10%
Gorard index	0.21	0.32	0.21	0.33	0.20	-
Dissimilarity index	0.28	0.36	0.28	0.37	0.21	-
Isolation index	0.32	0.17	0.31	0.17	0.07	-