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What Should an Index of School Segregation Measure?

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Executive Summary

The paper aims to make a methodological contribution to the education segregation literature, providing a critique of previous measures of segregation used in the literature, as well as suggesting an alternative approach to measuring school segregation. It also provides new empirical evidence on changes in the extent of socio-economic segregation (measured by free school meals (FSM) entitlement) in English schools during the last fifteen years. Specifically, the paper examines Gorard *et al.*'s (2000a, 2003) finding that FSM segregation between schools fell significantly in the years following the 1988 Education Reform Act. Using Annual Schools Census data from 1989 to 2004, the paper challenges the magnitude of their findings, suggesting that the method used by Gorard et al. actually overstates the size of the fall in segregation by 100%. Our results show evidence of an increase in the index of dissimilarity in many Local Authorities, especially in London, although in the South-East as a whole we note that it falls. We also observe higher segregation in LEAs with higher proportions of pupils at voluntary-aided schools. We cannot confirm however, whether this is a causal relationship. It is not necessarily the case that the rise in the segregation index in these Local Authorities is attributable to the behaviour of VA schools. Much of this paper is a critique of previous methods used to measure segregation in schools. For example, we suggest that the GS index is not the optimal way of measuring changes in school segregation for the following reasons:

1. GS is not bounded by 0 and 1: the upper boundary varies according to FSM eligibility, so GS is better described as an 'indicator' rather than an index of segregation;
2. GS is not symmetric, meaning that it is capable of showing that FSM segregation is rising and NONFSM segregation is falling simultaneously; and
3. GS is actually systematically variant to changes in overall FSM eligibility, except in the most stringent and unlikely of circumstances (the strict proportionate change in FSM); therefore we can properly describe it as composition variant. It had a tendency to fall as FSM eligibility rises, regardless of the change in the unevenness of school's shares of FSM and NONFSM pupils.

In this paper we make the case for a segregation curve approach to measuring segregation and use one exemplar index, the index of Dissimilarity, to re-evaluate the extent of school segregation in England over the last fifteen years. What can we conclude?

- There was no pervasive increase in segregation over the period.
- There are a number of potential explanations for this. For example, it may be that de facto school choice did not in fact increase during this period due to capacity constraints.
- The analysis does however provide clear evidence of an increase in segregation, as measured by the index of dissimilarity, in many Local Authorities, particularly in London. The index is also higher in LEAs with higher proportions of pupils educated at voluntary-aided schools, although this relationship is not necessarily causal.
- We have not been able evaluate the causal impact of policies that give schools increased control over their own admissions on segregation, however we have found an association between LEAs with higher proportions of pupils in schools that control their own admissions or have explicit select by ability and the level of FSM segregation. We suggest that the level of measured segregation be carefully monitored over time, as the proportion of schools that are LEA community schools continues to fall.
- We note that pupil numbers in secondary schools will fall from 2005. It will be important that measures are taken to improve the ability of disadvantaged pupils to take up free places in the schools of their choice, otherwise the spare capacity in the system may well result in rising levels of segregation and in particular a concentration of disadvantaged pupils in some schools operating in deprived areas.

We conclude that deciding how best to measure segregation is complex, combining fundamentally normative judgements about what exactly one intends to measure, with more technical judgements about the appropriate properties of the chosen measure. We believe that we have made a good case for a specific approach, being open about the normative judgements we have made to reach our conclusion. We have chosen to criticise one alternative approach to measuring segregation, GS, examining its properties in detail. Further research is certainly needed to subject alternative methods of measuring school segregation, such as multilevel modelling or the isolation index, to the same level of scrutiny.

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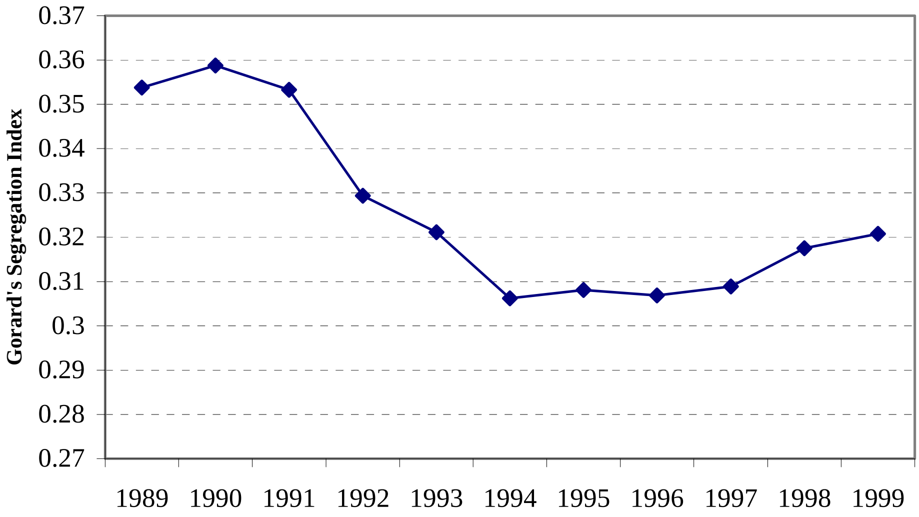
1 Introduction

It is important for policy makers and researchers to know how socially segregated our schools are, yet researchers still widely disagree on how to measure segregation. Measuring and trying to understand the reasons for changes in the level of school segregation in England have been central to the evaluation of policies designed to increase choice and competition both in and since the 1988 Education Reform Act (see Whitty *et al.*, 1998, for an overview). The direction of the effect of school choice policies on segregation is not clear. However, sociologists have argued that these policies would have unintended consequences in terms of stratification of different types of pupils across schools. The central hypothesis is that greater school choice will lead to parents/pupils from higher socio-economic groups being more successful than those from lower socio-economic groups in choosing the higher performing schools. This in turn will cause these high performing schools to improve still further due to positive peer effects from their advantaged intake. This so called virtuous cycle will, it is suggested, lead to increasing polarisation between schools in terms of the ability and socio-economic background of their intakes (Bourdieu, 1997; Bowe *et al.*, 1994; Halsted, 1994).

Whether this increased polarisation is actually happening in practice is of course an empirical question and a sizeable body of evidence, of differing types, has been accumulated on this issue. A number of qualitative and smaller scale quantitative studies have suggested that there has indeed been increasing polarisation between schools, measured in terms of the distribution of more socially disadvantaged students across schools. However, in the late 1990s, a major research programme on this issue, using large-scale longitudinal quantitative data, suggested that quite the opposite had happened in England and Wales following the 1988 Act (Gorard, 1997, 1999, 2000; Gorard & Fitz, 1998, 2000a, 2000b; Gorard & Taylor, 2002a; Gorard *et al.*, 2002). Using quantitative data on the distribution of pupils taking/eligible for free school meals (FSM) across all schools in the 1990s, the results from this body of work suggested that, contrary to most theoretical predictions, schools in England and Wales actually became less socially segregated in the 1990s. Figure 1 illustrates the level of segregation in the years 1989 to 1999, as measured by Gorard's Segregation Index (GS) and reported in Gorard *et al.* (2003).

Figure 1 Values of Gorard's Segregation Index (GS)



This was a highly controversial finding, given that it contradicted the evidence from previous (generally smaller scale) studies. Gorard, Taylor and Fitz's work then spawned a vigorous, and at times heated debate, that continues unabated (Gibson & Asthana, 2000, 2002; Harvey Goldstein, 2001; H. Goldstein & Noden, 2003; Gorard, 2002; Gorard, 2004; P. Noden, 2000; Philip Noden, 2002).

Of course disagreements about how best to measure segregation are certainly not unique to educational research, and 'index wars' (Peach, 1975) erupt frequently, for example, in the measurement of residential racial segregation in US cities and gender segregation in the workplace. Arguments combine normative disagreements about what segregation actually is with more technical arguments about the desirable properties of a segregation index. The normative debate about what one means by the term segregation is central because it necessarily guides us in our assessment of the relative importance of the different technical features of any given index of segregation.

The aims of this paper are twofold. Firstly, the paper seeks to shed further light on this ongoing methodological debate by providing both a normative discussion of what we mean by segregation, in the context of schools, as well as an explicit critique of the segregation index (the GS) used by Gorard, Taylor and Fitz to measure changes in school segregation over time. Whilst the findings of Gorard *et al.* do appear to hold regardless of measure used, we argue that GS is not the optimal measure for making inferences regarding changes in social segregation in schools. This is an important contribution to the literature, given the extensive use of the GS index in subsequent research on school segregation in England, Wales and Europe (e.g. Gorard & Smith, 2004; Gorard et al., 2003; Taylor *et al.*, 2005). The second aim of the paper is to propose some alternative measures of segregation that we argue are more appropriate for measuring segregation across schools. Specifically, in this paper we make a case for researchers adopting indices that are consistent with the segregation curve, such as the index of dissimilarity or Hutchen's Square Root index.[1] We then illustrate the use of these alternative measures of segregation and provide new empirical evidence on the extent and nature of segregation in England in the 1990s and early 2000s.

The rest of the paper is set out as follows. Section 2 provides both a normative discussion of the term segregation in the context of schools analysis, as well as a more technical account of the principles of segregation. The section introduces the segregation curve as a means of representing segregation and the index of dissimilarity (D) as a summary statistics of this curve. Section 3 describes Gorard *et al.*'s alternative index (the GS) and highlights the key features of that index. Section 4 uses Annual Schools Census data to illustrate the extent to which the GS index provides a different pattern of changes in school segregation between 1989 and 1995 onwards, as compared to alternative measures of segregation such as the dissimilarity index. It then analyses recent Annual Schools Census data to provide some more current empirical evidence on the extent and nature of segregation in England. Section 5 concludes.

2 A Good Index of Unevenness Segregation

2.1 Defining segregation

At a general level, segregation is the degree to which two or more groups are separated from each other. In evaluating school choice policies we are particularly interested in whether the distribution of a particular group of pupils across schools in an area has become more uneven;

[1] For reasons of space, we are unable to consider a number of other methods that might potentially be used to measure segregation. We cannot therefore compare our indices, or indeed the GS index, to alternatives that have been used elsewhere in the literature (such as Goldstein's multi-level modelling approach or Noden's isolation index analysis). This is clearly an area for future research effort.

where unevenness is the first of five dimensions of segregation categorised by Massey and Denton (1988).[2] In this paper, we focus solely on unevenness in the distribution of pupils who are either eligible for or in receipt of free school meals (FSM), using this as a proxy for social disadvantage (the drawback of this categorisation is discussed elsewhere (Croxford, 2000; Shuttleworth, 1995)). We define unevenness as the extent to which a school's share of FSM and NONFSM pupils deviates from the 'fair share' of these pupils that they would have if FSM and NONFSM pupils were distributed evenly across schools.

In choosing to define segregation as unevenness we have taken the first step in reducing a remarkably general term (segregation) to a more specific one (unevenness), a step that must be justified. We choose unevenness rather than isolation, for example, because isolation incorporates ideas of both the overall size of the minority group *and* the unevenness in its distribution. So, we argue that because education policy can only influence the latter, and not the former, unevenness in the distribution of a given minority group between schools is the relevant 'policy lever' for reducing all types of segregation between schools.

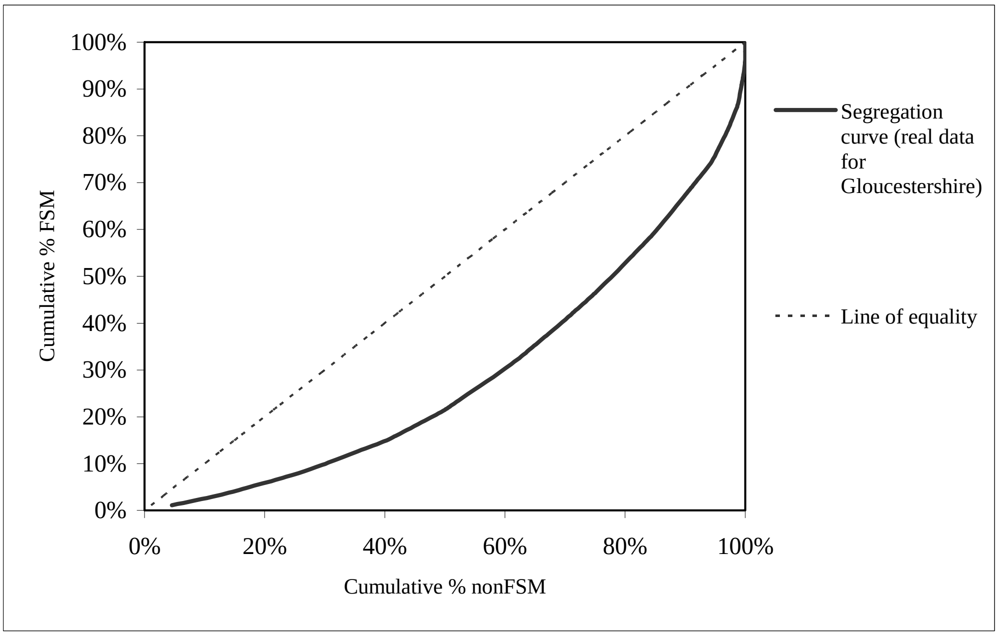
2.2 Segregation curves and segregation indices

Two group segregation, such as unevenness in the between school distribution of pupils eligible for free school meals (FSM) versus those not eligible for free school meals (NONFSM), can be graphically illustrated. Segregation curves show this unevenness without the loss of any information and without the need for strong value judgements regarding the exact location of unevenness. Figure 2 shows segregation curves created using actual data for a cohort of year 9 students attending school in Gloucestershire Local Education Authority (LEA) in 2002/3. The segregation curve is developed by first ranking the schools in order of their share of total pupils eligible for FSM in the LEA, then plotting the cumulative fraction of NONFSM pupils on the x axis and cumulative fraction of FSM pupils on the y axis. The line of equality represents total evenness where every school has its 'fair share' of FSM pupils and NONFSM pupils. Fair share means that if, for example, a school educates 16% of the pupils in an LEA, it will also educate 16% of the FSM pupils and 16% of the NONFSM

[2] The other dimensions being exposure (isolation), concentration (the amount of physical space occupied by the minority group), clustering (the extent to which minority neighbourhoods abut one another), and centralisation (proximity to the centre of the city).

pupils. Thus, the segregation curve plots the unevenness in the share of FSM pupils versus NONFSM pupils.

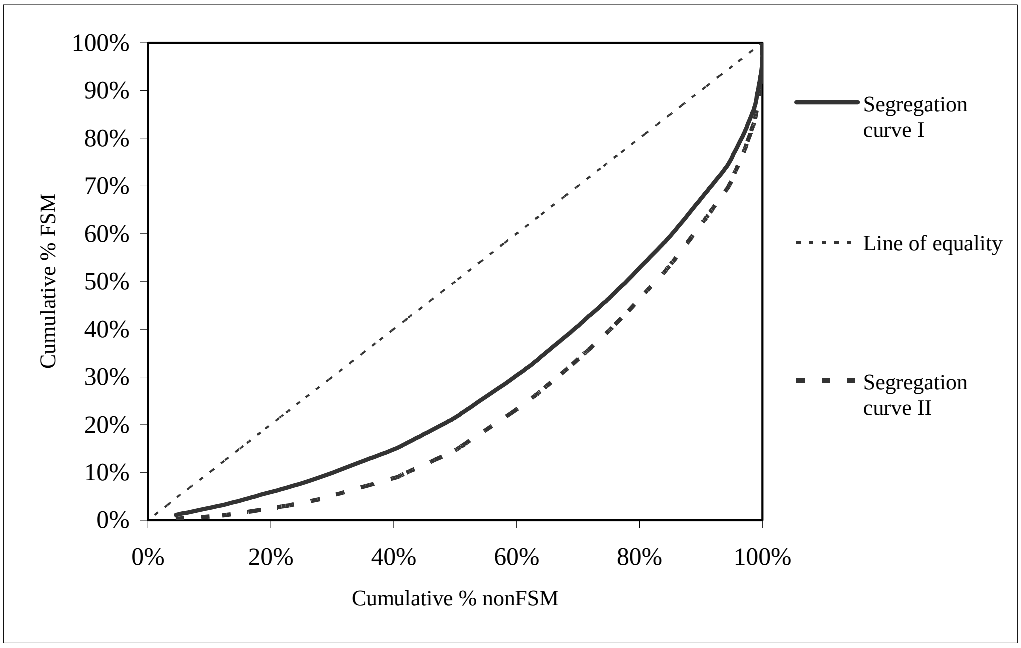
Figure 2 The FSM Segregation Curve for Gloucestershire LEA



So far, identifying the extent of segregation encounters little controversy: using segregation curves we can always identify whether one distribution of pupils is more uneven than another, as long as the two segregation curves in question do not intersect. However, where curves cross, value judgements are required in order to produce a complete ranking of segregation between, for example, different areas or different points in time (R. M. Hutchens, 2004). The purpose of segregation indices is therefore to produce a complete and unique rank ordering of segregation curves by area/time, in essence summarising the extent of segregation across schools in a single numerical value.

There are a set of segregation indices that are solely a function of the segregation curve, which means that if the segregation curve lies on the line of equality, the value of the index is by definition zero; if the segregation curve traces the x axis because all FSM pupils are concentrated in one school, the value of the index should be one. Importantly, the value these indices must, by definition, be lower for one segregation curve where it is both closer to the line of equality at all places and does not intersect with another segregation curve. So, for example in Figure 3, the segregation curves I and II are non-overlapping; all indices that are solely a function of the segregation curve must place a higher value on the segregation relating to curve II compared to curve I.

Figure 3 Two Non-Overlapping Segregation Curves



The segregation curve approach to developing segregation indices is well-established in the academic literature (Cortese *et al.*, 1976; Duncan & Duncan, 1955; Massey & Denton, 1988) precisely because the value of an index developed under this method is easily interpretable. Segregation curve approach indices always incorporate the absolute view that 0 is complete evenness in the distribution and 1 is complete segregation, regardless of the relative size of the FSM and NONFSM groups. It is certainly not the only approach in the literature, but we argue that it is the most appealing in this particular context. It allows measurement of the relative level of segregation in any situation, is axiomatically well-grounded (as shown in the next section) and has been shown to be the logical equivalent of the Lorenz curve approach in the inequality literature (Robert M. Hutchens, 1991). The Lorenz curve approach recognises that value judgements are inherent in any measure of inequality (Atkinson, 1970), but that all distributions of income across individuals can be ‘fairly’ compared using indices where complete evenness is zero and complete inequality is one. Thus, a segregation curve approach unifies the (mostly sociological) segregation literature and the (mostly economic) inequality literature.

2.3 Index of dissimilarity

Continuing the segregation curve approach, this section introduces the index of dissimilarity (known as 'D' from now on), which has long been established as the most popular index of unevenness segregation, following the review of indices by (Duncan & Duncan, 1955). The use of D is not, however, without controversy. D measures the 'dissimilarity' in the distribution of FSM pupils across schools from the distribution of NONFSM pupils across schools, is solely a function of the segregation curve and represents the maximum vertical distance between the segregation curve and the line of equality. In the context of segregation between schools by free-school meal eligibility, measured at LEA level, its formula is:

$$D = \frac{1}{2}\sum_{i=1}^{I}\left|\frac{fsm_i}{FSM} - \frac{nonfsm_i}{NONFSM}\right| \qquad (1)$$

where there are I schools in the LEA; school i has fsm_i pupils eligible for FSM *and* $nonfsm_i$ pupils who are not eligible for FSM.

In the LEA as a whole, the total number of pupils eligible for free school meals is denoted by 'FSM' whilst the number not eligible is denoted by 'NONFSM'.

For the remainder of this article, N and n_i will represent the total number of pupils in the LEA and school i, respectively, such that N=FSM+NONFSM.

The proportion of pupils eligible for FSM in the LEA, p = FSM/N.

2.4 Axioms of a good segregation index

There is no 'perfect' segregation index: each has different properties and incorporates different value judgements about the nature of segregation. The use of D as the primary measure of unevenness segregation in areas such as occupational gender segregation and residential racial segregation stems from its meeting the criteria for a good index, i.e. it is 0-1 bounded, is solely a function of the segregation curve and meets a set of generally agreed basic axioms reasonably well. These are adapted from the axioms in Hutchens (2004),[3] but are very similar to those discussed by James & Taeuber (1985). It can be shown that a measure that satisfies these properties will always yield a ranking of segregation consistent with the ranking provided by non-intersecting segregation curves (Robert M. Hutchens, 1991).

[3] These five principles relate to Hutchen's axioms 1, 2, 3, 4 and 7. Axioms 5 and 6 relate to an ability to aggregate and additively decompose a segregation index; D does not satisfy these axioms.

P1. Scale or composition invariance – D is invariant to a proportionate increase in FSM or NONFSM, providing each school's share of the sub-group (e.g. FSM) remains constant *and* the distribution of the other sub-group (e.g. NONFSM) does not change. This means that if *new* FSM pupils enter an LEA from outside, causing the number of FSM children to double across the LEA as a whole but the share in each school remains the same, the value of the index will not change.

P2. Symmetry in groups – schools can be relabelled and reordered, yet the value of D remains the same. This means that we are indifferent as to whether school A or school B is more segregated; we are simply interested in measuring the extent of segregation between the two schools.

P3. Principle of transfers – D is *usually* capable of being affected by the movement of one individual from school to school. Intuitively, this means that if a child who is eligible for FSM moves from a school with a small proportion of FSM children to a school with a high proportion of FSM children, then the index will show that segregation has increased. Strictly, D does not meet this principle in its 'strong form', but it is does capture pupil movements from a school with more than their 'fair share' of FSM pupils to a school with less than their 'fair share' of FSM pupils (the 'weak form'). [4]

P4. Organisational equivalence – D is unaffected by changes in the number of sub-areas; for example, if a school is divided into two sub-schools by proportional division, then the value of D will not change.

P5. Symmetry between types - D is symmetric in the sense that pupils with FSM could be substituted for NONFSM pupils and vice versa in the formula to produce an identical value

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[4] Strictly speaking the violation of the Principle of Transfers means we should not treat D as strongly segregation-curve-consistent because a dis-equalising movement will not always cause this index to indicate more segregation. However, it is sufficiently so for the purposes of this paper and so we set aside this well-documented issue.

for D. We note that there are indices, used in section 4, that are non-symmetric yet are still 0-1 bounded and solely a function of the segregation curve.

There are other segregation indices that, unlike D, meet the axioms above perfectly; most notably an index proposed by Hutchens (2001, 2004) called the Square Root index. The rationale for using D however, is two-fold. First, unlike the Square Root index it is familiar to researchers, and the Square Root index tends to display low values where the level of segregation is quite moderate, as is typical in schools. Second, D is closely related to the GS index that we discuss in the next section and therefore seems to be the more appropriate and fairer comparison to GS.

3 GS - the 'Strongly Compositionally Invariant' Index

3.1 Gorard's segregation index (GS)

As can be seen, D meets many of the criteria for a good segregation index. However, Gorard and Taylor created their own segregation index (known as GS from now on), criticising the appropriateness of D on the basis of a problem they label 'strong compositional variance' (Gorard & Taylor, 2002b). This is distinct from the scale or composition invariance described above (in Proposition P1). D *is* composition invariant in that it will not change value if *new* students entering an LEA causes the number of FSM children to rise but proportionately across all schools, i.e. provided that the shape of the segregation curve remains the same. However, if an event takes place that switches existing students' status from NONFSM to FSM (for example, a recession increases overall FSM take-up or the measurement of FSM is changed from take-up to eligibility), the value of D will alter even if all schools retain their existing share of FSM pupils. It does so because this type of event would alter the unevenness in the distribution of NONFSM pupils (Taylor *et al.*, 2000). For Gorard and Taylor (2002b), this was a problem that invalidated D's use in school segregation research where overall FSM proportions tend to vary from year to year because it is possible for pupils to change status from NONFSM to FSM, and vice-versa.

Gorard *et al.* rightly identified that the behaviour of an index in the event of an increase in FSM eligibility is particularly important in the context of educational research. They suggested that 'strong compositional invariance' (SCI) is a desirable feature of an index and developed an alternative segregation index (GS) that aims to measure unevenness, controlling for proportionate switches in student status to FSM. Whereas D calculates segregation based on the difference between the FSM share of pupils and NONFSM share of pupils at each school in the LEA, GS calculates segregation based on the difference between the FSM share of pupils and the share of total pupils (N) at each school in the LEA.

GS can actually be calculated by first measuring D and then multiplying D by 1-p, where p is the proportion of FSM pupils:

$$GS = \frac{1}{2}\sum_{i=1}^{I}\left|\frac{fsm_i}{FSM} - \frac{n_i}{N}\right| \equiv D*(1-p) \qquad (2)$$

Where the number of FSM pupils increases by scalar λ and by the same proportion in every school such that $FSM_1=\lambda FSM_0$ and $fsm_{1i}=\lambda fsm_{0i}$, GS will remain constant. Equation (2) shows that the distribution of NONFSM pupils is not in the calculation of GS, therefore the GS index ignores the fact that such a scalar increase in the number of FSM pupils will also alter each school's share of NONFSM pupils.

Gorard *et al.* made a strong case that GS was therefore the most appropriate index for measuring changes in social segregation between schools over time:

The (Gorard) segregation index is the only index we have encountered which is thus able to separate the overall relative growth of FSM from changes in the distribution of FSM between schools. It is suitably ironic that some commentators in educational research have turned this situation on its head and argued that our index is sensitive to changes in composition, while the decomposed index of isolation (P. Noden, 2000) or even unscaled percentage point differences (Gibson & Asthana, 2000) are composition invariant. That is how wars start! (Taylor et al., 2000)

The remainder of this section argues that, though the desire to create an index that can deal with the phenomenon of pupils changing their FSM status was important, GS is a measure of segregation with various features that we suggest renders it less desirable to use in measuring segregation between schools. We are not the first to make many of these arguments: Gorard rightly points out that his index, or close variants on it, has been proposed in the past in other fields. It's most cited appearance was as the 'WE' index (which is actually 2*GS) used in an OECD study of Women and Employment (Moir & Selby Smith, 1979; OECD, 1980).

However, the WE index has not been used in the field of occupational gender segregation since the mid-1980s, for many of the same reasons we discuss below.

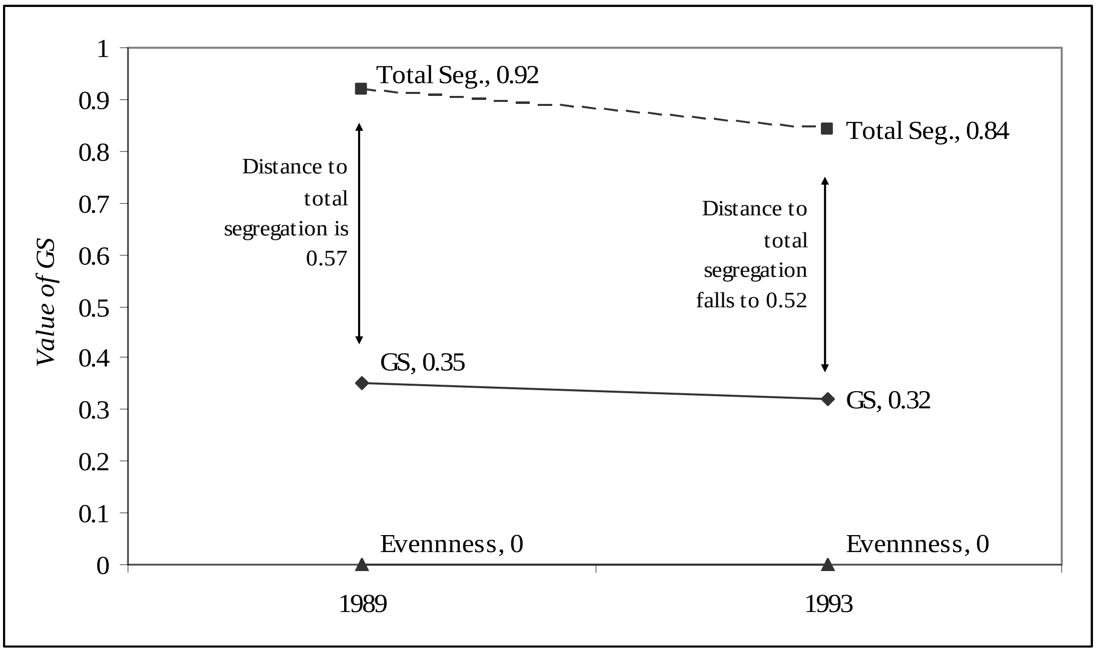
3.2 GS is not bounded by 0 and 1

As has been shown, the GS index is calculated by shrinking the dissimilarity index (D) by a factor of (1-p). The result is that GS is bounded by 0 and (1-p), i.e. it’s upper limit is variable. It seems desirable that any index has clear fixed limits, and the convention is that these are 0 and 1. This is a desirable feature because the meaning of complete segregation and complete integration is something that all researchers can agree on, so it seems logical that these should display fixed values of 0 and 1. The value of an index in any particular year or area can only have *relative* meaning with respect to the distance of the value from the boundaries of the index. Where the maximum value is varying according to the overall FSM proportion, the range will not be standard in each situation being compared. This means the value of the index cannot be standard either.

Following the argument of Blackburn *et al.* (1993) in their criticism of WE index, we say that it is not possible to directly compare two values of GS that come from indices with differing boundaries. This will always be the case where the comparison groups have different overall FSM eligibility, which ironically is the precise situation for which the GS was suggested. As an illustration, in England the FSM proportion rose from 8% in 1989 to 16% in 1993. GS is therefore bounded by 0 and 0.92 in 1989, but 0 and 0.84 in 1993. The value of GS fell in this period from 0.35 to 0.32, and the GS would describe this as a fall in segregation: indeed the value of GS is nearer to evenness (0). However, because the upper bound of the index has also fallen, segregation could also be described as being closer to total segregation, as illustrated in Figure 4.

We do, however, recognise that the absolute value of GS does have a specific meaning in itself and Cortese *et al.* (1976) suggest that it could be used as one *indicator* of the ‘displacement’ caused by segregation, which might aid interpretation of D. Once D is calculated, GS or D*(1-p) is the proportion of FSM pupils that would have to exchange schools in order to achieve evenness. D*p is the proportion of NONFSM pupils that must exchange schools to achieve evenness and D*2p(1-p) is the proportion of all pupils that would have to exchange schools to achieve evenness.[5] [6]

Figure 4 Comparing the Value of Gorard's Segregation Index between 1989 and 1993



The implication of the variable upper bound is that when using GS, segregation is always relatively low in areas of high FSM eligibility, even if all the NONFSM pupils are concentrated in one school. We argue that this view of the costs of segregation is an undesirable one. It implies that the range of possible effects of segregation is smaller where 90% of pupils are FSM eligible (maximum value of GS = 0.1), compared to a situation where, say, 5% of pupils are FSM (maximum value of GS = 0.95). We argue that since we understand so little about the relationship between segregation and social welfare, this supports the case for using a 0-1 bounded relative index. These 0-1 indices tell us the 'cost'

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[5] Note that 2*p(1-p) is the maximum possible value of the weighted sum of the absolute deviations of the FSM proportion for each school: $\sum_{i=1}^{I} \frac{n_i}{N} \left| p_i - p \right|$, where p_i is the FSM percentage in school i.

[6] By contrast, D's absolute interpretation as 'the share of either group which must be removed, without replacement, to achieve zero segregation' is not particularly useful to us in the field of school segregation since if we remove a child from one school, we must place them in another.

of segregation to society, not in an absolute sense, but relative to complete segregation and complete evenness. Interpretation of segregation indices is clearly always complex, but at least where an index is bounded by 0 and 1 it is 'fair' in that all LEAs have the 'opportunity' to be more or less segregated than one another.

3.3 GS is not symmetric

It is well recognised that one cannot switch the 'labels' on the FSM and NONFSM pupils and get the same value of GS, i.e. that GS is not symmetric. So, for example, the groups of schools in Figure 5 and Figure 6 will have different values of GS even though from an evenness perspective they could be described as identical mirror images of each other. We do not argue that symmetry is always a desirable feature of an index; indeed, we exploit the non-symmetry of other indices later in this article. However, where indices are not symmetric, interpretation becomes more difficult. If FSM pupils are separated from NONFSM pupils, NONFSM are also separated from FSM pupils, and this implies a symmetrical relationship (Blackburn et al., 1993). Where an index is not symmetric there exists two values for the index, and movements in the values may be contradictory (Karmel & MacLachlan, 1988). For example, how can we interpret a situation where segregation is said to be falling for FSM pupils, yet rising for NONFSM pupils?

In the case of segregation of FSM versus NONFSM pupils, it may be the effect of segregation of FSM pupils that is of interest to us. However this is a normative judgement. Indeed, from a social welfare perspective, it may be the numbers of NONFSM pupils in each school that determines the effect of school segregation on the FSM pupils themselves. In other situations it is not entirely clear which group of pupils we want to treat as the 'minority' group. Are FSM pupils in Tower Hamlets the minority group (they constitute over 60% of all pupils)? How can we treat girls or boys as the minority group? If we want to know about the unevenness of the distribution of high ability pupils (e.g. the top 20%) across schools, can we still say they are the 'minority', and does a non-symmetric index infer that our treatment of them in this respect places a greater emphasis on their welfare rather than the welfare of all pupils? In essence, the use of non-symmetric indices poses a number of problems of interpretation that need to be more fully explored if such indices are to be used to measure school segregation.

Figure 5 GS is 0.23

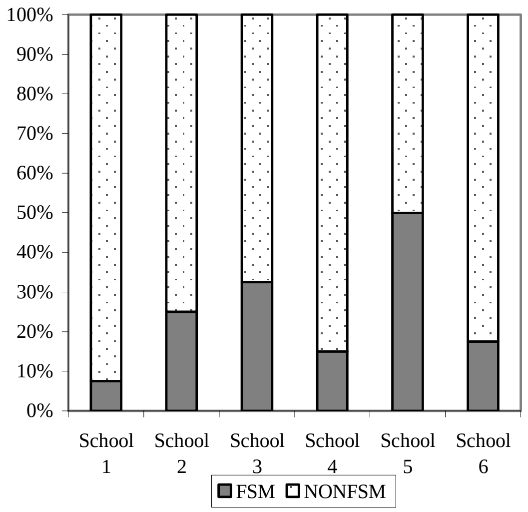
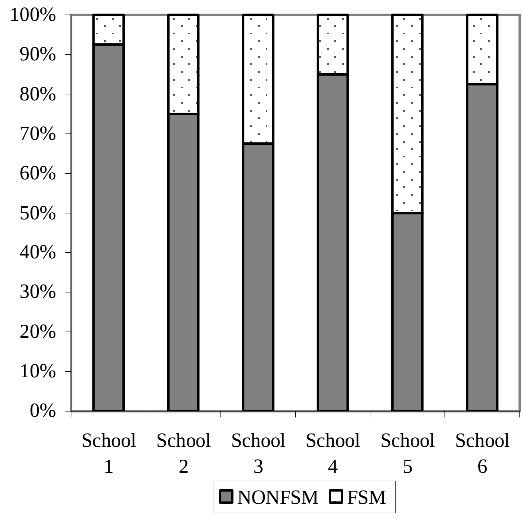


Figure 6 GS is 0.07



3.4 The undesirability of 'Strong Composition Invariance' (SCI)

Gorard *et al.* argue an index should remain constant if pupils switch their status from NONFSM to FSM in such a manner that $fsm_1 = \lambda fsm_0$ in every school in the LEA, allowing all schools to retain their existing shares of FSM pupils as the overall FSM proportion rises or falls. Where an index meets this requirement it can be said to be 'strongly composition invariant' (SCI). The SCI property means GS would not change in these circumstances, yet because these same pupils have lost their NONFSM status, this event will change the distribution of NONFSM pupils across schools. The nature of the constant proportionate increase in FSM means that the probability that a NONFSM child switches to FSM status is higher in schools with the highest FSM proportion. Therefore, these (already deprived) schools lose the greatest share of their NONFSM pupils, thus increasing the unevenness of the distribution of NONFSM pupils. In practical terms this means that a large constant proportionate increase in FSM is often not achievable because the most deprived school does not have enough NONFSM pupils to lose. When the SCI property is met, the resulting change in the unevenness of the NONFSM pupils changes the shape of the segregation curve. Thus, no index that has the SCI property can be consistent with the segregation curve approach.

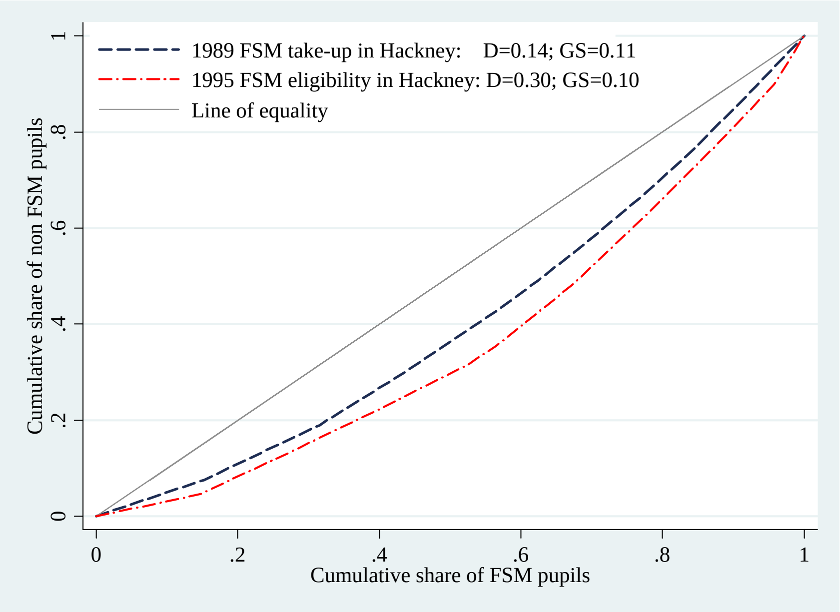
Using Annual Schools Census data, similar to that held by Gorard,[7] the segregation curve in figure 7 provides a graphical illustration of the unevenness in the distribution of FSM and NONFSM pupils in 1989 (using take-up) and 1995 (using eligibility, in line with Gorard's analysis). Since the curves are non-overlapping we can say that school segregation in Hackney – defined as unevenness of FSM pupils versus NONFSM pupils on a 0-1 measure - rose over these 6 years. However, the value of GS fell from 0.11 in 1989 to 0.10 in 1995; so, the problem of GS incorrectly ranking segregation curve is substantive in schools data. D, which is solely a geometrical function of the segregation curve, rose from 0.14 in 1989 to 0.30 in 1995. GS and D disagree on whether segregation actually fell or rose in an LEA between 1989 and 1995 in 35% of cases.

It can also be shown that GS incorrectly ranks segregation curves for two LEAs in any one year. Figure 8 shows that in 1995 the level of FSM segregation was higher in Tower Hamlets than in Ealing, and D correctly reflects this with values of 0.26 and 0.17 respectively. However, GS identifies Ealing as having the higher level of segregation (0.12 versus 0.09); it does this because it reduces D by a scalar (1-p), producing a small number in Tower Hamlets where overall FSM eligibility is very high. It would not matter how segregated Tower Hamlets schools had become: GS would never have risen above 0.21 in 1995. If we placed LEAs in deciles according to their value of D and GS in 1995, the two indices would disagree about which decile the LEA should be in 63% of cases.

The intuition behind the GS index of segregation seems sensible: it would seem unfair to attribute to schools changes that arise from general changes in the probability of being of FSM status. It is generally agreed amongst researchers of segregation that a good index should have an expected value that is not a function of the overall FSM proportion in the LEA (Winship, 1978), i.e. it is composition invariant. D is said to be composition invariant according to the conventional definition that the index should be invariant following 'uniform percentage changes in the number of [NONFSM] and [FSM] in each [school] reflecting the

[7] Our pre-1998 data uses pre-LGR definitions of LEAs, whereas Gorard aggregated schools on the basis on the new LEA boundaries. There are also occasional discrepancies in our calculation of GS versus those published by Gorard, but never by more than 0.01.

Figure 7 The Rise in Segregation in Hackney between 1989 and 1995



overall, but typically unequal, percentage changes in [FSM eligibility]' (Watts, 1998).[8] D is said to be independent of overall FSM eligibility (p) because it is solely a function of the segregation curve (Duncan & Duncan, 1955). The intuition behind this statement is that the segregation curve plots the shares of FSM pupils on one axis against the shares of the NONFSM pupils on the other. The distribution of these two groups can be treated as independent of each other since no pupil appears in both groups and each axis plots the cumulative distribution from 0% to 100%, regardless of the relative size of the two groups overall. Therefore, no part of drawing a segregation curve relies on knowledge of the value p.[9] Since GS = D*(1-p) and D is known to be solely a function of the segregation curve, GS is a function of the overall FSM proportion (i.e. p) in the area in question. Indeed any index that is 'strongly compositionally invariant', such as GS, *must* partially be a function of the overall FSM proportion, so we can properly describe it as 'composition variant', i.e. it will vary systematically where the overall FSM proportion differs. GS creates a paradox whereby

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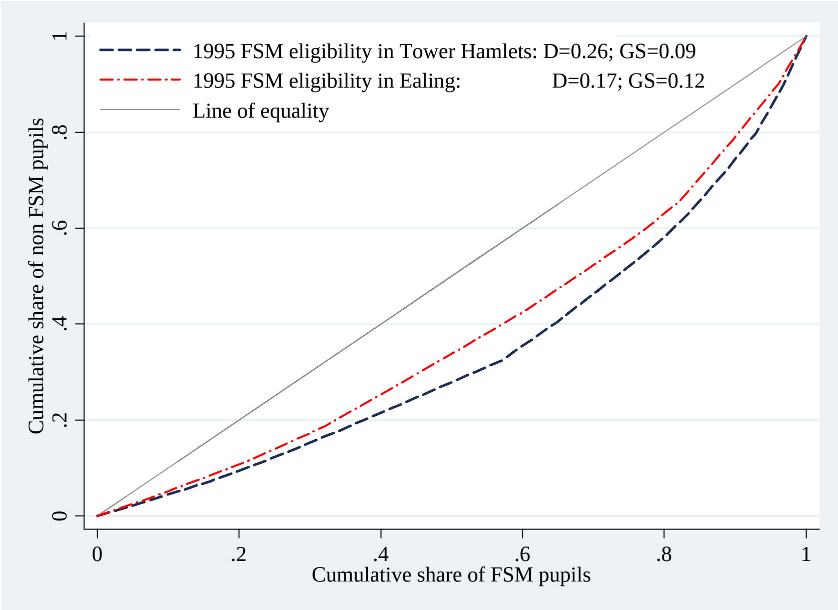
[8] We set aside the issue of random allocation bias that does make the distance of D from randomness (as opposed to evenness) a function of p.

[9] The segregation curve approach is not the only way to demonstrate the independence of the value of D to changes in p: Zoloth (1976) gives a short mathematical decomposition of D's formula to show the same result.

greater dissimilarity combined with higher levels of overall poverty may result in a lower measure of segregation.

Figure 8 FSM Segregation in Tower Hamlets versus Ealing



Showing that GS is a function of p (i.e. composition variant) is however not a trivial issue and has been suggested by other authors, but strongly refuted by Stephen Gorard (see earlier quote). Gibson and Asthana (2000) and Philip Noden (2000) pointed out the very high (over 0.95) correlation between the national segregation level measured by GS and England's overall FSM proportion. Gibson and Asthana also showed that over 70% of the variation in GS between LEAs can be explained by FSM eligibility and the number of pupils in the LEA.

4 Re-Examining the Empirical Evidence (1989 to 2004)

This section re-examines Gorard *et al.*'s (2003, pages 58-63) presentation of changes in the social composition of schools between 1989 and 1995. It goes on to present new empirical evidence on the extent and nature of segregation within LEAs between 1999 and 2004, using various segregation curve consistent measures of segregation.

4.1 (Un) changing school segregation from 1989 onwards

Re-analysis of Annual Schools Census data for the years 1989 and 1995 using D indicates that Gorard *et al.* were indeed correct in stating that, nationally, FSM segregation between schools fell during this period. However, by using the GS index with its falling upper bound (as the FSM measure rose) they overstated the magnitude of the fall by around 100%: D (measured nationally using FSM take-up in both years) fell by 5% from 0.292 in 1989 to 0.277 in 1995; GS fell by 10%. The picture in individual LEAs during this period is more balanced: segregation rose in 42% of (the 107 pre-LGR) LEAs; it fell in the remaining 62%. The national fall is shown in figure 9 to demonstrate that the fall in D was highly concentrated in the recession years of 1991 to 1993. We note that the national segregation figures are relatively uninteresting since they combine changes in the distribution of FSM pupils between LEA or regions (resulting, for example, from the migration of families) with changes in the distribution of FSM pupils within LEAs.

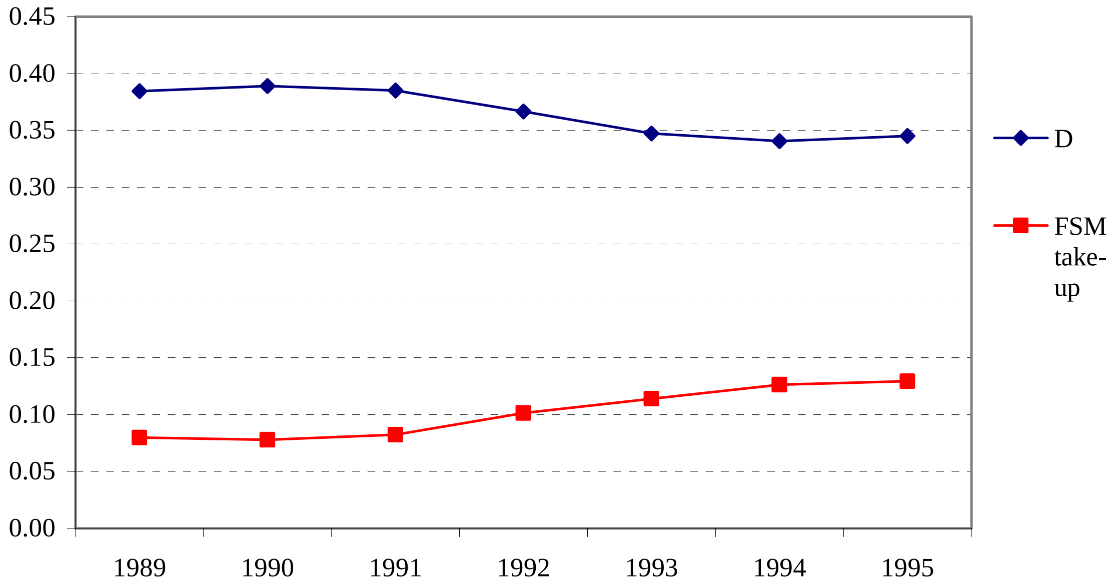
As noted by others including Gorard himself, it is unlikely that the substantial fall in the value of the GS index between two consecutive years (it fell 7% between 1991 and 1992) represents genuine changes in segregation across schools, caused by choice, as opposed to the impact of the recession. Our sub-unit of analysis is the entire school, i.e. five year groups grouped together. Therefore between 1991 and 1992, four of the cohorts would have been identical. A huge difference in the evenness of FSM pupils between those who left the school in 1991 and those who joined in 1992 would be required to make genuine changes in segregation, perhaps due to school choice, a primary explanation for the fall in the value of the GS index. Furthermore, it would seem likely that if genuine changes in segregation explained such a substantial fall in the GS index over the two year period, surely segregation would have continued to fall at a similar rate in the following few years; yet it did not.[10]

4.2 FSM school segregation in 2004

Levels of FSM segregation within LEAs in 2004 vary from as low as 0.11 in the tiny LEA of Rutland (with just 3 schools) to as high as 0.51 in Buckinghamshire. Overall, the average level of FSM segregation in English LEAs, weighted for LEA size, was 0.29 in 2004. The region with the greatest within LEA segregation was the North West, as shown in Table 1.

[10] Using FSM take-up, GS is 0.353 in 1991; 0.329 in 1992; 0.308 in 1993; 0.298 in 1994; 0.300 in 1995.

Figure 9 The Fall in School Segregation between 1989 and 1995



One cannot use this type of cross-sectional approach to suggest why some LEAs have greater levels of school segregation than others since causality is not easily established in this context. However, the value of D for each LEA in 2004 can be regressed against a range of variables describing different aspects of an LEA to examine associations between the level of segregation in an LEA and various characteristics of that LEA.[11] This is in itself a useful exercise as it highlights the types of LEAs that have, on average, higher levels of segregation.

Table 2 indicates that LEAs with higher proportions of pupils at grammar schools and higher proportions of pupils at voluntary-aided (VA) schools are all associated with higher levels of segregation. Although these results do not imply that VA schools are responsible for increasing the level of segregation in an LEA, they do confirm that it is those LEAs with the highest proportions of grammar and VA schools that face the highest levels of segregation.

[11] Though we do not discuss it in this article, we recognise that D should only be cautiously used as a dependent variable in a regression for two reasons. First, its use as a dependent variable means that we treat the values of the index as having cardinal meaning, so we would only want to do this where we accepted the linear payoff criterion of D as being appropriate given our view of segregation and social welfare. Second, we recognise that D displays a systematic random allocation bias where the value is non-zero even under random allocation and the extent of the bias depends on various features of each LEA.

Table 1 Summary LEA Segregation by Region in 2004

Name of Region	No. of LEAs	Weighted mean D	Lowest D	Highest D
South West	15	0.24	0.15 (Cornwall)	0.42 (Poole)
London	32	0.28	0.16 (Islington)	0.46 (H'smith & Fulham)
East Midlands	9	0.29	0.11 (Rutland)	0.39 (Lincolnshire)
North East	12	0.29	0.22 (Middlesbrough)	0.39 (Stockton-on-Tees)
East of England	10	0.29	0.23 (Norfolk)	0.39 (Southend)
England	**148**	**0.29**	**0.11 (Rutland)**	**0.51 (Buckinghamshire)**
West Midlands	14	0.29	0.20 (Sandwell)	0.43 (Solihull)
South East	19	0.30	0.13 (West Berkshire)	0.51 (Buckinghamshire)
Yorkshire & The Humber	15	0.31	0.20 (Rotherham)	0.39 (Bradford)
North West	22	0.32	0.16 (Knowsley)	0.40 (Bolton)

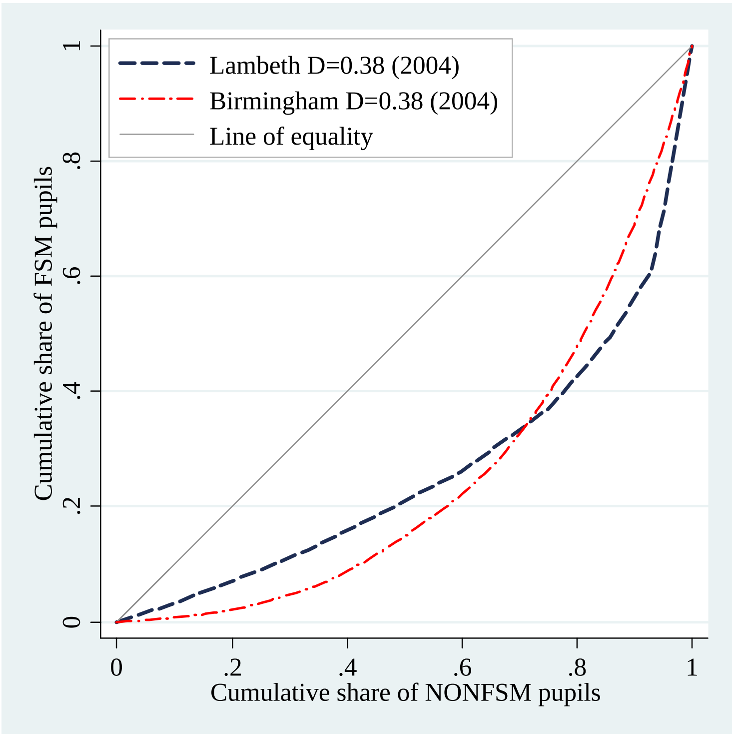
Table 2 Association between LEA Segregation and School Types

Number of obs.	148 (weighted for LEA size)	
Adj. R squared	0.34	
Coefficient	**Estimate**	**P value**
Population density in LEA	-0.95	0.013
LEA FSM proportion in 2004	0.08	0.354
Proportion of pupils at grammars	0.39	0.000
Proportion of pupils at CTCs/academies	0.20	0.389
Proportion of pupils at VA schools	0.23	0.000
Proportion of pupils at foundation schools	0.05	0.073
Constant	0.24	0.000

4.3 Different locations of segregation

Thus far we have relied on values of dissimilarity (D) to measure the level of segregation in an LEA. However, this may mask very different patterns of distribution of FSM pupils within LEAs. Drawing segregation curves for LEAs such as those in figure 10 illustrates this idea clearly. Both Lambeth and Birmingham had equal values of D (0.38). Lambeth's segregation curve is very steep on the far right hand side of the graph, suggesting that a large proportion of low-income pupils are highly concentrated in one or two schools. In other words, this LEA faces concentrations of its disadvantaged pupils. Birmingham's segregation curve is very flat on the left hand side of the graph, which means that there is a set of schools in the LEA with very few low income pupils. Thus, this LEA faces concentrations of more advantaged pupils. Clearly there are potentially different policy implications for these two different manifestations of the same level of segregation.

Figure 10 Segregation Curves for Lambeth and Birmingham



There exist a set of segregation-curve-consistent indices called the Generalized Entropy Measures of Segregation (R. M. Hutchens, 2004) that allow us to distinguish between these different patterns of FSM pupils in LEAs. The formula for these indices is:

$$O_c(x) = -\sum_{i=1}^{I} \frac{nonfsm_i}{NONFSM} \left[\left(\frac{fsm_i}{FSM} \Big/ \frac{nonfsm_i}{NONFSM} \right)^c - 1 \right], \quad where\ 0 < c < 1 \qquad (3)$$

Where c = 0.5, the index is symmetrical and is termed the Square Root index; otherwise they are non-symmetrical and it is this feature that allows us to use them to distinguish between

LEAs with ‘concentrations of disadvantage’ as compared to ‘concentrations of advantage’. We use a log ratio of the values of $O_{0.1}(x)$ and $O_{0.9}(x)$ (the choice of 0.1 and 0.9 being quite arbitrary) to rank LEAs in terms of their tendency to display ‘disadvantaged’ versus ‘advantaged’ segregation. This allows us to rank the proportionate differences in skewness between LEAs; where 0 indicates no skewness, positive values indicate increasing concentrations of advantage and negative values indicate increasing concentrations of disadvantage. We call this log ratio the ‘segregation skew’ of the distribution of FSM and NONFSM pupils:

$$segregation\ \ skew = \log\left(O_{0.1}(x) \middle/ O_{0.9}(x) \right) \qquad (4)$$

The greater the value of the segregation skew, the greater the concentrations of ‘advantage’ in the LEA: Birmingham’s value of the ratio is +0.22. The lower the value of the segregation skew, the greater the concentrations of ‘disadvantage’ in the LEA: Lambeth’s value of the ratio is -0.20.

Table 3 shows that English LEAs typically show concentrations of advantage and that these are most pronounced in the West Midlands region. Reading LEA shows the greatest concentration of advantage at +0.71. By contrast, Brighton & Hove LEA shows the greatest tendency towards concentrations of disadvantage. It should be emphasised that the value of the segregation skew does not indicate the absolute level of concentration of disadvantage or advantage. It simply indicates the tendency towards a concentration of disadvantage/advantage for any given level of segregation.

Perhaps not surprisingly, greater skewness towards concentration of advantage is correlated with a greater proportion of pupils in grammar schools ($\rho = 0.43$), voluntary-aided schools ($\rho = 0.25$) and foundation schools ($\rho = 0.18$).

4.4 Recent changes in social segregation between schools

Over the five year period of 1999 to 2004, the empirical evidence paints a mixed picture of rising social segregation between schools in 60% of LEAs and falling segregation in 40% (see table 4). School segregation has risen fastest in London, with a mean increase in D of 9% over the period. Indeed static or rising segregation is the trend in most regions, although the South East region has seen a dominant trend of falling segregation. However, these regional

Table 3 Skewness in the Segregation Curve

Name of Region	No. of LEAs	Mean ratio	LEAs with greatest concentration of disadvantage	LEAs with greatest concentration of advantage
Yorkshire & The Humber	15	+0.01	-0.14 (Rotherham)	+0.17 (Bradford)
East Midlands	9	+0.03	-0.05 (Leicestershire)	+0.13 (Lincolnshire)
East of England	10	+0.04	-0.12 (Bedfordshire)	+0.14 (Peterborough)
North East	12	+0.05	-0.06 (Newcastle)	+0.21 (Stockton-on-Tees)
South West	15	+0.06	-0.13 (Swindon)	+0.22 (Wiltshire)
England	**148**	**+0.07**	**-0.21 (Brighton & Hove)**	**+0.71 (Reading)**
South East	19	+0.07	-0.21 (Brighton & Hove)	+0.71 (Reading)
North West	22	+0.08	-0.08 (Rochdale)	+0.33 (Manchester)
London	32	+0.11	-0.20 (Lambeth)	+0.30 (Westminster)
West Midlands	14	+0.12	-0.05 (Sandwell)	+0.33 (Telford & Wrekin)

trends hide inter-LEA differences within regions: even in the South East 37% of LEAs actually saw a rise in segregation over the period, despite the downward regional trend. Some LEAs saw substantial rises in the value of D during the period: the LEAs with the greatest proportionate growth in the value of D over this period were 58% in Lambeth, 57% in Barking and Dagenham and 37% in Brighton and Hove.

Table 4 Changes in LEA segregation between 1999 and 2004

	No. of LEAs	Average change in D	Greatest LEA fall	Greatest LEA rise	% of LEA with higher D in 2004	% of LEA with lower D in 2004
South East	19	-2%	-26%	37%	37%	63%
East of England	10	1%	-16%	13%	70%	30%
East Midlands	9	2%	-15%	10%	56%	44%
West Midlands	14	3%	-20%	27%	50%	50%
Yorkshire & The Humber	15	3%	-19%	24%	60%	40%
England	**148**	**3%**	**-38%**	**58%**	**60%**	**40%**
South West	15	3%	-20%	19%	47%	53%
North East	12	4%	-38%	37%	67%	33%
North West	22	6%	-11%	25%	77%	23%
London	32	9%	-16%	58%	69%	31%

Again identifying the causes of changes in the level of segregation across LEAs is problematic. However, one can look at associations between changes in D and LEA characteristics. We have done this and our results, consistent with work of other researchers, suggest that school closure continues to be associated with falling segregation: schools have closed in 12 of the 20 LEAs where the value of D fell by over 10%. Regression of the percentage change in D between 1999 and 2004 in table 5 confirms this relationship.

Table 5 Regression of Percentage Change in Segregation 99-04

Number of obs.	148 (weighted for LEA size)	
Adj R-squared	0.26	
Coefficient	**Estimate**	**P value**
Population density	0.00	0.285
Dissimilarity in 1999	-0.47	0.003
Proportion of pupils at VA schools in 1999	0.24	0.020
Proportion of pupils at grammar schools in 1999	0.10	0.368
Proportion of pupils at foundation schools in 1999	0.01	0.758
Proportion of pupils at CTC/academy schools in 1999	-1.36	0.002
Change in number of pupils in LEA	0.07	0743
Change in number of schools	0.32	0.017
Change in LEA FSM proportion	0.08	0.426
Change in proportion at VA schools	0.12	0.036
Change in proportion at grammar schools	-0.36	0.025
Change in proportion at foundation schools	0.14	0.238
Change in proportion at CTC/academy schools	0.04	0.688
Constant	0.13	0.008

Given their level of prior attainment, there is evidence that FSM-eligible pupils are heavily under-represented in grammar schools. Whether this under-representation improves as grammar schools expand is an empirical matter. Growing grammar schools might take additional pupils eligible for FSM, or they might fill newly available places with non-FSM eligible pupils. Table 5 shows that areas with higher proportions of grammar schools have not generally been associated with falling segregation, but where there has been a growth in the proportion of pupils at grammar schools segregation appears to have fallen. It is possible this is due to grammar schools accepting pupils from lower down the ability spectrum as they expand, and therefore increasing their FSM share (albeit from extremely low levels to very low levels)[12].

Interestingly, areas with a higher proportion of pupils at voluntary-aided schools in 1999 have seen greater growth in segregation between 1999 and 2004. Where these VA schools have grown in size, increasing their share of pupils in the LEA, this is again associated with increasing segregation. Once again, while this pattern of changes in segregation is interesting, it would be unwise to attribute causation of this phenomenon to the behaviour of VA schools.

4.5 Describing changes in segregation curves using a set of indices

When segregation increases in an LEA, the nature of the change in the shape of the segregation curve will depend on the cause and location of the increased segregation. In particular, segregation might increase as a result of the school with the most deprived intake increasing its share of FSM pupils further, thereby concentrating disadvantage. Alternatively, segregation might increase if the school with the fewest FSM pupils reduces its share of FSM pupils, thereby concentrating advantage.

Segregation curves are an effective means to understand the nature of changes in segregation, but we suggest that a set of statistics based on the set of Generalized Entropy Measures of Segregation can summarise the salient features of the change in the shape of the curve. Using Reading LEA in figure 11 as an example, we suggest that four values can be used to describe both the level and changes in segregation as follows:

(a) the general level of school segregation can be represented by a symmetrical segregation curve approach index, such as D, the gini coefficient of segregation or Hutchens Square Root index (i.e. $O_{0.5}(x)$). So, for Reading LEA the level of FSM segregation in 1999 was D=0.28, which is higher than the typical LEA (64^{th} highest of 148 LEAs).

[12] The processes driving this result are not clear. Furthermore the coefficient on the variable measuring the change in the proportion of pupils enrolled in grammar schools is an average effect across all Local Authorities, including those with very high and very low proportions of pupils in grammar schools.

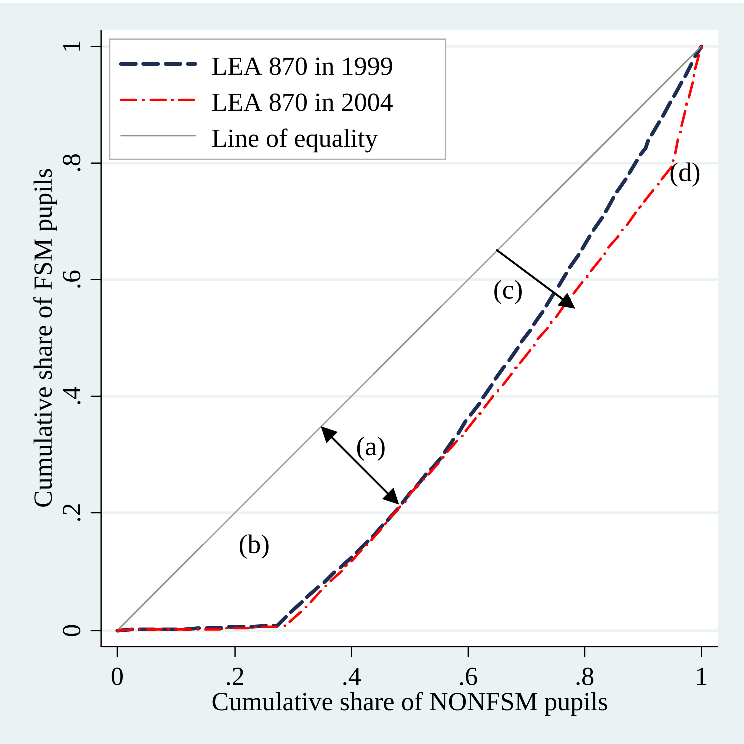
(b) the skew of school segregation – concentrations of ‘advantage’ versus ‘disadvantage’ – can be measured using $segregation\ skew = \log\left(O_{0.1}(x) \big/ O_{0.9}(x) \right)$. For Reading LEA the skew in 1999 was +0.74, one of the highest in the country (rank 12 of 148).

(c) the increase in school segregation can be represent by the growth in a symmetrical index. For Reading LEA, the growth in FSM segregation between 1999 and 2004 was 2% (lower than the typical LEA).

(d) the location of the change in school segregation, or change in skew, can be measured using a ratio indicating the relative skew in the two years:

$$\Delta\, segregation\, skew = \log\left[\frac{O_{0.1}(x_{2004}) \big/ O_{0.9}(x_{2004})}{O_{0.1}(x_{1999}) \big/ O_{0.9}(x_{1999})} \right] \qquad (5)$$

Figure 11 Increase in FSM Segregation in Reading



Here a value of 0 indicates that there is no change in the skewness of segregation; a positive value indicates that the increase in segregation is located in the most advantaged schools; a negative value indicates that the increase in segregation is located in the most disadvantaged schools. For Reading LEA the value is -0.03, suggesting that Reading schools where the

FSM proportion was already high in 1999 have increased their share of FSM pupils, thus increasing segregation. This is consistent with Figure 11.

As a further illustration of this approach, Figure 12 shows that Hammersmith & Fulham has a high, and rising, level of segregation (D=0.41 in 1999 with growth of 13% to 2004). It shows some skew towards having concentrations of 'advantage' (segregation skew = +0.14 in 1999), and has become more so over the five year period (Δ segregation skew = +0.13).

Figure 12 Increase in FSM Segregation in Hammersmith & Fulham

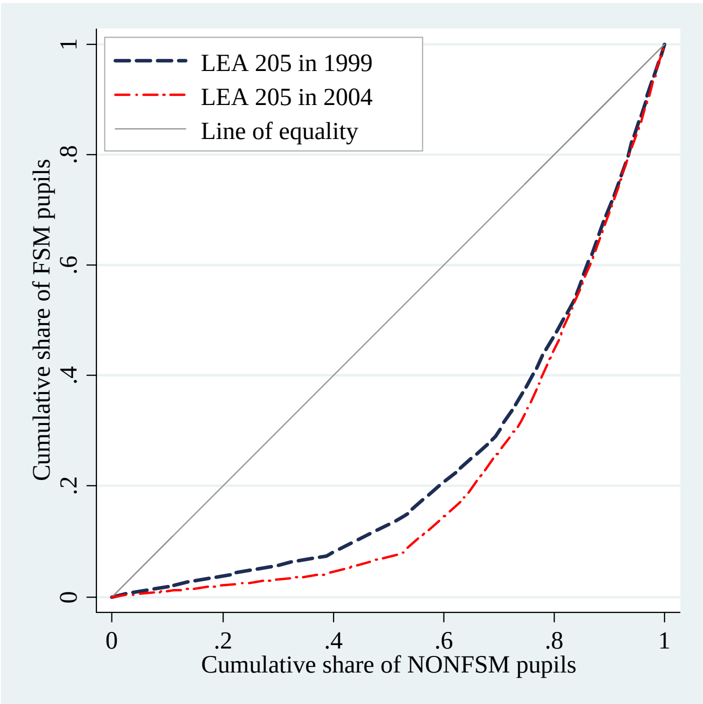
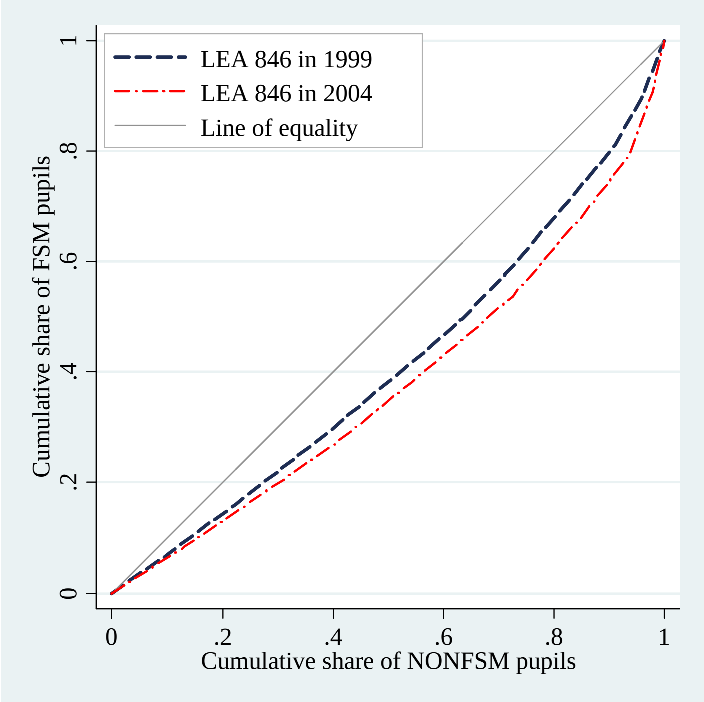


Figure 13 shows Brighton & Hove LEA had a low level of segregation in 1999 (D = 0.14), but it has risen significantly over the five year period to 2004 (growth = 37%). The skew in the segregation curve suggests concentrations of disadvantage, with one or more schools with FSM eligibility significantly above the LEA average (segregation skew = -0.12). This skew towards concentrations of disadvantage has increased (Δ segregation skew = -0.09).

Figure 13 Increase in FSM Segregation in Brighton & Hove



Using these four indicators to describe the extent and nature of segregation in an LEA, we can then identify particular trends that one might be concerned about, for example where the FSM pupils are becoming increasingly concentrated in one or two schools (often with falling rolls). Thus we might be particularly concerned if we see segregation rising with the increases in segregation concentrated at the right-hand end of the segregation curve, as was the case in Brighton & Hove during the period 1999-2004.

4.6 Is school choice increasing social segregation?

What can we conclude from the patterns of segregation occurring across England more generally? During the period in question, we do not see a pervasive increase in segregation, as was widely predicted to occur as a result of increased school choice. There are a number of potential explanations for this. Firstly, it may be that de facto school choice did not in fact increase during this period. This would be the case for example, if school choice was already being exercised through parents' choices of residential location (Gibbons & Machin, 2006) and if capacity constraints prevented the further exercise of choice. A second and related explanation is that the growth in pupil numbers in English secondary schools might have partially offset any potential segregation effect from school choice (there was a 1% increase in the secondary school population between 1999 and 2004). If the schools higher up the LEA league table of GCSE results were already full in 1999, and capacity did not significantly increase at these schools, the additional pupils would need to be taken by schools lower down the league tables, protecting them from a serious deterioration in their intake. We have undertaken some analysis of this issue. In fact, as table 6 shows, schools in all parts of the league table experienced growth in pupil numbers during this time, though this growth was lower at the very bottom of the league table. A third outcome is of course that choice has increased but has genuinely not led to increased segregation. This might occur if lower income parents were most constrained prior to the introduction of greater choice and have therefore been the group most able to benefit from choice.

Table 6 Changes in School Size between 1999 and 2004

	Mean change in school share of LEA pupils	**Mean change in FSM proportion relative to LEA**
Schools in bottom quintile of LEA league table of GCSE (5 A*-C) results in 1999	0.94%	6.20%
Quintile 2	2.82%	5.14%
Quintile 3	3.24%	1.83%
Quintile 4	2.68%	-0.52%
Schools in top quintile of LEA league table of GCSE (5 A*-C) results in 1999	2.51%	1.11%
All schools	**2.50%**	**2.54%**

Our evidence suggests that the level of school segregation needs to be of continuing concern to policy-makers, for several reasons. First, these results do provide clear evidence of rising segregation in many LEAs, notably many in London and for those with higher proportions of pupils educated at voluntary-aided schools. We need more work to understand the underlying causes of this phenomenon. Second, whilst we have not been able evaluate the causal impact of policies that give schools increased control over their own admissions on segregation, there is a significant association between the level of FSM segregation and LEAs with higher proportions of pupils in schools that control their own admissions or have explicit select by ability. Certainly, as the proportion of schools that are LEA community schools continues to fall, the level of segregation needs careful monitoring. Finally, pupil numbers in secondary schools will fall from 2005 onwards. It will be important that measures are taken to improve the ability of disadvantaged pupils to take up free places in the schools of their choice, otherwise the spare capacity that emerges in the system may well result in rising levels of segregation and in particular a concentration of disadvantaged pupils in some schools operating in deprived areas.

5 Concluding Comments

Gorard, Taylor and Fitz were the first researchers to use existing large-scale datasets to challenge the ‘crisis account’ that school choice would result in increasing social segregation and ‘spirals of decline’ for underperforming schools. Using alternative measures of segregation, we agree with Gorard *et al.’s* main conclusion that there has been no substantial across the board increase in socio-economic segregation between schools in the majority of LEAs since the Education Reform Act of 1988. However, our methods of measuring segregation do generate substantively different results to those produced by the measure of segregation devised by Gorard et al., namely the GS index. We conclude that the GS index actually overstates the magnitude of the fall in segregation in the 1990s by around 100%. Our results suggest that the level of school segregation should be of continuing concern to policymakers. Our evidence suggests rising segregation in many LEAs, particularly in London, and we found a significant association between the level of segregation in an Authority and the proportions of pupils educated at voluntary-aided schools, although this relationship is not necessarily causal.

Much of this paper is a critique of previous methods used to measure segregation in schools. For example, we suggest that the GS index is not the optimal way of measuring changes in school segregation for the following reasons:

1. GS is not bounded by 0 and 1: the upper boundary varies according to FSM eligibility, so GS is better described as an ‘indicator’ rather than an index of segregation;

2. GS is not symmetric, meaning that it is capable of showing that FSM segregation is rising and NONFSM segregation is falling simultaneously; and

3. GS is actually systematically variant to changes in overall FSM eligibility, except in the most stringent and unlikely of circumstances (the strict proportionate change in FSM); therefore we can properly describe it as composition variant. It had a tendency

to fall as FSM eligibility rises, regardless of the change in the unevenness of school's shares of FSM and NONFSM pupils.

We recognise that the GS index has meaning. It can be used, for example, to count the proportion of FSM pupils that would have to switch schools to achieve evenness. However, in this paper we have made the case for a segregation curve approach to measuring segregation. This is an approach where comparisons of the level of segregation are possible regardless of the percentage FSM eligibility (p). Therefore, it can be used in cross-sectional and time-series comparisons of school segregation. This is because segregation curve approach indices are 0-1 bounded and solely a function of the segregation curve, which itself is independent of p. The value of the index is therefore the *relative* level of segregation compared to complete evenness and complete segregation. Given how difficult it is to quantify the effect of segregation on social welfare, we suggest that the relative approach is superior. Though we have relied on the dissimilarity index for much of this article, we have not made a claim for its superiority over other segregation curve consistent indices, notably the Gini index and Hutchen's Square Root index. Researchers wanting to take a segregation curve approach to the measurement of segregation should choose the index that aligns most closely with their view of the effects of segregation on social welfare.

We do not, however, want to overstate the case for a segregation curve approach to measuring segregation. First, it cannot separate out the change in segregation due to school choice as compared to processes that change overall FSM eligibility. We take the view that it is not possible to construct an index to do this. Second, it measures the effect of segregation in an area *relative* to the maximum possible effect if pupils were completely segregated, yet we recognise that the effect of segregation on social welfare may differ in areas of high deprivation versus low deprivation. Finally, the segregation curve judges the degree of segregation in a specific way: it measures unevenness based on each school's share of FSM pupils versus their share of NONFSM pupils. We recognise that unevenness is not the only dimension of segregation; therefore researchers will continue to use other approaches too.

Deciding how best to measure segregation is complex, combining fundamentally normative judgements about what exactly one intends to measure, with more technical judgements about the appropriate properties of the chosen measure. We believe that we have made a good case for a specific approach, being open about the normative judgements we have made to reach our conclusion. We have chosen to criticise one alternative approach to measuring segregation, GS, examining its properties in detail. Further research is certainly needed to subject alternative methods of measuring school segregation, such as multilevel modelling or the isolation index, to the same level of scrutiny.

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