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Commentary

Are indices still useful for measuring socioeconomic segregation in UK schools? A response to Watts

Introduction

> "Academies 'increase divisions between the rich and poor': Study finds segregation made worse by a wider choice of schooling"
>
> Headline: *The Independent* (4 September 2013)

In a concise yet thorough commentary on the indices used typically to measure changes to socioeconomic segregation between UK (secondary) schools, Watts (2013) reopens debates about the advantages and disadvantages of different approaches. Such arguments have been well rehearsed in this and other journals (see inter alia, Allen and Vignoles, 2007; Gibson and Asthana, 2000; Goldstein and Noden, 2004; Gorard, 2000; 2004; 2007; 2011; Johnston and Jones, 2010). However, where previous debates focused on the statistical properties of the index used by Gorard in his studies of school choice policies (see especially Gorard et al, 2003 and its appendix), Watts inflicts a deeper wound, suggesting no index is particularly useful for either cross-sectional analysis or for measuring change over time ["Cross-section comparisons of schools' levels of segregation are largely meaningless" (page 1533)]. Whilst the use of these indices remains headline-grabbing (see above), Watts questions whether they are actually useful given the ambiguity of the measurement and also the rapid pace of change in the UK educational system: "the structural features of UK school segregation are such that a meaningful interpretation of changes (differences) in index magnitudes over time (across space) is highly problematic" (page 1528).

In this short response we are in broad agreement with but qualify Watts's arguments, leading us to be more optimistic about the potential for using indices in educational as in other social research. Like Watts, we focus on the particulars of the UK educational system but offer also some general comments on measurement, and the construction and interpretation of index values.

Watts's critique of index measures

In broad summary, Watts's commentary consists of three main parts. The first gives consideration to five indices—the Gorard index, the Karmel and Maclachlan index, the index of dissimilarity, the index of isolation, and the modified index of isolation (Bell, 1954; Cutler et al, 1999; Duncan and Duncan, 1955; Gorard and Taylor, 2002; Karmel and Maclachlan, 1988). Attention is paid to the mathematical relationship between the first three of these indices (they are direct functions of each other) and also to the desirable properties of indices as described by Allen and Vignoles (2007). Watts adds the distinction between composition invariance and schools invariance to the latter, recognising that an index value may be sensitive both to the changing total enrolments across schools, and to the proportion that are free school meal eligible (the standard but imperfect measure of economic disadvantage—see below). He appears to advocate a process of data transformation following Deming and Stephan (1940) but in any case notes that no index can satisfy all the properties now required.

The general observation is that where an index value is comparing one population subgroup with another, and those populations are situated in particular places (here schools but more typically residential areas), then the index value can be affected not only by the distribution of those subgroups across the places (which is what the index seeks to measure) but also the prevalence of the subgroups within the general population and/or the number

of places over which the measurement is calculated (as well as by the boundaries, often somewhat arbitrary, of the places or study region for which the calculations are made). It follows that a change in an index can arise due to demographic changes or structural changes to the system under observation, not necessarily due to an increase or decrease in segregation (or whatever else is being measured).

Structural changes are pertinent to the UK educational system. The second part of Watts's commentary moves away from a 'technical' review of the indices to a more applied consideration of what it is they are trying to measure. Watts identifies the changes to and fragmentation of the previously largely comprehensive state school system in the UK (and especially England[(1)]) through the closure, merger, rebranding and (re)opening of schools under the broadly neoliberal thrust of promoting competition and choice, occurring by means of various types of private and third sector sponsorship and a range of government-led schemes, most particularly Academies but more recently also as 'Free Schools' (Ball, 2013).[(2)] These changes and the problems of using eligibility for free school meals as a measure of low income (to measure social segregation) combine with the effects of economic and business cycles on levels of eligibility, challenging any simple explanation for why an index value differs from one time period to another. A change in a segregation index is a composite effect arising from changing numbers of pupils, changing numbers eligible for free school meals, changing numbers of schools, and changing admission policies, as well as (unobserved?) externalities including public housing policies, local public transport provision, and the effects of employment and housing markets on residential choices and access to schools. All of these potential confounders operate in tandem with what for many is the actual goal of the measurement: to understand the direct effect on segregation of the promotion of school choice (and this is before the deeper questions of whether the segregation matters, for whom and why: does it, for example, affect learning outcomes?) Here the general issue is one of establishing causation: if an index value changes then how do you establish the cause of the change, especially in a dynamic and changing system? Can indices of segregation that were originally developed for measuring entrenched patterns of ethnic segregation in particular US cities really be applied in more fluid contexts?

Additionally, in switching from ethnic to social segregation we encounter the problem of making an empirical connection between some conceptual idea of what is meant by social segregation and that which actually is measurable. There is agreement in the literature that free school meal eligibility is a poor proxy for low family income let alone exposure to poverty, deprivation, or social exclusion (Hobbs and Vignoles, 2009). Unfortunately, it is also the only measure available for individual pupils within state-funded schools (even less is known about pupils in fee-charging schools). Whilst Watts is correct to observe that there are school segregation studies based on ethnicity, and that ethnic categorisations are more 'stable' than whether somebody is eligible for free school meals or not, to use ethnicity data is not a solution if what the analyst is interested in understanding, is, for example, whether richer and poorer pupils separate in the transition from primary to secondary schools

[(1)] Watts refers throughout to the UK but its four constituent countries have separate education systems and produce different datasets. Many of the empirical studies of school segregation have been of England only.

[(2)] Academies were originally launched by the Labour government (1997–2010) as a means to target investment into schools within deprived neighbourhoods, allowing those schools to have charitable or private sector backers and to operate outside the direct control of a local authority. The programme has subsequently been extended as a means to allow many more schools to opt out of local authority control and has been imposed on 'failing' schools. Free Schools, although inspired by the Swedish education system (Bunar, 2011), are really only a continuation of the Academies programme now promoted as a means to give parents and teachers the opportunity to create new schools if they are unhappy with existing provision within their local area.

(Burgess et al, 2008). Ethnic categorisations are themselves contentious but presumably not affected by economic cycles.[3]

The third part of Watts's commentary focuses on spatial indices of segregation, including reference to work undertaken by one of us (Harris, 2011; 2012). These indices make comparisons of pupils in geographically proximate schools where the level of association or—perhaps—competition between the schools is defined by a spatial weights matrix (the presence of which in the equation characterises the index as being spatial). Watts's review of that work is accurate and perceptive. He is correct to observe that the spatial weight matrices employed in these indices have utilised imperfect and simplified measures of actual competition between schools, being based only on the observed admissions of pupils to schools. Arguably, that competition would be better-defined using data about the applications made to secondary schools as opposed to the final admissions, were the former datasets readily available.[4] Doing so would allow the weights matrix to reflect the actual preferences expressed by pupils or their parents rather than reflecting an outcome that mixes those preferences with the consequences of other peoples' preferences upon the possibility of being admitted to the school, as well as any covert or explicit methods of selection a school might employ. Yet, even if applications data were available, Watts is right that issues of prior sorting into neighbourhoods and into primary schools—"mortgage by postcode" as Watts describes it (page 1533)—would remain relevant and uncorrected for; as also would the distinction between the applications people make and those they would like to make were they not in a system of competition for places typically giving priority to those living closest to a school—the dominant measure used to allocate students to schools in most local authorities.[5] We can agree that in the studies Watts cites, it is postresidential sorting that the index seeks to measure and that that sorting is not simply a function of individual school choice.

Watts is also correct in saying that the measures employed by Harris (2012; see also Harris, 2013) are biased—they underestimate (and potentially even exclude) the differences in the intakes of what *could be* competing schools. The reason they are biased is that they give most weight to secondary schools that draw the greatest proportion of their intakes from the same primary school. In this sense the secondary schools are observed to be 'competing'. However, consider the case where there are two secondary schools, side by side, and one is able to exert a process of selection that excludes pupils from a particular primary school located, for example, in a low-income estate. Under the formulation described, these schools are no longer taken to be competing, although one of the secondary schools is surely benefitting at the other's expense. The resultant index score is therefore downplaying the differences we might have discovered between those schools had the matrix been constructed in a different way. Even in the less extreme case of the one school somehow acting to dampen the number of applications it receives from the estate, the consequence will be to reduce the apparent strength of competition between the two schools.

Note, however, that the bias is downward: the index values obtained are conservative estimates summarising local differences between schools. If, as Harris (2012) finds, there is often a marked reduction in the proportion of free school meal eligible pupils entering selective schools (those setting an entrance examination) as opposed to other surrounding schools,

[3] However, the categories deployed by the Office for National Statistics, and applied to other datasets, were changed between the 1991, 2001, and 2011 Censuses.

[4] Parents can express a ranked preference for which school they would like their child to attend but may not receive an offer for their top or indeed any preferred school if there are no places available. Put simply, the probability of a successful preference increases the closer to the school the person lives.

[5] There are national guidelines to which the admission authorities responsible for allocating students must apply, but variations are possible depending on individual schools' status (including Academies and Free Schools and also some in whose management various religious bodies are involved).

then it is evidence of the (postresidential) social sorting that selective schools can create. Of course, that selective schools recruit proportionally fewer free school meal eligible pupils is hardly surprising given the relationship between material advantage and educational attainment. Nevertheless, if selective schools 'underrecruit' such pupils compared with other locally competing schools then it does ask questions of those who advocate selective education systems as a means to enhance social mobility [albeit that one solution to the underrecruitment might be to increase the number of selective schools available (Harris and Rose, 2013)]. The same approach can be employed to compare the intakes of, say, recently established Free Schools and determine whether they really have been as socially selective and as 'cherry picking' as their critics presume.

In any case, if one is unhappy with the bias it can be changed by respecifying the weights matrix. Watts gives one way this can be achieved based on the idea of each school's core catchment area where that catchment can be defined either as the places where proportionally more of the school-age population attend the school (as in Harris and Johnston, 2008) or as the places where the absolute number is greatest (Harris and Johnston, 2011; Singleton et al, 2011). Doing so would need to recognise that those catchment areas are not fixed but can change substantially over relatively short periods (most likely contracting around the most popular schools). This relates to Watts's point that the weights matrix inevitably changes from year to year but is not entirely true: it is fully possible to hold the matrix constant and see if differences between local schools have increased or otherwise given the definition of how they were competing in some initial time period albeit that any changes may be exogenous to the schools themselves (Harris, 2014). Unfortunately, the method Watts is suggesting does not avoid the problem he wishes to avoid: the core catchment areas are also based on observed patterns of admission and therefore are affected both by admission practices and prior residential sorting.

Another method, less computationally demanding, is to use a simple binary matrix whereby two secondary schools are defined as competing if both recruit a threshold number (or proportion) of their intake from the same primary school (but this still encounters the problem of prior sorting into primary schools). Alternatively, a distance-based approach can be used, simply defining competition between schools as the inverse of their distance apart [cf Allen (2007), although an inverse distance weighting is not applied] or, perhaps better, the travel times between them. These distance-based approaches make intuitive sense: given it is generally easier to travel a short distance to school and given the distance criterion that applies to many admission procedures, it seems reasonable to assume that geographically proximate schools are, in some sense, competing. The problem is in deciding over what distances that assumption remains true.

All of this discussion is less a critique of spatial indices, per se; it is a question of how best to operationalise the weights matrix in a meaningful and defensible way. More generally, it is an issue of comparison: if we are going to make a comparison between places then which places should we pick? The choice matters in much the same way that the standard segregation and dissimilarity indices, although related, are not measuring the same thing and will therefore produce different results (the first compares population subgroup A with not A, the second compares subgroup A with a second subgroup B). What to compare with what is a salient issue regardless of whether the comparison is of different population subgroups living in the same places (the standard segregation index approach), or the same population subgroup living in geographically proximate places (the spatial approach).

Some additional comments

It should be clear from the preceding discussion that we are in broad agreement with the thrust of Watts's argument. Specifically, we agree that:

(1) There is no perfect index. Even if there were, measurement issues would remain. This is true for all studies of segregation, not just those concerned with the particularities of the UK education system.

(2) Those particularities are nevertheless important. Of especial note is that the rapid and ongoing changes in the UK's educational landscape, combine with ambiguity about what free school meals eligibility actually measures to make assessment of social segregation between schools—particularly changes to it—problematic.

(3) The spatial indices used in our own work employ a loose and imperfect definition of competition between schools. More generally, any index that incorporates a spatial weights matrix in its formulation will encounter the issue of how best to define the weights.

These are far from trivial issues. However, does it follow, as Watts implies, that indices are no longer useful and that "locally focused case studies represent a superior approach" (page 1528)? In answering this, we make six qualifications to Watts's argument.

First, too much authority has been given to treating differences (or changes) in any chosen segregation index as the end point for enquiry as opposed to motivating deeper understanding of what caused the numeric change. There is an analogy here with indices of segregation applied to ethnicity data from the 2001 and 2011 Censuses for England. From these data it is straightforward to show that in many urban places there has been a reduction in (relative) residential segregation between, for example, the White British and Asian groups over the intercensal period—the groups are more evenly distributed. However, that finding is not in itself sufficient to infer that processes of separation are diminishing because it is also true that in many of those same places there has been a marked decrease in the number of (self-categorised, from the options available) White British people living there. Our point here is not to make a statement on whether the UK has become more or less ethnically divided but only to emphasise that where an index is used as a descriptor to compare places over time it does not, in itself, explain any changes. An index is merely description but it can be the launch pad for explanation—although, as Johnston et al have argued in a number of papers, including a response to Watts's earlier paper (Johnston et al, 2008), such indices may indeed say little about the local contexts that Watts now brings to centre stage: indices may not change at all but the ethnic diversity of each of the constituent areas (in studies of residential patterns) or schools can nevertheless change considerably. A central question is what is it that studies of school segregation want to 'explain', if anything? Many have segregation as the dependent variable, suggesting that changes in public policy can account for the degree of segregation. Others focus on the local milieux that result.

Second, it is an unfortunate consequence of some of the heated arguments about how best to measure social segregation within the educational system that they have lost sight of Massey and Denton's (1988) demonstration that no single index is sufficient. Admittedly, Massey and Denton are writing in the context of measuring residential and ethnic segregation within American cities but it is hard to see why their conclusion should not apply to educational research also: "segregation is a multidimensional phenomenon that should be measured by a battery of indices rather than one single index" (page 312). Although some of these dimensions—evenness, exposure, concentration, centralisation, and clustering—move together they are not perfectly correlated and more than one is required to gain a fuller understanding of the sorts of processes that are occurring.

Third, Watts's commentary makes no reference to cross-sectional analyses that compare the segregation between schools with that between neighbourhoods (howsoever measured). Finding that the former is sometimes greater than the latter is an indication that social

sorting occurs through the educational system (Johnston et al, 2006; 2007). It seems overly pessimistic to argue, as Watts does, that the populations of schools and neighbourhoods are so heterogeneous that cross-sectional analyses are inevitably meaningless. Or maybe it is optimistic: if Watts were right in his claim we would not need to worry about segregation because there would be none!

Watts also makes no reference to the emergence of model-based approaches for estimating segregation (Goldstein and Noden, 2003; Leckie et al, 2012). These are no simple panacea for the issues that he raises but they do have some useful capabilities and could form a basis for a research programme on changing segregation. They can handle binary outcomes such as free school meal eligibility with a binomial model, as well as multigroup ethnicity via a multinomial model. The degree of segregation is estimated as a variance term around a mean, and with confidence intervals. This is important as apparent increases in segregation may merely be the result of increased 'stochasticity' due to falling school rolls. Moreover, as the variance is estimated in relation to the mean, it takes account of the overall, and possibly changing, magnitude of the proportion. These models are also capable of modelling at multiple scales and there is no requirement of exact nesting of units, so that between-school and between-neighbourhood variation can be analysed simultaneously in a cross-classified model. The multiple membership version of the model allows individual pupils to belong to different schools at different times. It is also possible to model spatial segregation at any scale by a multiple membership model in which spatial weights can be included in a flexible manner. Admittedly, neighbourhoods have to be defined and so to do spatial weights, but the approach allows the comparison of goodness-of-fit measures for alternative specifications. Finally, explanatory variables can structure the variance to ascertain, for example, the degree of segregation in different types of school.[6]

Fifth, we acknowledge that dissatisfaction with the problems of segregation indices led to one of us developing, with other colleagues, a different approach—specifically, a typology of area types based on the relative mix of the majority and minority population groups (see, for example, Johnston et al, 2002). The main application of this typology has been in ethnic residential segregation and used, for example, to show that a lower proportion of London's population are now living in dominantly white neighbourhoods than a decade ago (Johnston et al, 2013). However, a similar ethnicity-based typology has been applied in educational research (Johnston et al, 2005). There is no reason why the approach could not be extended to studies of social segregation to see which schools have the greater or lesser concentrations of free school meal eligible pupils (or, ideally, a better measure of low income) and how those patterns shift over time. No typology is perfect either and will require care in its interpretation. Nevertheless, it is not without irony that a previous critique of the typology used by Poulson and Johnston (2006) to consider changing levels of segregation (in Bradford and Greater London especially) leads Watts to the following conclusion: "index measurement is a succinct means of measuring change, but needs to be supplemented by other summary statistics" (Watts, 2008, page 2031)—a comment with which we heartily agree.[7]

Finally, we are curious about Watts's claim that locally focused cases studies are superior to using segregation indices. Our curiosity should not be interpreted as antipathy to such studies. Whilst it is not entirely clear exactly what Watts is advocating (no example is given) we would readily agree that more idiographic and often qualitative case studies such as those

[6] Gorard et al (2013) write that "we do not need the complexity of analysis that they [Leckie et al, 2012] propose, based on their misunderstandings" (page 190). This sentiment is unnecessarily dismissive. What Gorard et al describe as a misunderstanding is actually a differing perspective on what causes uncertainly in index values even when you appear to have a complete census of a population.

[7] We are, perhaps, being unfair: there is no necessary contradiction in advocating the use of indices in one area of social research but not in another.

brought together in Butler and Hamnett's (2011) fascinating book about London's East End offer important insights about what school choice actually means to people 'on the ground' and how they act or are limited in their ability to game the system in response to what is on offer (see also Dench, 2006; Gewitz et al, 1995). The issue is not to dispute the value of locally focused studies, only to question whether they and index-based approaches are necessarily in opposition. That qualitative studies have tended to highlight more of the insidious effects of school choice policies whereas index-based approaches have generally suggested the consequences of social segregation have been relatively slight is useful for a balanced understanding both of general trends and also of local variations from them.

The indices Watts reviews are global measures, essentially averages, but they emerge as the sum of their parts and can be used to identify interesting localised cases for further study. This is particularly the case for the spatial indices reviewed, the first step of which is to create a distribution of values across a study region that can be looked at to consider geographically localised deviations from the norm.[8] Even with the more conventional aspatial index, it is often forgotten that Gorard et al's (2003) book on schools, markets, and choice policies included not only the index of segregation but also segregation ratios looking at changes to specific schools, as well as qualitative research [Watts cites Taylor et al's (2003) paper that uses segregation ratios to undertake case studies of four schools]. Watts's assertion of the superiority of local case studies is not demonstrated; in any case, we do not want to create a competition between different methodological approaches. Instead, we simply note that judicious use of index values can motivate precisely that sort of work that Watts appears to advocate.

In conclusion

Watts has written an insightful and useful commentary that provides excellent coverage of the problems of applying indices to measure social segregation between (secondary) schools in the UK. His question—are indexes still useful—is never explicitly answered although it is clear he is sceptical, asserting instead the superiority of a localised case studies. For the most part, we are in agreement: considerable care is required in interpreting simple descriptive measures applied within complex and changing (educational) systems. But can indices remain useful? Here we are more sanguine than Watts. *Caveat emptor* means only to exercise caution. There may still be gain from the purchase.

Richard Harris, Ron Johnston, Kelvyn Jones, Dewi Owen
School of Geographical Sciences, University of Bristol

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[8] Applications of local spatial statistics have also gained currency in other areas of segregation research, being employed, for example, in studies of changing patterns of ethnic clustering (Poulsen et al, 2011a; 2011b).

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